

NONNATIVE PLANT MANAGEMENT PLAN
FOR
GUILFORD COURTHOUSE NATIONAL MILITARY PARK
GREENSBORO, NORTH CAROLINA *

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INTRODUCTION

Nonnative plant invasions have wide-ranging impacts that compromise natural resource management goals. Controlling invasive nonnative plants on National Park System lands has, consequently, become a high priority. The National Park Service (NPS; U.S. Department of the Interior) is committed to protecting the natural and cultural resources within its parks and is “required by law to keep ... parks as unaltered by human activities as possible (NPS, 1996).” The proliferation of invasive nonnative plants [which, by definition, have been introduced deliberately or accidentally by humans (NPS, 1996)] has been linked to alterations in ecosystem processes, losses in native biodiversity, and environmental degradation. While the effects of invasive nonnative species have long been recognized by the Park Service, the agency has only recently (i.e., within the past 15 years) begun to elaborate an integrated, comprehensive management strategy to deal with the issue. The overall strategy is based on the concepts of integrated pest management and adaptive governance and considers a number of tenets including, but not limited to, prevention, inventorying, prioritization, treatment, outreach, and monitoring. This approach may represent the Park Service’s most viable option for controlling invasive nonnative plants and keeping parks “as unaltered ... as possible.”

The management history of the Guilford Courthouse National Military Park (GUCO) mirrors the evolving approach to nonnative plant management within the Park Service. Nonnative plants have been seen as a distraction to historic interpretation and a threat to conservation goals at the park since the early 1930’s, when the Park Service began operations at the site. Early control efforts focused on removing nonnative plants and planting native species. The *ad hoc* nature of these efforts, stemming from a lack of baseline information on nonnative plants in the park, and the failure to address the issue at the larger landscape level, resulted in only limited gains in terms of controlling or eliminating invasives. More recently, the Southeast Nonnative Plant Management Team (SE-EPMT; Fraley et al., 2007) has used integrated pest management principles and a more systematic treatment approach to reduce populations of nonnative plants within the park. While these efforts have been moderately successful in controlling certain problem species (e.g., wisteria), the SE-EPMT and park managers recognize that several basic components are still missing and must be addressed in order to achieve long-term management goals.

The following report provides some of the basic information, analyses, and recommendations that have been missing or incomplete in nonnative plant control efforts at GUCO. The SE-EPMT and the resource management staff at GUCO coordinated this project with the Ecological Restoration Program in the Department of Forestry and Environmental Resources at North Carolina State University (NCSU). In the summer of 2007, we conducted a census of nonnative forest plants at the park, identifying and mapping species throughout the park. Based on this information, we prioritized nonnative species for control and made recommendations for preventive strategies, including education/outreach initiatives. Treatment and monitoring recommendations are made throughout and are presented by individual species in the final section. We hope that this plan will better inform management decisions, increasing the efficacy of control efforts at GUCO.

A. Guilford Courthouse National Military Park and Management Goals

The Guilford Courthouse National Military Park (GUCO) is a historically significant site that protects important ecological, as well as cultural, resources. The 89 hectare (220 acre) property, located in the city of Greensboro, Guilford County, North Carolina (36° 7' 53" N, 79° 50' 47" W; population 237,000), contains at least part of the area on which the pivotal Battle of Guilford Courthouse was fought (Figure 1). On March 15, 1781, Major General Nathaniel Greene led a battalion of almost 4,500 American servicemen against a smaller British army of 1,900 troops commanded by Lord Charles Cornwallis in a heated, tactical battle near the county judicial seat (NPS, 2006). Although American troops were forced to retreat, Cornwallis's unit suffered heavy losses at Guilford Courthouse and surrendered seven months later at Yorktown, the last major land battle of the Revolutionary War.

While GUCO is first and foremost a military park, it has become an important natural area in its own right. Greensboro's rapid urban expansion over the past half century has drastically changed the once-rural setting of the park; today, GUCO resembles "a small nucleus of green-space encapsulated within a frenzied and ever-thickening 'electron cloud' of residential and commercial development (Hiatt, 2003)." Ecological communities within GUCO may serve as a refuge for plant and animal species that are scarce or non-existent in the developed and fragmented surrounding areas (White et al., 2003).

Management History

At the time of the battle, and for many years after, the area of the battlefield comprised an essentially-rural scattering of cultivated fields in an oak-hickory-pine forest matrix. On small private holdings, farmers grew corn and other crops and grazed livestock in pastures and the surrounding woods (Hiatt, 2003). In 1785, the small town of Martinville was established on the property around Guilford Courthouse. Though the town never developed into a major commercial or population center and it slowly declined after the county seat was relocated in 1809, its establishment was accompanied by the construction of many new roads and the expansion of cultivated lands on and around the battlegrounds (Hiatt, 2003). In spite of these developments, the battlefield remained relatively intact well into the mid-1800's. In 1857, a visitor to the battlefield remarked:

The face of the country answered so well to the descriptions which I had read, and there had been apparently so little change since the day of the battle, that there was no difficulty in recognizing the localities (Strother, 1857).

By the time of the nation's Centennial, renewed interest in commemorating Revolutionary War sites had stimulated efforts to memorialize the Battle of Guilford Courthouse (Hiatt, 2003). In 1887, Guilford Battle Ground Park was established by the Guilford Battle Ground Company (GBGC) to preserve and commemorate the battlefield. The park originally comprised approximately 20 ha (50 ac) of the central battle grounds. In spite of stated intentions, the GBGC drastically modified the landscape, managing the park essentially as a pleasure grounds. Among other activities, the company erected numerous commemorative and leisure structures,

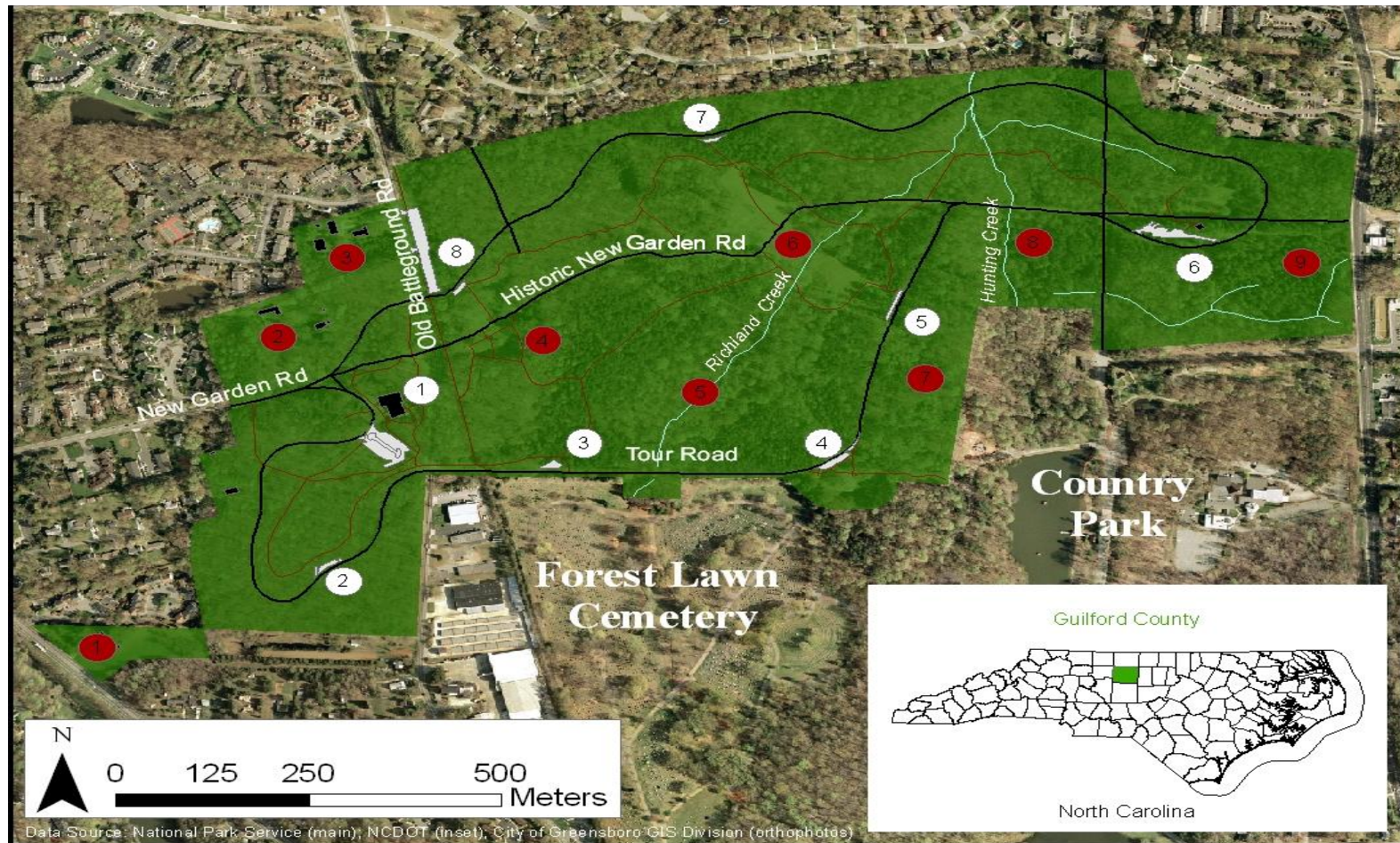


Figure 1. Map of Guilford Courthouse National Military Park. The 89 hectare park (shaded green) commemorates the Battle of Guilford Courthouse. White circles mark 8 Tour Stops. Red circles mark areas that are referenced throughout this report: 1) Kotis Tract; 2) Utility Building and Superintendent's Quarters; 3) Andrews Tract; 4) Greene Monument; 5) Lake Wilfong bed; 6) "Schenck's Field"; 7) petting zoo site; 8) Lake Caldwell bed; and 9) Drive-in Tract.

constructed an artificial pond (Lake Wilfong), and altered native plant communities through extensive plantings and removals. The GBGC's management approach is likely responsible for much of the environmental and ecological degradation that the park has subsequently experienced.

In 1917, Guilford Battle Ground Park became the first Revolutionary War site declared a National Park, and was thereafter known as Guilford Courthouse National Military Park. Management of the park was transferred to the War Department under a congressional mandate "to preserve the battlefield for professional and military study", an objective that suggested a "sounder approach to resource management" than had been previously employed at the park (Hiatt, 2003). The War Department, however, continued the GBGC's intensive management approach. In 1933, when the National Park Service (NPS; hereafter referred to as the Park Service) began operations at GUCO, this approach was finally abandoned in favor of historic preservation and rehabilitation (White et al., 2003). Since then, many of the incongruous structures and modifications installed by the Guilford Battle Ground Company have been removed, and highly modified areas have been, for the most part, allowed to regenerate naturally to forest. In some cases, as with the area of the drained lake bed, trees and shrubs have been planted in an effort to speed up the reforestation process. Native species have been primarily used for these plantings though some nonnative plants have also been included (Hiatt, 2003). Nonnative plants have occasionally been favored for certain applications, such as the adornment of the administrative area and the superintendent's quarters. Several small sections of the park that either contained important commemorative structures, such as the Greene Monument, or were believed to have been open agricultural land at the time of the battle, have been continuously maintained as lawn or meadow. In recent years, the Park Service has also begun an active campaign to eradicate some of the problematic invasive plants (i.e., species capable of spreading within undisturbed sites, forming dense infestations, resisting control efforts, and/or reducing native plant diversity) in the park. These landscape treatments have presumably helped rehabilitate ecological form and function in the park's natural communities.

Physical Description

Located in the Carolina piedmont, the park has physical features typical of the region. A gently rolling topography characterizes the upland portion of the park, although several relatively broad, flat sections also exist. Steep east-facing slopes occur in separate sections adjacent to the park's two small perennial streams, Richland Creek and Hunting Creek (Figure 1). Relatively-narrow floodplains make up the bottomland portion of the park. Elevation ranges from 241 meters (790 feet) near the confluence of the park's two streams to 265 meters (870 feet) near the Visitor's Center (White et al., 2003). The park and its waterways drain into the upper Cape Fear River.

GUCO is underlain by the shear zone between two geological units: the Charlotte Belt, which consists primarily of porphyritic granite, and the Carolina Slate Belt, which is primarily biotite schist (Mininger and Nunnery, 2001). The park's upland soils developed residually from these parent materials. Three types of the Cecil soil series (Typic kanhapludults) dominate the upland portion of the park: Cecil sandy loam, Cecil sandy clay loam, and Cecil-Urban land complex (Soil Survey Staff, 2006; Figure 2). Intensive cultivation of these soils has resulted in

significant erosion losses in all uplands of the region. Management practices at GUCO, particularly under the GBGC and the War department (1917 – 1933), exacerbated erosion problems in the park. Slopes and bottomlands in GUCO contain two other soil types, Madison sandy loam and Wehadkee silt loam. Madison sandy loam (Typic kanhapludults) is found on the steep slopes adjacent to both of the park's creeks, and, in particular, near their confluence. The bottomland portion of the park, essentially the floodplains of Richland Creek and Hunting Creek, contains Wehadkee silt loam (Fluvaquentic endoaquepts).

The climate at GUCO is mild and wet. Data from a Wetlands Determination (WETS) station in Greensboro, NC indicate that over a 29 year period (1971 – 2000) the mean annual temperature was 14.4°C (58°F) and mean annual precipitation was 1.10 meters (43.14 in.) (NRCS, 2002). The average length of the growing season (number of days without an air temperature below 32°F) estimated from data recorded at the Greensboro WSO Airport from 1951 to 1980 was 199 days (Perry, 1998).

Landscape Context

The area surrounding GUCO is a mix of residential/commercial properties and semi-natural park-like landscapes. The park is bounded on the north and west by “a nearly unbroken arc of residential development – including single-family homes, townhouse communities, and apartment complexes (Hiatt, 2003).” Housing along the northern boundary is in close proximity to the property line, and several walking trails have been established between these communities and the park. GUCO shares its southern boundary line with (from west to east) residential and commercial properties along Old Battleground Road, Forest Lawn Cemetery, and Greensboro Country Park. The latter property is a 79 acre recreational area that forms part of the larger Guilford Court House Battlefield landmark district (~ 140 ha) of which GUCO is the centerpiece; the nearby Tannenbaum Historic Park is also part of the National Historic Landmark. This district was established in 2001 to preserve topographically intact areas that were part of the battlefield but were not federally protected (GBC, 2005). Country Park and GUCO are connected by two paved trails that provide pedestrian access between the parks. GUCO shares its eastern boundary with Lawndale Drive, a heavily trafficked local road lined with commercial and residential properties. In this way, GUCO is bounded within a suburban matrix of housing and businesses.

Internal Features

The park's infrastructure and intrusive features such as public roads traverse and partition the battlefield. The most prominent infrastructural feature at GUCO is the Tour Road, a 2.4 mile loop that provides vehicle and pedestrian access to 8 interpretive stops scattered throughout the park. The Tour Road spans almost the entire length of the park and effectively divides the park into inner and outer sections. Most of the interpretative features, walking trails, and major landscape components of the battlefield are represented inside of the main tour loop. The section outside of the Tour Road is a relatively narrow strip of mostly-forested land that extends to the park's boundary line; in wider sections, the forest serves as an effective visual buffer between

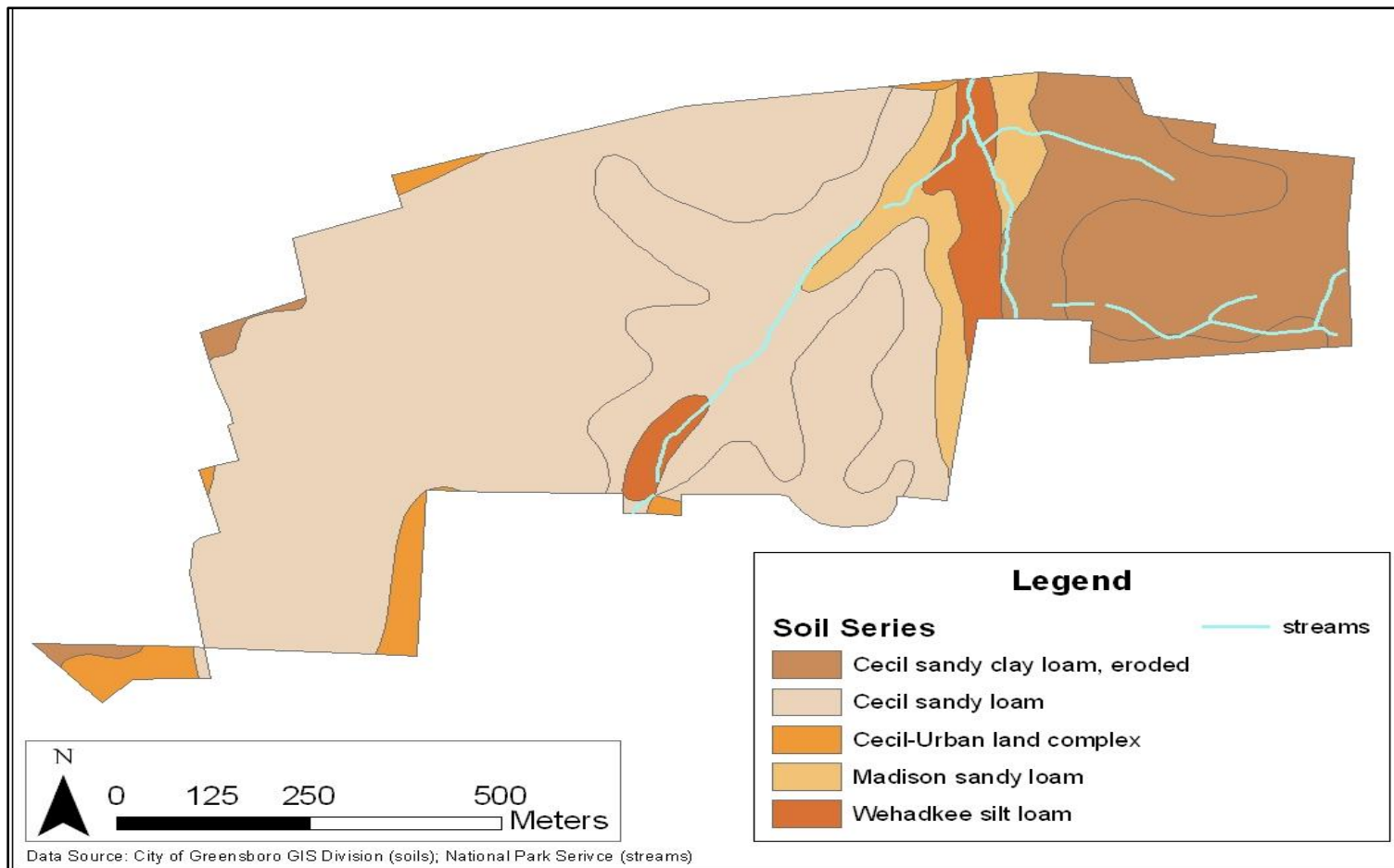


Figure 2. Soils of Guilford Courthouse National Military Park. Upland areas are dominated by the Cecil soil series. 3 types of the Cecil series have developed within the park as a result of past land use and environmental conditions. Steep slopes adjacent to the park's creeks contain Madison sandy loam, and floodplains contain Wehadkee silt loam. Lines on map mark changes in soil type and/or slope.

neighboring properties. Two city streets (New Garden Road and Old Battleground Road) further divide the battlefield as they cut across the western third of the park.

While important as access routes, roads and trails compromise the historical accuracy and ecological integrity of the park's landscape. With the exception of historic New Garden Road, the current network of roads and trails in no way resembles the few transportation routes that existed in the area at the time of the battle (Hiatt, 2003). Furthermore, new roads and trails intersect many important battle-era locations, compromising the historic scene and limiting the interpretative value of these important sites.

The relatively extensive network of roads and trails causes adverse ecological effects by increasing habitat fragmentation and providing entry routes for invasive species. The park's trails and roads, to some extent, disconnect adjacent areas of forest and create increased edge habitat. Forest fragments can be ecologically impoverished relative to tracts of continuous forest because of "edge effects" (changes in biotic and abiotic conditions in the forest interior due to increased exposure to conditions in adjacent ecosystems; Murcia, 1995), reduction in extent of the forest interior (Whitcomb et al., 1981), and increased propagule pressure from invasive species (Alpert et al., 2000). Increased vehicle and foot traffic around forest fragments perhaps marginalizes otherwise intact habitat for some animal species by increasing noise and disturbance around the forest edge (Spellerberg, 1998).

Increased visitor traffic may also mean increased transport and introduction of invasive plants (Brothers and Spingam, 1992). Many seeds and other propagules are spread inadvertently by vehicles and pedestrians. The highly disturbed forest edge habitats that have been created and maintained along trails and roads at GUCO may provide appropriate conditions for the establishment of invasives (Alpert et al., 2000). Forest edges within the park support a high number of nonnative (and potentially invasive) plants; at least 38% of all nonnative plant occurrences recorded during the census described in this report were within 6 m of features that marked forest edges (roads, trails, and boundaries), though this area covered only about 20% of the total land area¹.

Ecological Communities

GUCO contains several distinct plant communities. A natural community is defined as "a distinct and reoccurring assemblage of populations of plants, animals, bacteria, and fungi naturally associated with each other and their physical environment (The Nature Conservancy, 1981)." Most of the dominant plant assemblages occurring within GUCO are not classified as "natural" because they have developed, in large part, as the result of human-induced disturbance (White et al., 2003). Of the 11 vegetation associations identified at GUCO in a recent plant inventory conducted by NatureServe (White et al., 2003), only four are "natural" while the rest are either "semi-natural" or "nonnative-dominated", using the United States National Vegetation Classification (USNVC; Grossman et al., 1998; Anderson et al., 1998).

¹ This probably underestimates the abundance of nonnatives in edge habitats because the features used to define these areas do not border all forest edges in GUCO and, in some sections of the park, features such as the property line do not mark forest edge (e.g., between the sections of continuous forest that extend from GUCO into Country Park).

In keeping with the historical rehabilitation of the battlefield, most of the park has been allowed to regenerate to forest since 1933. At the time of the battle, approximately three fourths of the estimated 400 ha (1,000 acres) of battleground were under forest cover (Baker, 1995). Today, approximately 90 % of the park (80 ha) is forested (Hiatt, 2003).

GUCO's forest is a mix of successional and "climax" community types (Grossman et al., 1998). NatureServe (White et al., 2003) lists the following forest communities as occurring in GUCO: Virginia Pine Successional Forest; Shortleaf Pine Early Successional Forest; Successional Loblolly Pine – Sweetgum Forest; Acidic Piedmont Mesic Hardwood Forest; Tulip-tree – Hardwood Successional Forest; Piedmont Dry – Mesic Oak – Hickory Forest; Southern Red Oak – White Oak Forest; and Piedmont Small Stream Sweetgum Forest. The successional forest types are not classified as "natural" because of the potentially-strong influence of past land use on their development and the greater abundance of invasive plants within them (White et al., 2003). Indeed, although invasive plants are present throughout the park, infestations are densest in successional forests and other highly disturbed sites.

The more-intact forest communities in GUCO support a diversity of plant and animal species that may no longer exist in the surrounding suburban landscape (White et al., 2003). The oak-hickory and mixed hardwood assemblages in the park contain many understory and herbaceous species that are less common in heavily disturbed and fragmented forests (Walker and Oswald, 2000). The park serves as a refuge for a number of forest herbs that may be uncommon in the surrounding suburban matrix, including Virginia snakeroot (*Aristolochia serpentaria*), black bugbane (*Cimicifuga racemosa*), horsebalm (*Collinsonia canadensis*), striped gentian (*Gentiana villosa*), Carolina lily (*Lilium michauxii*), and foamflower (*Tiarella cordifolia*). Although these species are not particularly rare throughout their ranges, they may be poorly adapted to heavily disturbed sites and therefore at a competitive disadvantage in the fragmented forest landscape of suburbia (Levine et al., 2003). In GUCO, these species are by no means abundant and, in some cases (e.g., striped gentian and horsebalm), may be limited to a few individuals or small patches within the oak – hickory, beech slope, or small stream communities. As White et al.(2003) concluded, these relatively-intact forest communities warrant highest conservation priority at GUCO.

Forest communities in GUCO support animal species that are perhaps similarly affected by habitat reduction. Birds and mammals are among the most conspicuous inhabitants of GUCO's forests, and the park is appreciated as "an oasis for wildlife" by local birders (Burnette, 2003). GUCO is home to many more-secretive animals as well. During the 2-month nonnative plant census described in this report, we casually observed at least 9 members of the park's herpetofauna (Appendix 2), including: copperhead (*Agkistrodon contortrix*), American toad (*Bufo americanus*), worm snake (*Carphophis amoenus*), black rat snake (*Elaphe obsoleta*), rough green snake (*Opheodrys aestivus*), slimy salamander (*Plethodon glutinosus*), green frog (*Rana clamitans*), eastern box turtle (*Terrapene carolina*), and garter snake (*Thamnophis sirtalis*). Although these are all fairly common species, their habitat requirements are, still, perhaps more likely met within the park than in the developed areas surrounding it. The park's streams, in spite of being relatively small and highly modified in some areas, support a surprisingly high diversity of fishes: in a survey conducted by the National Park Service in 2004, 14 species were identified in park waters (NPS, 2006). Given the intensity of development in surrounding areas, the park undoubtedly provides important habitat for a wide variety of plants and animals.

Non-forested lands are a relatively minor component of GUCO's contemporary landscape but are nonetheless important historically and ecologically. Approximately one-fourth of the battle field was in cultivation or otherwise cleared at the time of battle (Hiatt, 2003). During the battle, American forces formed three defensive lines across the landscape, with the first and third lines maintaining positions "partially in the rear" of separate clearings (Hiatt, 2003). The present-day clearing between Tour Stops 5 and 7 was believed to mark the site of the American third line. This location was based on Judge David Schenck's (original park founder and GBGC president) interpretation of a third line position west of Hunting Creek. More recent analyses place the third line approximately 400 meters east of Schenck's position, discounting the current placement of the park's central clearing (Baker, 1995). Current treatment recommendations call for the establishment of clearings west of the first and third lines and the replanting of "Schenck's field" in order to "bring the battlefield landscape into a better state of correspondence with its conditions at the time of the bloody clash (Hiatt, 2003)." Schenck's field is currently maintained as a meadow by yearly or twice-yearly mowing. Smaller clearings are located throughout the park around monuments and historic sites; these are mowed frequently (approximately once every 2 weeks during the growing season) and maintained essentially as lawns.

The park's maintained clearings support both semi-natural and nonnative species-dominated plant communities. Two community types have been discerned within the park's mowed areas: Blackberry – Greenbriar Successional Shrubland Thicket and Cultivated Meadow (White et al., 2003). Shrubland Thicket occurs in areas that are mowed occasionally (once every 2 to 5 years). This community type is dominated by, as the name suggests, blackberry (*Rubus* spp.), and may contain greenbriars (*Smilax* spp.) depending on landscape position and other factors. Herbaceous old field species persist wherever there are gaps in the blackberry canopy. These thickets are often found in close proximity to the park's cultivated meadows, which are maintained by at-least-yearly mowing. Cultivated meadows are nonnative-species dominated grasslands that can also support a high diversity of native herbaceous species. Schenck's field is the largest cultivated meadow in GUCO; smaller examples of this community type occur around most of the park's other monuments.

Several patches of the nonnative-dominated Wisteria Vineland community type were also recognized within GUCO (White et al., 2003). These are essentially monocultures of wisteria (*Wisteria japonica* and/or *W. sinensis*) that may have formed where disturbance patterns promoted the vine's spread from previous plantings. In such situations, wisteria climbs and covers all woody vegetation in the area, forming a dense infestation that inhibits natural successional processes ("arrested succession" *sensu* Niering & Goodwin, 1974). Within the park, there are three epicenters of wisteria infestation: the forested area just west of the Visitor Center; the area adjacent to Richland Creek, extending from the drained lake bed east to Schenck's Field; and the area just west of the meadow at Tour Stop 6, around what appears to be an old homestead. Recent control efforts have reduced the extent and severity of these infestations but ongoing management attention will be necessary to ensure that these and other sites are not re-invaded.

Invasive plants

Many invasive plants have well-established populations within GUCO². The park's history of human-induced disturbance and widespread planting of nonnative species has facilitated the establishment of a large number of nonnative plants. Commercial and residential development around the park has perhaps further promoted the spread of nonnative and invasive plants through habitat fragmentation and increased propagule pressure.

Most nonnative plants at GUCO are relatively innocuous species that have persisted from earlier plantings or "are harmless present day components of the flora" (White et al., 2003), but others are aggressive invaders that threaten to displace native species and upset natural ecological processes. Of the 346 plant species reported to occur within GUCO by NatureServe, at least 25% (87 species) were nonnative, and 28 of these were considered highly invasive or potentially so (White et al., 2003). Some invasive plants can adversely affect ecosystems by reducing native species richness (Hobbs et al., 1992), modifying habitats (Kourtev et al., 2002), and altering key ecological processes (Schofield, 1989; Vitousek, 1986). Invasion success has been linked to a number of factors including plant attributes (Rejmanek and Richardson, 1996), disturbance patterns (Hierro et al., 2006; Davis and Thompson, 2000; Sher and Hyatt, 1999), absence of natural enemies ("enemy release" *sensu* Elton, 1958; Lake and Leishman, 2004), and propagule pressure (Lonsdale, 1999; Lockwood et al., 2005; Von Holle and Simberloff, 2005). All of these factors have almost certainly contributed to the abundance of invasive plants at GUCO. Nonnative plants represent a major management challenge for the park, one that will require an adaptive control and monitoring approach to be effectively addressed.

Management Goals

Restoring the landscape to its condition at the time of the battle is a "cardinal (management) goal" at GUCO (Hiatt, 2003). Park management is focused on creating a historically accurate setting to the extent possible given the many intrusive features that interfere with this goal. Two objectives comprise the basic criteria for measuring progress toward this goal: 1) accurate recreation of the "mosaic of forest and fields" that characterized the battlefield, and 2) accurate placement and depiction of battle positions and important landmarks (Hiatt, 2003). While much progress has been made toward historical rehabilitation, the park faces challenges on a number of fronts, and much is left to be done.

Under the broad management goal of historical accuracy, several ecological/conservation goals/objectives exist for the park:

- 1) Restore the natural community types that existed in the area at the time of the battle through natural regeneration and supplemental plantings of appropriate species.

² The term "invasive plant" has been the source of some confusion because it has been used "imprecisely, erroneously or in contradictory ways" by many authors (Richardson et al., 2000). In this report, the general definition put forth in the Executive Order on Invasive Species (1999) is used: "alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health."

- 2) Eliminate or control persistent nonnative and invasive plants in the park's natural areas through an adaptive approach involving inventorying/mapping, prioritization, treatment, and monitoring species.
- 3) Identify community types and species of conservation concern within the park for increased protection and monitoring.
- 4) Limit human-induced disturbance in natural areas.

B. How Invasive Plants Interfere with Management Goals

Invasive plant species are the greatest threat to the ecological well-being of the park (White et al., 2003) and, as such, represent the biggest management challenge at GUCO today. Most of the invasive forest species in GUCO were not introduced to the United States by the time of the battle [exceptions are Asiatic bittersweet (*Celastrus orbiculatus*) and common periwinkle (*Vinca minor*); Miller, 2003] and so were not part of the battle-era landscape. In keeping with the historic rehabilitation of the battlefield, elimination or control of many of these species is therefore an appropriate management goal. Efforts to restore historic plant communities are directly compromised by the presence of many highly-aggressive invasive species.

The influence of propagule pressure [a measure of the number of individual plants released in an area at any one time and the number of times a species has been introduced to an area (Lockwood et al., 2005)] and disturbance patterns on plant invasion is illustrated at GUCO. The park contains a number of nonnative species that are not considered particularly invasive [e.g., Japanese holly (*Ilex crenata*), Chinese fir (*Cunninghamia lanceolata*), bridal wreath spiraea (*Spiraea prunifolia*), and sweet cherry (*Prunus avium*)] but have apparently persisted from earlier plantings and are now naturalized in forest communities within the park. These species are often most common in areas that have experienced high levels of human-induced disturbance in the recent past. Their presence is probably the result of past propagule pressure within GUCO. Some of these species have invaded natural communities and may represent a threat, albeit a minor one, to conservation goals at the park.

Many of the region's most harmful forest invasives occur throughout GUCO. Some of these [e.g. wisteria, English ivy (*Hedera helix*), common periwinkle, Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*)] form dense infestations, resembling monocultures in places. Invasive plant infestations are often associated with a number of adverse ecological effects including competitive exclusion of native plants and loss of biodiversity (Pimental, 2002), decreased recruitment of native plants (Wyckoff and Webb, 1996; Levine et al., 2003; Lichstein et al., 2004; Shulz and Thelen, 2000)), and changes in ecosystem function (Kourtev et al., 2002; Wolfe and Klironomos, 2005). Evergreen, patch-forming, understory invasives are particularly problematic to accurate historic interpretation at the park because there probably was not a dense evergreen component to the understory at the time of the battle; such species are also very obvious to visitors, particularly in the winter. Consequently, invasive plant management is essential to protect the park's ecological resources and improve the historic interpretation of the battlefield.

C. Assessment of plant species that interfere with management goals

Nonnative Plant Census

A park-wide census of nonnative forest and forest edge plants was conducted at GUCO from June to August, 2007³. The park was divided into 83 blocks, ranging in size from approximately 0.2 to 2 ha and bounded by physical features such as trails, roads, streams, fences, etc. and/or lines defined by a GIS grid. Maps of each block were created in ArcMap (ArcGIS 9.2; ESRI, 2007) using shapefiles (i.e., spatially georeferenced databases) of GUCO supplied by the Park Service. Shapefiles were overlain by a 15 × 15 m park-wide grid (created using Hawth's Tools Version 3.26; Beyer, 2004) to aid in distance determination in the field.

Each block was inventoried by first walking along the perimeter and recording all non-native plants occurring within approximately 3 m of the edge. We used a hip chain to measure the distance from a starting point to a non-native plant occurrence; each occurrence was drawn as a point on a map at the estimated location based on the measured distance. Each point was recorded using species codes (PLANTS Database, USDA, NRCS, 2008) and a unique identifier. Information on the characteristics of the plant(s) was also recorded. Most plants were easily identified but others required use of manuals (Radford et al., 1968; Dirr, 1998; Still, 1994) or consultation with local botanists (e.g., Dr. Alexander Krings, Dept. of Plant Biology, North Carolina State University; Dr. Paul Fantz, Dept. of Horticulture, North Carolina State University) to confirm identification.

Nonnative plants were recorded as trace, individual, patch, or throughout. "Trace" was used to describe any tree, shrub, or upright herbaceous plant shorter than 2 ft tall and present as fewer than 5 separate stems; vines were recorded as trace if they covered less than a square meter and/or occurred at less than 15% cover. "Individual" was used primarily to describe trees and shrubs that were taller than 2 ft tall and were present as between 1 and 5 separate stems (i.e., not connected aboveground and usually more than 1 foot apart); occasionally, large individual vines were also recorded this way. The number of separate, visible stems and plant heights were often recorded for points described as individuals. All nonnatives covering more than a square meter at greater than 15% cover were recorded as patches. Patch area and percent cover were visually estimated. The term "throughout" was used occasionally to describe patches (usually of vine species) that were very large and difficult to measure, although the percent cover may not have been very high (i.e., usually less than 50%). Other notes were often included to further describe infestations (e.g., observations on reproductive state, the general appearance of plants, presence or absence of other noteworthy species, etc.) and their locations (e.g., nearby physical structures, noticeable vegetation, monuments, etc.).

The interior portion of each block was examined along north-south or east-west transects beginning at one end of the block and covering its entire length. Transects were spaced approximately 6 m apart from each other and vegetation was visually assessed 3 m on either side of transects. Nonnative species were recorded and drawn on a map as before. Mowed areas

³ Due to the timing of this study, it is possible that we missed many cool-season nonnatives; however, some of these species, e.g., garlic mustard (*Alliaria petiolata*), often persist as standing seedstalks after plants have died, allowing identification into the summer months.

within the park were assessed more generally because of (1) time constraints, (2) the perceived lower priority of these areas (based on the fact that Schenck's field, for example, will be reforested in the near future and that these areas are generally dominated by a high diversity of difficult-to-control nonnative field and lawn weeds), and (3) frequent summer management activities (i.e., mowing), which often made plant identification in these areas more difficult. Most woody nonnative plants in clearings were recorded but small herbaceous lawn weeds were not. [See the Cultivated Meadows section (pg. 17) in the NatureServe document (White et al., 2003) for more detailed discussion of nonnative plants in managed clearings at GUCO]. Pressed specimens of all nonnative plants observed during the inventory were submitted to the NC State Herbarium (Collection: Nonnative Plants of Guilford Courthouse NMP, Matt O'Driscoll). A number of native species that had not been reported at GUCO in the recent NatureServe inventory were also recorded and submitted as specimens (Table 1).

Table 1. Native species not previously reported at GUCO. These species were observed and, in most cases, collected during the nonnative plant census. All species are potentially new for the park [i.e., were not reported in the most recent plant inventory (White et al., 2003)] Asterisks (*) indicate species that are likely persisting from earlier plantings.

Species Name	Common Name	Family
<i>Asimina triloba</i>	pawpaw	Anonaceae
<i>Cicuta maculata</i>	spotted water hemlock	Apiaceae
<i>Ilex decidua</i>	possumhaw	Aquifoliaceae
<i>Ilex verticillata</i>	winterberry	Aquifoliaceae
<i>Matelea carolinensis</i>	maroon Carolina milkvine	Asclepiadaceae
<i>Ambrosia trifida</i>	great ragweed	Asteraceae
<i>Baccharis halimifolia</i>	groundsel tree	Asteraceae
<i>Chrysogonum virginianum</i>	green and gold	Asteraceae
<i>Mikania scandens</i>	climbing hempweed	Asteraceae
<i>Calycanthus floridus</i> *	sweetshrub	Calycanthaceae
<i>Hypericum mutilum</i>	dwarf St. Johnswort	Clusiaceae

Table 1 Continued

Species Name	Common Name	Family
<i>Senna marilandica</i>	Maryland senna	Fabaceae
<i>Quercus nigra</i>	water oak	Fagaceae
<i>Collinsonia canadensis</i>	horsebalm	Lamiaceae
<i>Gelsemium sempervirens</i>	yellow jessamine	Loganiaceae
<i>Cypripedium acaule</i>	pink lady's slipper	Orchidaceae
<i>Pinus rigida</i> *	pitch pine	Pinaceae
<i>Ceanothus americana</i>	New Jersey tea	Rhamnaceae
<i>Aronia arbutifolia</i>	red chokeberry	Rosaceae
<i>Aronia melanocarpa</i> *	black chokeberry	Rosaceae
<i>Crataegus sp.</i>	hawthorn	Rosaceae
<i>Malus sp.</i> *	crab apple	Rosaceae
<i>Rosa palustris</i>	swamp rose	Rosaceae
<i>Mitchella repens</i>	partridge berry	Rubiaceae
<i>Saururus cernuus</i>	lizard's tail	Saururaceae
<i>Tiarella cordifolia</i>	foamflower	Saxifragaceae
<i>Mimulus ringens</i>	monkey flower	Scrophulariaceae
<i>Sparganium americanum</i>	American bur-reed	Sparganiaceae
<i>Celtis tenuifolia</i>	dwarf hackberry	Ulmaceae
<i>Ulmus alata</i>	winged elm	Ulmaceae

Data were entered into GIS using ArcMap. Points for nonnative plant records were placed on the park map, and relevant information was entered in attribute tables for each species. Additional fields were added to attribute tables, including common name, scientific name, and plant form (based on information from PLANTS Database, USDA, NRCS, 2008). A single shapefile (point) was created for all nonnative plants observed at GUCO (5,024 records). Using the “Select by Attributes” tool, shapefiles were created for each of the nonnative species recorded in this census (n = 62). Layer files were created with unique display options such as color coding for points based on the presence category (e.g. trace, individual, patch, or throughout) or patch size of records. Hyperlinks to photographs were added to at least one record for each species shapefile. Finally, relevant metadata for each shapefile were entered using ArcCatalog. Basic data summarization and analyses were performed in ArcMap. A shapefile of the NPS Cumberland-Piedmont Network (CUPN) Vegetation Map for GUCO (Jordan & Madden, 2008) was used to analyze species’ distributions within different community types.

Nonnative Plants by Regional Threat

At least 62 species (3 species were identified only to genus, and 1 genus, *Rosa*, contained at least 2 species) of nonnative forest and forest edge plants were recorded at GUCO. In the recent species inventory conducted by NatureServe (White et al., 2003), at least 87 nonnative plants were recorded. The discrepancy in species counts between both studies is likely accounted for by NatureServe’s inclusion of non-forested clearings, which are generally “comprised of a large number of nonnative plants (White et al., 2003).” 26 of the nonnative forest species observed during our study, however, were not reported in the NatureServe document, perhaps reflecting our more thorough treatment of the park’s forested areas. Almost half of the nonnative forest species found at GUCO are considered highly aggressive invaders of southern forests and their margins: 28 species are among the most harmful invasives in the region (Table 2).

Table 2. High threat forest invasives at GUCO. 28 nonnative plant species at GUCO pose high threats to forest ecosystems; these species are noted forest invaders in the Southeast (Miller, 2003). The number of records refers to all occurrences (traces, individuals, patches, and throughout) documented during this census. Total patch area is the sum of all areas with 15% or higher cover for each species within the entire park. Asterisks (*) indicate species that were not previously reported in the park. Note: patch size alone does not indicate the entire extent of infestation at GUCO; many species were recorded more often as isolated individuals, so although their total patch area may be small, they may still be widespread in the park.

Species	Common Name	Records	Total Patch Area (ha)
<i>Microstegium vimineum</i>	Japanese stiltgrass	196	4.3
<i>Hedera helix</i>	English ivy	345	2.0
<i>Ligustrum sinense</i>	Chinese privet	878	1.9
<i>Elaeagnus umbellata</i>	autumn-olive	608	1.0
<i>Lonicera japonica</i>	Japanese honeysuckle	399	0.9
<i>Vinca minor</i>	common periwinkle	73	0.8
<i>Rosa multiflora</i>	multiflora rose	625	0.5
<i>Wisteria floribunda</i>	Japanese wisteria	189	0.5
<i>Celastrus orbiculatus</i>	Asiatic bittersweet	266	0.2
<i>Lonicera fragrantissima</i>	fragrant honeysuckle	208	0.1
<i>Ailanthus altissima</i>	tree of heaven	70	0.1
<i>Elaeagnus pungens</i>	thorny-olive	108	0.08
<i>Vinca major</i> *	bigleaf periwinkle	4	0.03
<i>Euonymus fortunei</i>	winter creeper	114	0.02
<i>Dioscorea oppositifolia</i>	Chinese yam	33	0.02

Table 2 Continued

Species	Common Name	Records	Total Patch Area (ha)
<i>Lespedeza cuneata</i>	sericea	23	0.02
<i>Ligustrum japonicum</i>	Japanese privet	87	0.01
<i>Albizia julibrissin</i>	silk tree	105	< 0.01
<i>Rosa</i> spp.*	rose	7	< 0.01
<i>Phyllostachys aurea</i>	golden bamboo	1	< 0.01
<i>Nandina domestica</i>	sacred bamboo	87	< 0.01
<i>Euonymus alatus</i> *	burning bush	19	< 0.01
<i>Ligustrum vulgare</i>	European privet	3	< 0.01
<i>Paulownia tomentosa</i>	princess tree	3	< 0.01
<i>Ligustrum lucidum</i> *	glossy privet	2	< 0.01
<i>Lespedeza bicolor</i> *	shrub lespedeza	2	< 0.01
<i>Lonicera</i> sp.*	bush honeysuckle	1	< 0.01
<i>Melia azederach</i> *	Chinaberry	1	< 0.01

Six nonnative plant species are of growing concern in the forests of the Southeast (Miller, 2003), and several others have more recently shown invasive tendencies in the region (Allen et al., 2006; Whittemore, 2004; Swearingen et al., 2003); these species probably pose medium threats to forest ecosystems in the region (Table 3).

Table 3. Medium threat nonnative forest species at GUCO. 11 species potentially pose medium threats to forest ecosystems at GUCO; these species are listed as “of growing concern” by Miller (2003) or have been documented elsewhere as moderately invasive in the region. Asterisks (*) indicate species that were not previously reported in the park.

Species	Common Name	Records	Total Patch Area (ha)
<i>Broussonetia papyrifera</i>	paper mulberry	6	0.04
<i>Liriope spicata</i>	creeping liriope	60	0.01
<i>Mahonia bealei</i>	Beale's barberry	81	< 0.01
<i>Ulmus pumila</i>	Siberian elm	19	< 0.01
<i>Clematis terniflora</i>	sweet autumn virginsbower	19	< 0.01
<i>Morus alba</i> *	white mulberry	4	< 0.01
<i>Rubus phoenicolasius</i> *	wine raspberry	4	< 0.01
<i>Pyrus calleryana</i> *	Callery pear	2	<0.01
<i>Akebia quinata</i> *	chocolate vine	1	<0.01
<i>Berberis thunbergii</i> *	Japanese barberry	1	<0.01
<i>Quercus acutissima</i> *	sawtooth oak	1	<0.01

Several species are not known to be invasive in the region but are volunteering (i.e., becoming established through natural means of dispersal) with regularity in GUCO's forests. The remaining nonnative species are probably persisting from earlier plantings [e.g., leatherleaf viburnum (*Viburnum rhytidophyllum*), peach (*Prunus persica*), western red cedar (*Thuja plicata*), Japanese maple (*Acer palmatum*), and forsythia (*Forsythia hybrida*)] or occasionally volunteering from outside sources [e.g., annual honesty (*Lunaria annua*), Japanese laurel (*Aucuba japonica*), and rose-of-Sharon (*Hibiscus syriacus*) dispersing from neighboring yards along the northern property line]. These species probably represent a low threat to forest ecosystems in the region (Table 4).

Table 4. Low threat nonnative forest species at GUCO. 23 species occurring within forests in GUCO are generally not considered invasive in the region. Most of these species are simply persisting from earlier plantings, while others (e.g., Japanese holly and sweet cherry) do appear to be spreading throughout the park. All of these species probably pose low threats in the region. Asterisks (*) indicate species that were not previously reported in the park.

Species	Common Name	Records	Total Patch Area (ha)
<i>Ilex crenata</i>	Japanese holly	227	0.1
<i>Thuja plicata</i> *	western red cedar	1	0.02
<i>Cunninghamia lanceolata</i>	Chinese fir	7	0.01
<i>Spiraea prunifolia</i>	bridalwreath spiraea	7	0.01
<i>Lunaria annua</i> *	annual honesty	4	< 0.01
<i>Prunus avium</i>	sweet cherry	87	< 0.01
<i>Hibiscus syriaca</i> *	rose-of-Sharon	8	< 0.01
<i>Aucuba japonica</i> *	Japanese laurel	4	< 0.01
<i>Pyrus communis</i>	common pear	4	< 0.01
<i>Chaenomeles japonica</i>	Maule's quince	3	< 0.01
<i>Viburnum</i> sp.	viburnum	3	< 0.01
<i>Iris germanica</i>	German iris	2	< 0.01
<i>Commelina communis</i>	Asiatic dayflower	2	< 0.01
<i>Forsythia hybrida</i> *	forsythia	1	< 0.01
<i>Jasminum nudiflorum</i> *	winter jasmine	1	< 0.01
<i>Poncirus trifoliata</i> *	hardy orange	1	< 0.01
<i>Melilotis officinalis</i>	yellow sweetclover	1	< 0.01
<i>Acer palmatum</i> *	Japanese maple	1	< 0.01

Table 4 Continued

Species	Common Name	Records	Total Patch Area (ha)
<i>Osmanthus heterophylla</i> *	holly osmanthus	1	< 0.01
<i>Populus canescens</i> *	gray poplar	1	< 0.01
<i>Prunus persica</i> *	peach	1	< 0.01
<i>Prunus</i> sp.*	cherry	1	< 0.01
<i>Viburnum rhytidophyllum</i> *	leatherleaf viburnum	1	< 0.01

Nonnative Plants by Community Type

Nonnative plants, as a whole, are not evenly distributed within GUCO. Nonnative forest species appear to be most abundant in the various successional communities within the park (Figure 3). Mixed pine and tulip poplar successional forests cover approximately 45% of the park [based on the area mapped for the CUPN Vegetation map (82 ha); may actually be closer to 40% of the park's total land area] and yet account for 57% of nonnative plant occurrences recorded. Most of these sites have experienced high levels of human-induced disturbance within the past 100 years, a factor which has likely increased their susceptibility to nonnative plant invasion (White et al., 2003). The eastern half of the park is heavily invaded throughout, but especially along its border with Country Park and within highly disturbed sites such as the Petting Zoo and Drive-in Tracts. Other problem areas include the drained Lake Wilfong site, the Kotis Tract (southwest corner), and most bottomland sections of the park. Piedmont Small Stream Sweetgum Forest occupies floodplains along both streams in GUCO and is considered the most threatened natural community within the park due to high levels of nonnative plant invasion and hydrological degradation (White et al., 2003). Stream communities cover roughly 6% of the land area at GUCO (5.2 ha using the CUPN Veg. Map) but contain over 9% of nonnative plant records.

Upland "climax" community types (e.g., the various oak-hickory and beech dominated communities described by NatureServe) contain fewer nonnative species. Together, these communities cover 31% of GUCO and contain only 18% of nonnative plant records from this census. These sites are most heavily invaded along their edges; forest interiors support few, if any, large infestations. The section of oak-hickory dry mesic forest between Tour Stops 7 and 8 is perhaps the best example of an intact (i.e., relatively invasive-free) forest community within GUCO. On a per acre basis, the 4 "natural" forest communities (Acidic Piedmont Mesic

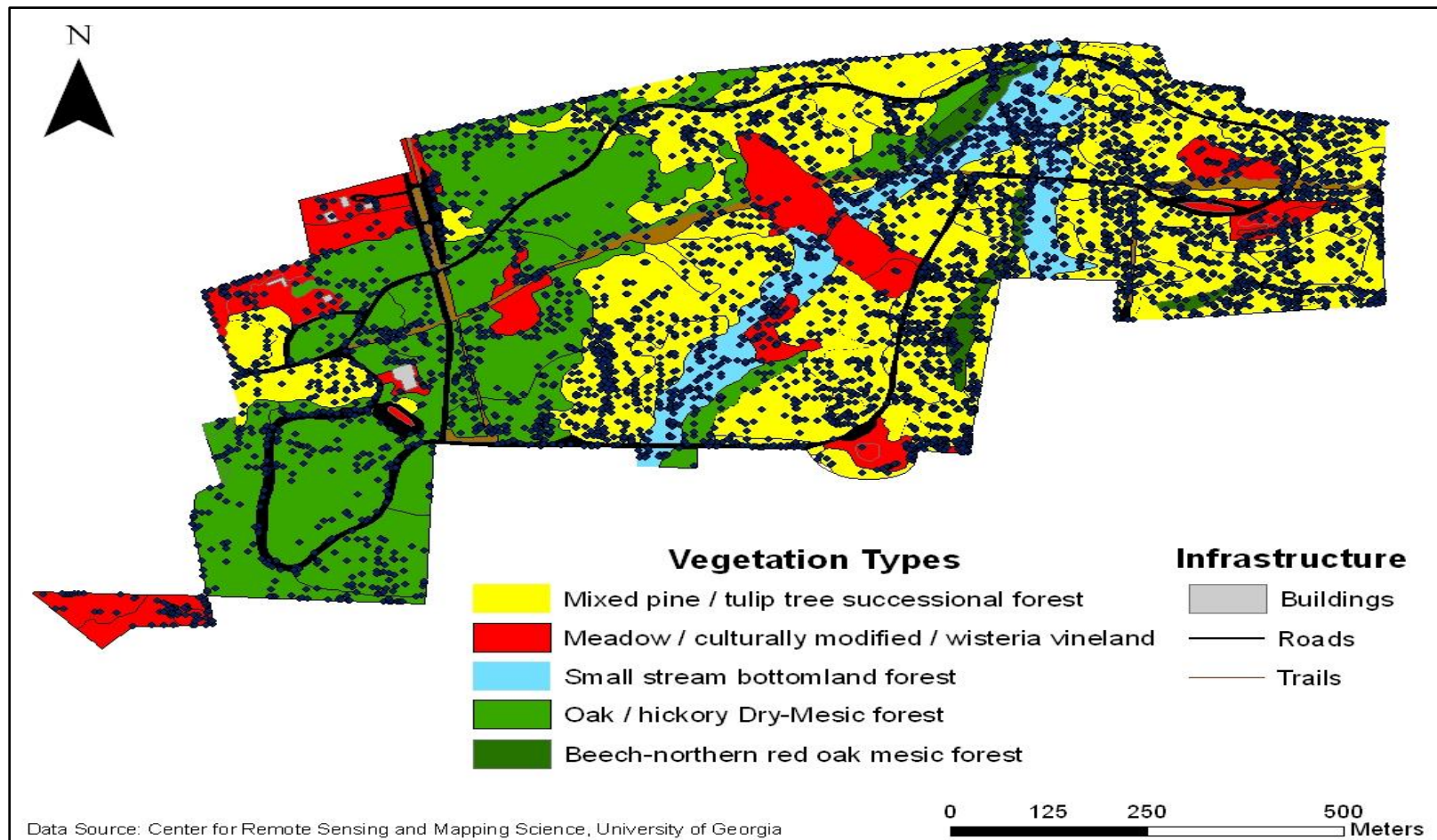


Figure 3. Nonnative plants in ecological communities of GUCO. Nonnative plants (dots on map) occur throughout the park but are more abundant in the various successional forest communities, sites that have experienced high levels of disturbance in the past. Dominant vegetation types described in the CUPN Vegetation Map for GUCO (Jordan & Madden, 2008) were adapted to create broad vegetation types. Note: culturally modified sites include large areas of meadow and lawn, which were not inventoried here. These areas are generally dominated by common herbaceous weeds.

Table 5. Distribution of nonnative plants in broad community classes at GUCO.

Successional forests support more nonnative plants than “natural” forest communities (White et al., 2003) in GUCO. Community classes were created by grouping dominant vegetation types from the CUPN Vegetation Map for GUCO (Jordan & Madden, 2008). [Note: total land area (76 ha) and total records (4688) in the table do not match total area in the CUPN map (82.1 ha) or total records from the nonnative plant census (5024); this is accounted for by 1) the remaining map area being covered by roads and trails and 2) mapping limitations where many records occur in roads, trails, and the remaining area not contained in the CUPN map].

Community Class	Land Area (ha)	Total Records	Trace (#/ha)	Individual (#/ha)	Patch (#/ha)	All Records (#/acre)
Successional Forests	37	2919	41	24	14	79
"Natural" Forests	31	1403	21	14	11	45
Culturally-Modified	8	366	13	18	17	46

Hardwood Forest, Piedmont Dry – Mesic Oak – Hickory Forest, Southern Red Oak – White Oak Forest, and Piedmont Small Stream Sweetgum Forest), as a group, had fewer nonnative species records than either the successional forest communities or other culturally modified sites (e.g., wisteria vineland, cultivated meadow, etc.; Table 5). Although nonnatives occur essentially throughout the park, some community types are less heavily invaded and should therefore be given higher priority in keeping with conservation goals at GUCO.

Nonnative Plants by Extent of Infestation

Distribution patterns among species also vary considerably, from those present essentially throughout the park to those represented by a single or few plants in one location (See individual species maps in Section 3). The area covered by an individual species can be roughly estimated from its distribution map. The following species appear to cover at least 50% of the park’s forested area, albeit at varying densities, and may therefore be considered as present throughout GUCO: Asiatic bittersweet, autumn olive, Chinese privet, English ivy, Japanese honeysuckle, Japanese stilt grass, and multiflora rose. While some of these species may show habitat preferences [e.g., stilt grass in bottomlands (White et al., 2003)], each has, to some extent, invaded forest interiors of all community types in GUCO and should be considered serious ecological threats.

Japanese holly, common periwinkle, thorny olive, and fragrant honeysuckle⁵ are found in approximately 25-50% of the park's forested area. These four species are traditionally popular ornamentals that were probably planted abundantly at the park in the past, and are still used widely in surrounding neighborhoods. Although these species are less invasive in the region than the more widespread nonnatives at GUCO, 3 of them (periwinkle, thorny olive, and fragrant honeysuckle) are listed among the aggressive invaders of southern forests (Miller, 2003) and have been linked to losses in native species diversity elsewhere (Williams, 2005; Darcy and Burkart, 2002; Miller, 2003). In addition, all 4 species are evergreen (or tardily deciduous in the case of fragrant honeysuckle) and highly visible year-round, visually impacting the historical accuracy of the battlefield.

Another set of invasive or potentially invasive plants occur in approximately 10-25% of the forested area in GUCO. These less-widespread, but often locally-abundant, species include Japanese wisteria, sweet cherry, silk tree (*Albizia julibrissin*), tree-of-heaven (*Ailanthus altissima*), sacred bamboo (*Nandina domestica*), Beale's barberry, creeping lillyturf, Japanese privet (*Ligustrum japonicum*), and winter creeper (*Euonymus fortunei*). Japanese wisteria has been the focus of a concerted control effort at GUCO for at least the past 5 years, and the current extent of infestations is apparently greatly reduced from pre-treatment levels (Roop, 2003). Wisteria still, however, represents a significant threat, as many dense patches persist within the three larger wisteria sites (northwest of the Visitor's Center, the drained lake bed area, and west of Tour Stop 6, adjacent to the clearing) and in some areas it appears to be spreading (e.g., from the infestation along the Richland Creek at Schenck's Field to further downstream). Silk tree and tree-of-heaven are represented similarly within the park: each is present as several-to-many large individuals in a few locations and then as saplings or seedlings throughout, with the occasional large tree. Tree-of-heaven is most abundant in the forested area adjacent to the northern property line, between Old Battleground Rd. and Richland Creek. Silk tree is more common in the center of the park, especially in the forest around Schenck's Field. Sacred bamboo and Beale's barberry occur as scattered traces or individuals and occasional small patches throughout the park; in several areas they seem to occur together, which may reflect past planting patterns. Both species are most common in the northeast corner of the park. Japanese privet is present mostly as scattered traces and occasional larger individuals along sections of the northern and southern property lines. Winter creeper occurs as traces and small patches in several areas of the park but most commonly in the eastern half. Although creeping lillyturf and sweet cherry are not ranked among the most invasive species in the region, they appear to be spreading throughout GUCO's forest and may warrant attention. Sweet cherry is a conspicuous component of the relatively intact forest community just south of the Greene Monument, demonstrating its potential ability to invade other high quality sites in the park. While several of these species are highly problematic invasives, the likelihood of successful control may be increased by their relatively contained distributions within GUCO.

Forty-two nonnative species have distributions each covering approximately 10% or less of the park's forested area. Some of these species have distinct populations within the park whereas

⁵ Some of the plants identified as fragrant honeysuckle may have been other nonnative bush honeysuckles such as Amur honeysuckle (*Lonicera mackii*), which was reportedly treated in the park several years earlier (NPS treatment notes, 2005). Treatment recommendations are generally the same for all nonnative bush honeysuckles.

others occur as isolated traces or individuals. Shapefiles have been created for all of these species but only those that are clearly invasive or potentially so will be discussed in greater detail here. Among the relatively uncommon forest nonnatives at GUCO, the following species warrant some level of management attention: bigleaf periwinkle (*Vinca major*), bridalwreath spiraea, burning bush (*Euonymus alatus*), Chinaberry (*Melia azedarach*), Chinese fir, Chinese yam (*Dioscorea oppositifolia*), chocolate vine, European privet (*Ligustrum vulgare*), glossy privet (*Ligustrum lucidum*), golden bamboo (*Phyllostachys aurea*), Japanese barberry (*Berberis thunbergii*), paper mulberry, Callery pear, princess tree (*Paulownia tomentosa*), nonnative rose (*Rosa* sp.), sawtooth oak, sericea (*Lespedeza cuneata*), shrub lespedeza (*Lespedeza bicolor*), Siberian elm, sweet autumn virgin's bower, white mulberry, and wine raspberry. Most of these species have been observed as forest invasives in the Southeast and at least 11 of them have been previously treated within the park (Roop, 2003; NPS treatment notes, 2004-2007). Several species were found in so few numbers (e.g., from one to five records) that they probably do not pose an immediate threat to the overall ecological health of the park. Given their invasive tendencies, however, it will be important to treat and monitor all of these species to prevent further spread within GUCO.

Species Maps

The information contained in the species maps is essential for setting control priorities, locating nonnative plants in the field, and monitoring future population patterns. Knowledge of the extent of infestations within GUCO can be used in combination with larger landscape patterns and species characteristics to estimate the significance of impact (i.e., the ecological threat level) and the feasibility of control for each species. Priority rankings may be assigned to species based on these two variables. Park managers can use these shapefiles to help locate infestations or plants for monitoring and control purposes; spatial coordinates for each record can be entered into GPS units for guidance in the field. Many of the hand-drawn point records appeared to be fairly accurate when compared to points taken at the same location with a GPS unit (Garmin, 2007): all were within 50 ft of the GPS points, most were 10-25 ft away. This level of accuracy is sufficient to locate most infestations; additional information contained in the GIS attribute tables will also be helpful. These baseline data will be useful for comparison with future distribution patterns to monitor the spread of invasives and/or the effectiveness of control measures. We recommend that similar censuses be conducted at least every 3 years to monitor current infestations and detect new ones; all treated sites should be monitored, and possibly re-treated, yearly until no regrowth of the treated species is observed for at least 2 consecutive growing seasons. The GIS files should be updated at least annually to document new infestations, population growth patterns, control practices, and other relevant information.

OVERVIEW OF NONNATIVE PLANT MANAGEMENT PLAN

A. Management Philosophy

The feasibility of restoring the park landscape to its battle-era condition is affected to varying degrees by the different nonnative species present. Some nonnative plants are capable of invading high quality sites while others are restricted to recently disturbed sites. Several of the species recorded in this census do not appear to behave invasively in the region and are probably only persisting in the park from earlier plantings. Eliminating all nonnatives plants from GUCO would not only be extremely difficult, costly, and improbable, but also unwarranted. Many nonnative plants are relatively harmless components of forest communities at GUCO, i.e., they do not appear to adversely affect native plant diversity or overall ecosystem functioning. Although such species may not have occurred in the area at the time of battle, their contemporary presence is tolerable because they do not significantly affect the structure or function of ecological communities.

Instead of focusing on eliminating nonnative plants from GUCO, a more practical approach is to manage for desired species and communities. Only nonnative species that threaten the survival of conservation targets warrant consideration for control actions. Nonnative species can be ranked according to their actual and potential impacts on native species and communities to determine what control priority they deserve. Priority ranking should also factor in the feasibility of control and potential impacts of control measures. Species prioritization based on the best available information will better inform management decisions, resulting in more efficient use of park resources and increased likelihood of achieving conservation goals.

Preventive measures must be taken to guard against future infestations by species new to GUCO and re-infestations by species previously eliminated from the park. Programs to inform park visitors and neighboring residents about invasive plants represent perhaps the most important component of an effective prevention strategy. Neighboring properties along the park's northern boundary, for example, appear to contain the propagule sources for many current infestations in GUCO, and will contribute to future infestations unless residents take action. In addition, dumping of garden refuse onto park property is a common practice that may help spread certain species (Twyford and Baxter., 1999). Over the course of this census, we communicated with several local residents who expressed concern about invasive plants but admitted that they were somewhat ignorant on the subject. Outreach programs that provide information on invasive species and potential landscape alternatives to neighboring residents could help significantly reduce propagule pressure from surrounding areas.

Managers should also coordinate with nearby parks and other non-residential properties (e.g., Forest Lawn Cemetery and local businesses) to ensure that propagule pressure is reduced from these potential sources. Country Park, in particular, shares a large section of property line with GUCO and is home to a similarly-high diversity of nonnative plants. Some of GUCO's most problematic species (e.g., wisteria and autumn olive) are present as dense infestations in Country Park. Species absent or uncommon at GUCO may have an enhanced entry route through Country Park as a result of varied land use practices in the latter (including planting of many potentially invasive nonnative species) and the high level of foot traffic between both sites. Several nonnative species that are uncommon within GUCO are found only along the trails connecting

both parks. For example, a small infestation of chocolate vine, a species of growing concern in the Southeast and previously unreported at the park, occurs only along the paved trail between Tour Stop 4 and Country Park. Forest Lawn Cemetery poses similar management challenges because of its close proximity to the park. Richland Creek, which enters GUCO via an underground connection to Forest Lawn, often carries debris from the cemetery (e.g., plastic grave flowers) into the park, demonstrating another potential entry route for invasive plant propagules. Park management must therefore not only practice preventive measures within park bounds (e.g., minimize disturbance during management activities, develop an early detection program, provide information on invasives to park visitors) but must also work directly with neighbors to reduce infestation threats in the surrounding landscape.

Setting control priorities for current infestations and working preventively to reduce the risk of future infestations are two important strategies that should be part of a larger adaptive management approach at GUCO. Adaptive management is defined as “the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn (Salafsky et al., 2001).” Seven phases of the adaptive approach to weed management have been described (TNC, 2001):

- 1) Establish and record management goals for the site.
- 2) Identify species that interfere with management goals and assign priorities to these based on their impacts.
- 3) Consider methods for controlling or mitigating impacts of each species, factoring in the likely effects on target and non-target species. If necessary, re-order priorities based on this analysis.
- 4) Develop a weed control plan based on information produced during the previous phases.
- 5) Evaluate the effectiveness of weed management activities in light of overall site goals, and use this information to guide the modification of control priorities, methods, and plans.
- 6) Start the cycle again with new/modified goals.

B. Control Priorities at GUCO

Species that were identified as potential threats to management goals were ranked to determine control priorities for the park. Initial inclusion in this group was based on review of the “invasion literature” and species distribution patterns within GUCO. Of the 62 nonnative forest species encountered, 43 were identified as interfering or potentially interfering with goals at the park. Many of the region’s most problematic invasives occur essentially throughout GUCO, often as dense infestations. Other highly invasive species occur as isolated individuals or small populations. Several species that are not generally considered invasive appear to be spreading within forest communities at GUCO. Differences in invasive potential and extent of infestation illustrate the need for a robust ranking system that prioritizes species based on a suite of characteristics and site-specific conditions.

Priorities were assigned to species of concern using the Alien Plant Ranking System (APRS) version 5.1 (APRS Implementation Team, 2000), developed by the US Geological Survey. This system is based on the *Handbook for Ranking Nonnative Plants for Management and Control* by Hiebert and Stubbenfield (1993), which was originally developed for prairie and grassland parks of the Central United States but has since proven useful in other regions of the country, including the Southeast (e.g., Akerson et al., 2000). The program ranks species based on user responses to 23 multiple choice questions in three sections: 1) significance of threat or impact (site characteristics), 2) innate ability to be a pest (species characteristics), and 3) difficulty of control (Appendix 1). As Drake et al. (2003) point out, “the rationale behind this approach is based on limited evidence suggesting that the invasion of a community by a non-native plant species is controlled by the biological characteristics of the species in question, the number of propagules entering the community, and the susceptibility of the community to invasion.”

Responses to APRS questions were given based on reviews of existing literature, communications with land managers, and results from the nonnative plant census. For less-studied species, insufficient information was available to answer all questions confidently; in these cases, either an educated guess was made based on field observations and relevant information from closely related species or the response was left as “unknown”. The program assigns numerical values to each response and then sums values within each section (Impact, Pest, or Control) to generate an overall value for the species in that section. Species values are from zero to one hundred, with high values (i.e., 50 and greater) indicating a potentially problematic species. Finally, the program assigns each species to 1 of 4 priority blocks based on values from the 2 sections being considered. When impact and control are the variables used to rank species, priorities are assigned as follows: first priority is given to high impact species that may be easier to control; second priority to high impact species that are harder to control; third priority to lower impact species that are easier to control; and fourth priority to lower impact species that are harder to control. Impact and control values can be plotted in a four quadrant grid to illustrate how priority groupings are partitioned (Figure 4). Ranking by significance of impact and control potential is perhaps most appropriate for natural area applications and was therefore chosen for setting priorities at GUCO.

Nonnative species prioritization results for GUCO using the APRS program are summarized in Table 6. Urgency ratings are included as a supplemental assessment of the need for rapid control response to each species. These ratings factor in APRS impact and control values but also draw on field observations and species characteristics that are perhaps not fully accounted for in the ranking system. For example, Japanese barberry was recorded only once at GUCO as a small, isolated bush, but the APRS program requires that this be entered as a population with an aerial extent of less than 5% of the site, an area that could be much larger than that covered by the single barberry plant. Although Japanese barberry is a problematic invasive in other regions (e.g., Ehrenfeld, 1997) and a species of growing concern in the Southeast (Miller, 2003), its presence as a small, isolated individual at GUCO probably does not warrant an urgent control response, and hence the urgency rating of “low” for the species. On the other hand, chocolate vine is a third priority species that may warrant a more urgent response even though it too was recorded only once and covers an area far less than 5% of the park. The small patch of chocolate vine appears to be growing vigorously and spreading along the forest edge. Although the APRS ranking reflects most of the relevant information in impact and control values, urgency ratings

may provide a useful synthesis of these values and additional information to further assist land managers in assigning control priorities; we recommend urgency ratings be used to guide management actions within priority blocks.

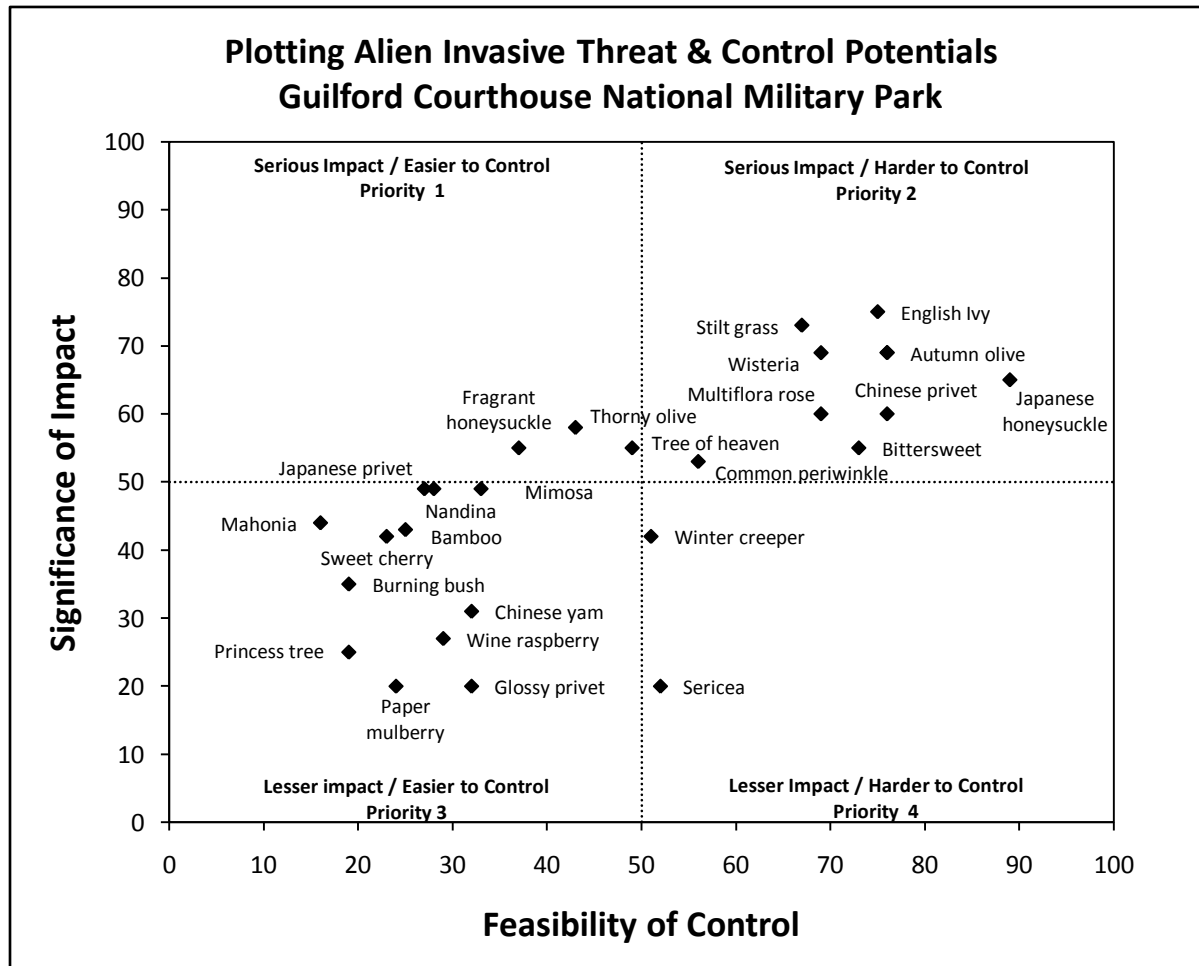


Figure 4. Ranking nonnative vegetation at Guilford Courthouse National Military Park (Adapted from Akerson et al., 2000). The APRS program was used to rank nonnative plants by their site-specific impact and control potentials. Some species of concern at GUCO are shown in the plot.

Priority Rankings

First Priority: First priority ranking was given to 3 species that pose relatively high ecological threats but may be comparatively easy to control. Fragrant honeysuckle and thorny olive are shade-tolerant understory invaders that are capable of displacing native vegetation (Williams, 2005; Miller, 2003). Both species are widely distributed in the park (though perhaps most

abundant in its eastern third) but rarely occur as large, dense infestations. Upright, bushy growth forms and thick, evergreen to semi-evergreen leaves make both species conspicuous members of the forest understory/shrub layer. Tree of heaven is a particularly prolific invasive that can form thickets and dense stands to the exclusion of native species (Miller, 2003). The population at GUCO is distributed over 10-25% of the forested area within the park, with only one relatively large, discontinuous patch extending from the Andrews Tract to the forest adjacent of the northern parking lot. Tree of heaven is a difficult species to eliminate because of its abundant seed production, high germination rate, and vigorous vegetative reproduction (Swearingen and Pannill, 2005), but its relatively small population size and somewhat restricted distribution within GUCO may increase the likelihood of effective control. It is important to note that all of the first priority species have impact and control potentials that are close to (i.e., within 15 points of) the cutoff values for other priority blocks, indicating that they are neither extreme threats nor very easy to control. Both shrubs were given an urgency rating of medium because each is widely distributed in the park, and neither appears to be spreading particularly rapidly nor forming large, dense infestations. Tree of heaven warrants a more urgent response because it is currently somewhat contained within the park (and therefore easier to control) but is also highly invasive and most abundant in an area adjacent to high quality forest. Specific control plans for all species of concern are presented in Section 3.

Second Priority: Nine highly invasive species were ranked as second priority. All of these species are listed among the most problematic invasives in the region because of their ability to displace native plant communities, alter ecosystem functioning, and/or persist in spite of control efforts. The generally high impact values (60 and above for all but periwinkle) reflect these tendencies and each species' current status at GUCO. It is unlikely that any of these species will be easily eliminated from the park but even achieving some level of control (i.e., containment or reduction in population size) will be a significant management challenge. Most second priority species are widely dispersed both within the park and throughout the surrounding area, so treating all potential propagule sources will not be feasible. Common periwinkle and Japanese wisteria, on the other hand, do have somewhat contained populations within the park; these may represent the most manageable species among this group. Periwinkle is also the only species in the group that was given a medium urgency rating (all others are rated as high urgency), which is based on the fact that, in this region at least, it spreads (probably) entirely by vegetative means, and patches within the park do not appear to be expanding rapidly. All Priority 2 species, in particular, will require ongoing, integrated control efforts that emphasize preventive measures both within and beyond park boundaries to reduce the likelihood of re-infestation.

Table 6. Priority ranking based on threat and control potentials of nonnative forest species at GUCO. Priority rankings were made based on impact and control potential. (Urgency ratings were based on impact and control values as well as other information that may not be factored in to the ranking process, e.g., the apparent rate of spread, actual size of population, etc.).

Common / Species Name	Impact ⁶	Control ⁷	Priority ⁸	Urgency ⁹
Fragrant honeysuckle (<i>Lonicera fragrantissima</i>)	55	37	1	Medium
Thorny olive (<i>Elaeagnus pungens</i>)	58	43	1	Medium
Tree of heaven (<i>Ailanthus altissima</i>)	55	49	1	High
Asiatic bittersweet (<i>Celastrus orbiculatus</i>)	55	73	2	High
Autumn olive (<i>Elaeagnus umbellata</i>)	69	76	2	High
Chinese privet (<i>Ligustrum sinense</i>)	60	76	2	High
Common periwinkle (<i>Vinca minor</i>)	53	56	2	Medium
English ivy (<i>Hedera helix</i>)	75	75	2	High
Japanese honeysuckle (<i>Lonicera japonica</i>)	65	89	2	High
Japanese stilt grass (<i>Microstegium vimineum</i>)	73	67	2	High
Japanese wisteria (<i>Wisteria floribunda</i>)	69	69	2	High
Multiflora rose (<i>Rosa multiflora</i>)	60	69	2	High
Beale's barberry (<i>Mahonia bealei</i>)	44	16	3	Medium
Bigleaf periwinkle (<i>Vinca major</i>)	27	44	3	Medium

⁶ Impact values are calculated by the APRS program based on species characteristics and site-specific conditions that may indicate to what extent a nonnative species threatens native communities. Values greater than 50 are considered relatively high impact.

⁷ Control values are calculated based on information that may indicate the likelihood of effectively controlling the species. Values greater than 50 indicate that the species may be relatively easy to control at the site in question.

⁸ APRS makes priority rankings based on Impact and Control values, placing species into 1 of 4 Priority blocks. Priority 1 species are thought to have relatively high impact potentials at the site but may be easier to control; Priority 2 species have high impacts and may be harder to control; Priority 3 species have relatively low impacts and may be easier to control; and Priority 4 species have relatively low impacts and may be harder to control. The APRS program recommends that control efforts be directed towards species in order of priority ranking, e.g., Priority 1 species should be controlled first, then Priority 2 species, etc.

⁹ Urgency ratings should be used to direct management attention within Priority blocks. Species with high urgency ratings should be focused on first within each priority block.

Table 6 Continued

Common / Species Name	Impact	Control	Priority	Urgency
Bridalwreath spiraea (<i>Spiraea prunifolia</i>)	31	19	3	Medium
Burning bush (<i>Euonymus alatus</i>)	35	19	3	Medium
Callery pear (<i>Pyrus calleryana</i>)	20	19	3	Medium
Chinaberry (<i>Melia azederach</i>)	15	32	3	Low
Chinese fir (<i>Cunninghamia lanceolata</i>)	25	20	3	Low
Chinese yam (<i>Dioscorea oppositifolia</i>)	49	32	3	Medium
Chocolate vine (<i>Akebia quinata</i>)	38	25	3	Medium
Creeping lillyturf (<i>Liriope spicatum</i>)	35	19	3	Medium
European privet (<i>Ligustrum vulgare</i>)	20	17	3	Low
Glossy privet (<i>Ligustrum lucidum</i>)	20	32	3	Low
Golden Bamboo (<i>Phyllostachys aurea</i>)	38	25	3	Medium
Japanese barberry (<i>Berberis thunbergii</i>)	15	21	3	Low
Japanese holly (<i>Ilex crenata</i>)	49	35	3	Medium
Japanese privet (<i>Ligustrum japonicum</i>)	49	27	3	Medium
Paper mulberry (<i>Broussonetia papyrifera</i>)	20	24	3	Medium
Princess tree (<i>Paulownia tomentosa</i>)	25	19	3	Medium
Rose (<i>Rosa</i> spp.)	38	36	3	Medium
Sacred bamboo (<i>Nandina domestica</i>)	49	28	3	Medium
Sawtooth oak (<i>Quercus acutissima</i>)	9	9	3	Low
Shrub lespedeza (<i>Lespedeza bicolor</i>)	9	25	3	Low
Siberian elm (<i>Ulmus pumila</i>)	29	21	3	Medium
Silk tree (<i>Albizia julibrissin</i>)	49	33	3	Medium
Sweet autumn clematis (<i>Clematis terniflora</i>)	20	20	3	Medium

Table 6 Continued

Common / Species Name	Impact	Control	Priority	Urgency
Sweet cherry (<i>Prunus avium</i>)	47	25	3	Medium
White mulberry (<i>Morus alba</i>)	18	19	3	Low
Wine raspberry (<i>Rubus phoenicolasius</i>)	27	29	3	Medium
Yellow sweetclover (<i>Melilotis officinalis</i>)	11	28	3	Low
Sericea (<i>Lespedeza cuneata</i>)	20	52	4	Low
Winter creeper (<i>Euonymus fortunei</i>)	42	51	4	Medium

Third Priority: Twenty-nine of the 43 species ranked were assigned third priority for control efforts. While several of these are problematic invasives in the region (e.g., chinaberry, princess tree, and golden bamboo) their limited distributions and/or absence from high quality sites influenced their placement in this group. The more widespread and/or potentially problematic Priority 3 species at GUCO (Beale's barberry, Chinese yam, Japanese holly, Japanese privet, sacred bamboo, silk tree, and sweet cherry) received impact values very close to (within 6 points of) the cut off for Priority 1 ranking. These species may pose the highest ecological threat within this group because they are relatively widespread, often occur in or adjacent to high-quality sites, and/or have a number of characteristics or tendencies that allow them to invade natural communities. Neither Japanese holly nor sweet cherry are well-documented as invasives in the region but both are fairly abundant (227 records for holly and 87 records for cherry) and apparently spreading within forests GUCO. Sweet cherry is well established in some of the park's highest quality sites, including the oak-dominated dry mesic forest south of the Greene monument. Although this species is a common overstory component (some trees are 60-70 ft tall) in some parts, including interior regions of high quality sites, it does not form dense thickets or appear to significantly affect native plant diversity. Furthermore, it is an attractive tree that produces a high quality fruit for many wildlife species. For these reasons and because it would perhaps be among the easier species to eliminate eventually, sweet cherry was given a relatively low urgency rating

Many Priority 3 species were given an urgency rating of low indicating that they are not presently a significant ecological threat but may become more so with time, if left unchecked. These species are generally present in small numbers or relatively contained populations and don't appear to be spreading aggressively at the moment. Some of the clearly-problematic species in the region should be located and monitored carefully, if not removed immediately, to decrease the likelihood of further invasion. With further monitoring, urgency ratings can be adjusted in response to population growth/decline to more adequately address the threats posed by these species.

Low urgency species do not pose an immediate threat to park conservation goals and will therefore only be discussed briefly here. It is, however, recommended that managers at least locate and monitor their presence to ensure that they do not become a bigger problem in the future. The Priority 3 species considered low urgency for control response are: Chinaberry, Chinese fir, European privet, glossy privet, Japanese barberry, sawtooth oak, shrub lespedeza, white mulberry, and yellow sweetclover. All of these species were observed in very low numbers within the park and most were absent from or uncommon in nearby parks and neighborhoods. Chinaberry, Japanese barberry, sawtooth oak, shrub lespedeza, and yellow sweetclover were each only recorded once during this census (though sweetclover may be more abundant in the park's clearings, which were not thoroughly inventoried). These species should be located and monitored, if not removed, whenever time and resources permit.

Other low urgency species were slightly more common: European privet was recorded 3 times and glossy privet twice in forest edge and interior locations within the park; white mulberry was recorded 4 times in highly disturbed sites or along the forest edge; and Chinese fir was recorded 7 times in the successional forest adjacent to the drained Lake Wilfong bed. Both species of privet are considered invasive in the region, but are apparently far less so than other congeners, e.g., Chinese privet. They do not appear to be spreading in the park and may therefore be treated with less urgency. White mulberry is a species of growing concern primarily because of its ability to hybridize with, and thereby threaten the genetic integrity of, our native red mulberry (*Morus rubra*) (Burgess & Husband, 2006). White mulberry is usually encountered along forest edges, hedge rows, recently disturbed sites, and waste lots but rarely invades forest interiors. The few small individuals present at GUCO occur in low quality sites and currently do not represent a serious ecological threat. The naturalized population of Chinese fir currently consists of stump and root sprouts from small trees that were cut recently (i.e., within the past 5 years); one larger individual (~15 ft tall) was recorded somewhat apart from (~90 meters south of) the main patch (see species map). Although this species is present in the forest interior and has persisted after removal efforts, it does not appear to be spreading aggressively or otherwise behaving invasively. Its striking appearance and evergreen foliage make Chinese fir more of a visual distraction to historic interpretation than an ecological threat at the park. Park managers should monitor the presence of low urgency species but direct resources towards their removal only after resources have been secured for higher urgency species.

Fourth Priority: Only two species (sericea and winter creeper) were ranked as fourth priority for control, reflecting their relatively low impacts but challenging control potentials. Winter creeper and sericea are both ranked among the aggressive invaders of southern forests (although sericea is more commonly a forest edge/open, disturbed site species). Both have intermediate population sizes in GUCO (winter creeper appears somewhat more widespread and numerous) and are distributed throughout several sections of the park. Neither species forms large or exceptionally dense infestations, and both generally occur in more disturbed sites within the park. Based on control experiences elsewhere and their current distributions within GUCO, successfully controlling these species will be somewhat difficult. Since these species currently represent only a moderate threat to conservation goals but may not be easily controlled or eliminated from the park, they warrant management attention only after higher priority species have been dealt with. Within this group, winter creeper deserves a more urgent control response because of its

presence in several forest interiors; as such, a specific control plan will be included for this Priority 4 species.

C. Summary of Specific Actions Planned

Control and monitoring programs for the different community types at GUCO are outlined below. The eleven vegetation associations identified by NatureServe (White et al., 2003) have been divided into three groups based on conservation priority at GUCO: Natural Forest Communities (high conservation priority); Successional Forest Communities (medium conservation priority); and Culturally Modified Communities (low conservation priority). The following community types at GUCO are considered “natural” under the United States National Vegetation Classification: Acidic Piedmont Mesic Mixed Hardwood Forest; Piedmont Dry – Mesic Oak – Hickory Forest; Southern Red Oak – White Oak Forest; and Piedmont Small Stream Sweetgum Forest. These communities warrant high conservation priority because they may be the closest representation of battle-era forest types at GUCO today (Hiatt, 2003) and are also the highest quality sites within the park, containing many of the park’s less common native plants and relatively few invasives (though they are by no means invasive-free). Management actions will be described for the Natural Communities group as a whole, with some reference to specific community types where appropriate.

Successional forests at GUCO are human modified communities that harbor many invasive nonnatives (White et al., 2003) and should therefore be considered of only medium conservation priority. Although conservation concern is not warranted for these systems directly, controlling nonnative plants within successional forests may prevent their spread into adjacent higher quality sites (White et al., 2003) and reduce the risk of arrested succession (*sensu* Neiring and Goodwin, 1974) or further ecological degradation. Management actions described for Successional Forest Communities refer to the following community types: Virginia Pine Successional Forest; Shortleaf Pine Successional Forest; Successional Loblolly Pine – Sweetgum Forest; and Tulip-tree – Hardwood Successional Forest.

Lowest conservation priority is given to the 3 “semi-natural” or nonnative-dominated communities identified by NatureServe: Wisteria Vineland; Blackberry – Greenbriar Successional Shrubland Thicket; and Cultivated Meadow. These are all highly disturbed, human-associated communities that are often dominated by invasive nonnatives. Some of the park’s meadows do harbor a surprising diversity of native grasses and forbs (White et al., 2003) and perhaps warrant some conservation concern for this reason. In general though, these areas are a low priority given the overall goals at the park and are probably mainly of management interest because they contain species that could potentially invade higher quality sites. Management actions for these communities and other highly modified sites at GUCO (e.g., the Andrews Tract and areas around other park buildings) are described below in the Culturally Modified Communities section.

Natural Communities

Efforts to control and monitor high ranking species [Priority 1 & 2 species (Table 6)] should be directed first towards infestations that immediately threaten high priority natural communities.

Lower impact species should be assessed and treated similarly when resources become available. Urgency ratings can be used to further guide prioritization among the differently-ranked groups. Among Priority 1 species, for example, control measures should first be taken against tree of heaven (high urgency) because most of its relatively contained population occurs in close proximity to the park's highest quality forest communities.

Between approximately 15-35% of records for each Priority 1 & 2 species occurred within "natural" forest communities, with the exception of common periwinkle which had approximately 44% of its records in these higher quality sites. Infestations that occur within or adjacent to high quality sites should be located using the species maps, treated using appropriate control procedures (Section 3), and monitored at least yearly, or as frequently as resources permit, to evaluate effectiveness of control actions. Treated sites should be monitored until 2 consecutive years without invasive plant regrowth are observed. Area of infestation, number of individuals, and/or percent cover of invasives should be estimated during site monitoring. Re-sprouting and/or establishment of other invasive species at treated sites should also be noted. This information should be entered into GIS data tables, and species maps should be updated to reflect changes in distribution.

Control actions may include a variety of chemical and manual procedures depending on the species, but in all cases efforts should be made to limit site disturbance and damage to non-target species, especially within high quality sites. Treated trees and large shrubs should be left standing (unless they pose a human safety risk) so as not to create rapid openings in the canopy or disturb the soil excessively during removal; snags created in this way may create foraging and nesting habitat for a variety of animals (Meyers-Rice and Tu, 2001).

Once nonnative plants are effectively treated, it may be important to promote native plant competition through plantings, especially if the infestation has reduced native plant abundance or diversity. Such infestations are relatively uncommon within the higher quality sites at GUCO, so supplemental plantings may not be necessary in these areas. The park's "natural" communities contain a number of native species that would be highly appropriate for restoration efforts elsewhere in the park (Table 7). If sufficient resources are available, we strongly recommend that the park considers establishing a small nursery for the production of native plants using seed sources from within the park and other suitable local sites. Planting local ecotypes of desirable species may help reduce the chances of re-infestation and speed up the process of community restoration, thereby contributing to the realization of larger management goals. Additionally, the park appears to have an active volunteer community which may be willing to participate in planting events; this could be an important way to increase awareness among visitors and/or local residents.

Table 7. Native woody species for restoration at GUCO. Areas of low native plant diversity or abundance may benefit from plantings after treatment of invasives. Below are some appropriate native woody species that are culturally and ecologically valuable, attractive, and/or under-represented at the park. Asterisks (*) indicate species that were not observed at the park during the nonnative plant census; form is either tree (T) or shrub (S); and habitat is classified broadly as dry (D; e.g., ridge tops and drier uplands) or mesic (M; e.g., bottomlands and moist slopes) sites.

Species Name	Common Name	Form	Habitat
<i>Amelanchier arborea</i>	serviceberry	T	M-D
<i>Asimina triloba</i>	pawpaw	T	M
<i>Betula nigra</i> *	river birch	T	M
<i>Carya</i> spp.	hickories	T	D,M
<i>Celtis tenuifolia</i>	dwarf hackberry	T	D-M
<i>Crataegus</i> spp.	hawthorns	T	M-D
<i>Diospyros virginiana</i>	persimmon	T	M,D
<i>Fagus grandifolia</i>	American beech	T	M
<i>Fraxinus</i> spp.	ashes	T	M,D
<i>Magnolia tripetala</i> *	umbrella tree	T	M
<i>Morus rubra</i>	red mulberry	T	M
<i>Nyssa sylvatica</i>	blackgum	T	M,D
<i>Ostrya virginiana</i> *	hop-hornbeam	T	M
<i>Quercus</i> spp.	oaks	T	M,D
<i>Ulmus</i> spp.	elms	T	M
<i>Aesculus sylvatica</i> *	painted buckeye	S/T	M
<i>Ilex decidua</i>	possumhaw	S/T	M-D
<i>Styrax grandifolia</i> *	bigleaf snowbell	S/T	M-D

Table 7 Continued

Species Name	Common Name	Form	Habitat
<i>Aronia arbutifolia</i>	choke berry	S	M
<i>Ceanothus americanus</i>	New Jersey tea	S	M-D
<i>Cornus amomum</i>	silky dogwood	S	M
<i>Corylus americana</i>	hazel	S	M
<i>Euonymus americanus</i>	strawberry bush	S	D,M
<i>Hamamelis virginiana</i>	witch-hazel	S	M
<i>Ilex verticillata</i>	winterberry	S	M
<i>Lindera benzoin</i>	spice bush	S	M
<i>Rhododendron</i> spp.	azaleas	S	D,M
<i>Rosa palustris</i>	swamp rose	S	M
<i>Staphylea trifolia</i> *	bladdernut	S	M
<i>Viburnum</i> spp.	viburnums	S	M,D

Several areas outside of the park harbor nonnative invasives that may spread to the higher quality forest communities in GUCO. Residential properties along the park's northern boundary contain numerous invasive and potentially invasive species that spread across the property line, threatening the adjacent high quality oak – hickory forest. During a reconnaissance survey along the northern park boundary, 27 neighboring residential properties, extending from the northern parking lot to Richland Creek, were casually inspected for nonnatives/invasives; each property had several potentially invasive species within approximately 6 m of the park fence, and a total of 19 forest invasives were recorded. It will be important to inform and involve local residents in order to reduce this potential threat. Pamphlets with information on invasive plants (including impacts, identification, potential native alternatives, etc.) should be created or adapted and distributed among local communities as part of a larger outreach/prevention program. Country Park also contains many invasive species, which may threaten the few narrow stretches of high quality American beech – northern red oak slope forest in the eastern third of the park. Working with managers at Country Park to reduce these threats will therefore be important. Kudzu (*Pueraria montana* var. *lobata*), which was not recorded at GUCO during this census but has

been treated within the park in recent years, was observed as a large infestation on the corner of British Lakes Road and Old Battleground Road, just one block south of the park boundary. This infestation is of particular concern because it is very close to a high quality/priority example of dry – mesic oak – hickory forest and should therefore be continually monitored to ensure that it does not spread on to park property.

Successional Forest Communities

Successional forest communities contain disproportionately more invasive nonnatives than higher priority sites at GUCO. Most Priority 1 and 2 species have between approximately 50-65% of their recorded occurrences within successional forests, with the exception of common periwinkle, which has only 33% of records in these sites. Management of invasive nonnatives within these communities should emphasize controlling species/infestations that immediately or potentially threaten higher quality sites and/or ecosystem functioning and successional trajectories. Most of this information is factored into species rankings and urgency ratings but further examination of species maps and field conditions will be necessary to efficiently allocate management resources. The patches of mixed pine and tulip-poplar successional forests west of the Visitor's Center, throughout the drained Lake Wilfong bed, and adjacent to Tour Stop 7 are of most concern among these community types because of their proximity to several high priority/quality forests. The eastern half of the park, which is dominated by various successional forest types, contains approximately 57% of all non-native plant records at GUCO though it only covers ~ 39% of the total land area. Invasive plants in this sector pose a direct threat to high quality slope communities and high priority stream communities. Control actions should be first directed toward infestations that are close to or likely to spread into these communities. Nonnatives should be located, treated, and monitored as described above for Natural Communities. Emphasis should be placed on limiting disturbance to soils and damage to non-target (i.e., native) vegetation.

Active planting of native vegetation may be a crucial component of effective restoration in these successional communities. The park should ideally produce or obtain native plants from local sources and plant this material after invasives have been treated. This is likely to be most important in areas where dense infestations have reduced native plant diversity and abundance. Efforts to restore understory and ground layers by planting native shrubs, vines, and forbs/herbs will not only help reduce the likelihood of re-infestation by invasives (Kennedy et al., 2002) but will also be a major step towards historical rehabilitation of the battlefield. Indeed, the often dense forest underbrush was a key feature of the battle-era landscape at Guilford Courthouse, significantly affecting strategies and outcomes of the battle (Hiatt, 2003).

Culturally Modified Communities

Culturally modified communities and other highly disturbed sites should be managed through a combination of treatment and monitoring. Reducing the extent and severity of wisteria infestations (Wisteria Vineland Community) is the highest priority among this group. Three major areas of infestation have been identified: within the patch of mixed-pine successional forest directly in front (west) of the Visitor Center; the area of the old Lake Wilfong pond bed;

and the area just west of the meadow at Tour Stop 6. The infestation near the Visitor Center, although relatively small and not particularly dense, is of concern because of its proximity to a high quality patch of oak – hickory dry – mesic forest. Ongoing control efforts have greatly reduced the extent of infestation at the Lake Wilfong site; similar attention should be given to the two other smaller sites. Patches and traces observed downstream from the lake bed site, especially in the area of Schenck’s Field, should be located and treated to avoid spread to higher quality sites. Traces of wisteria along the northern property line should be located and monitored, if not removed, immediately. As wisteria can form monocultures that shade out or strangle trees and shrubs, it may be necessary to plant native species after treatment of these areas. While control efforts have been somewhat successful in the Lake Wilfong area, several sections currently have a very sparse canopy, understory, and/or ground layer, and patches of exposed soil are observed throughout. Planting natives in this area may help speed up successional processes and protect the exposed soil. Much of the better developed soil in this area has likely been lost to erosion, so some form of amendment(s) may be necessary to improve soil properties for better plant growth and survival.

All wisteria sites should be monitored at least yearly to evaluate control efforts, document changes in distribution, and note overall vegetation response after treatment. Other invasive plants (e.g., Japanese stilt grass in the lake bed site) may spread to the treated areas once wisteria is removed; planting native species may lessen this risk slightly but control measures will likely be necessary.

The Park’s cultivated meadows should be monitored for the spread of problematic invasives. The many common nonnatives found in these communities co-exist with a surprisingly high diversity of native grasses and forbs. Given that these systems are by no means nonnative monocultures, and it would be difficult to treat the nonnative plants without also harming native species, meadows do not currently warrant management attention beyond monitoring for spread and arrival of problematic species. Cogon grass (*Imperata cylindrica*), in particular, should be watched for attentively within the park’s meadows and other clearings. While this species has not been reported in North Carolina, it is an extremely problematic species further south and appears to be spreading northward. The best chance of dealing with this and other species, should they arrive at the park, will be through early detection and rapid response.

Tall fescue (*Lolium arundinaceum*) is present in high concentrations in most of the meadows, but unless park managers have a comprehensive restoration plan (e.g., including reintroduction of appropriate native species after removal of fescue and use of fire to maintain native prairie vegetation) it is probably not worthwhile to treat these areas because of the risk of subsequent invasion by other abundant field nonnatives. Additionally, plans to move the Third Line clearing make it somewhat uneconomical to invest park resources in prairie restoration at the moment; this will be more worthwhile once a permanent position is established for this and other clearings (e.g., the proposed First Line field). During reforestation of the current Third Line clearing (Schenck’s Field) it will be important to monitor and control problematic invasives in the area so that planted materials can become established; fescue should be treated around the base of each planted tree or shrub to reduce root competition, and the dense infestation of wisteria along the creek within the clearing should be treated and watched carefully to prevent interference with forest regeneration.

Species of high control priority in the cultivated meadow and shrub thicket communities of the Kotis Tract (southwest corner of the park) should be located and treated to prevent further spread into the park's high quality oak - hickory forest. Several forest invasives are highly abundant in and adjacent to the cultivated meadow at Stop 6; priority rankings should guide control actions here. Paper mulberry is ranked as a Priority 3 species but managers may consider giving it somewhat higher priority in the area near Stop 6 because of its poor aesthetic qualities and tendency to harbor other invasives (e.g., multiflora rose and Chinese privet) within its thickets. The species forms highly visible, unsightly weed patches in an area that receives many visitors. Removal of paper mulberry from this area could be an appropriate job for the prison crews that occasionally work at the park; as there are few-to-no native species within the mulberry thickets, this work would not require a great deal of care. A few native shade trees could be planted in place of the paper mulberry, if such action is in keeping with overall management goals for the area.

Other highly modified sites (e.g., areas around park buildings and intensively managed clearings at tour stops) warrant management action similar to that recommended for cultivated meadows. These sites should be monitored periodically for forest invasives, but until a comprehensive restoration plan is in place it may not be worthwhile to treat the many ubiquitous field weeds that are present. Two of these sites (the Andrews Tract and the Utility Building yard), however, should be the focus of active weed control because of the abundance of forest invasives they contain and their proximity to higher priority forest communities. Much of the Andrews Tract is overrun by some of the park's most problematic invasives, including tree-of-heaven, multiflora rose, and thorny olive, among others. All of these species are invading the nearby oak – hickory forest (especially in the area directly in front (east) of the Andrews Tract, near the parking lot), possibly from sources located in the Andrews Tract. Tree of heaven is the highest priority species for control in the Andrews Tract, but other species should receive management attention according to priority rankings. If the tract will remain essentially as a residential yard, native ornamental species could be used to adorn the various structures (the house, barn, and hangar) in place of the many nonnatives currently present. This area will require at least yearly monitoring and follow up treatments to ensure that invasives do not persist or re-establish. The area around the Utility Building should be treated similarly. Japanese honeysuckle, fragrant honeysuckle, and autumn olive are more problematic at this site; these and others should be treated in order of priority. The area around (in particular, just west of) the work yard should be cleaned of the various wood piles and other forms of debris, which limit access to areas of dense infestations and perhaps inhibit tree growth along the forest edge. After cleaning this area, native trees should be planted throughout the weedy edge zone.

SPECIFIC CONTROL PLANS FOR HIGH PRIORITY NONNATIVE SPECIES

Thirty-three nonnative forest species were given an urgency rating of medium or high within their priority blocks (1-4). Specific control plans for each of these species are given below. Each control plan provides the following information: priority ranking; species description; distribution map and notes; damage and threats posed by the species; measureable management objectives; control options; and actions planned. Species descriptions, damage/threat potentials,

and control options are often quoted from sources as cited; information in other sections is entirely specific to GUCO. The Nature Conservancy's Site Weed Management Plan Template (TNC, 2001) includes 2 other relevant sections, Goals and Evaluation; as these are generally the same for species in the same priority group or between similar priority groups (e.g., easier to control species of Priority 1 and Priority 3) they will not be included in each control plan but instead will be stated once here by priority group(s).

Species that were ranked as Priority 1 or Priority 3 were determined to be somewhat easier to control based on species characteristics and/or distribution patterns in the park. Based on the predicted (relative) ease of control, the **Goal for Priority 1 and Priority 3 species is: eradicate from GUCO**. Common periwinkle and Japanese wisteria are both Priority 2, but given their relative containment and, in the case of wisteria, the progress made from previous control efforts, the management goal of eradication is also reasonable for these 2 species. Priority 2 and Priority 4 species are more difficult to control. The management **Goal for Priority 2 and Priority 4 species is: reduce populations and control spread within high quality sites in GUCO**.

The following evaluation statement is for all control actions:

HOW ACTIONS WILL BE EVALUATED (Criteria for success): Treated areas will be monitored for regeneration of invasives and native plant response to control efforts. These sites will be checked yearly for signs of regeneration by the species in question and/or other invasive species. The presence or absence of invasives and the extent of infestation will be added to GIS files to track the contraction or expansion of invasives within the park. Censuses similar to the one described in this report will be conducted at least every third year to detect new infestations and further track the spread of current ones. Diversity and abundance of native species in treated areas will be recorded. If native species are planted, survival and growth will also be recorded yearly. For Priority 1 and Priority 3 species, efforts will be considered successful if eradication is achieved and native plants regenerate at former sites of infestation. The species will be considered eradicated from the site of infestation when 2 consecutive years of no re-growth are observed. For Priority 2 and Priority 4 species, efforts will be considered successful if population sizes are reduced, spread of invasives within high quality sites is not observed, and native plants regenerate at sites of infestation. General assessments of control measures will be made yearly after monitoring data are collected; control efforts will be modified based on these data. A major evaluation of control efficacy will be conducted after 5 years of treatment and monitoring; a new management plan will be produced, or the old one updated, to reflect this information.

Scientific name: *Lonicera fragrantissima*
Updated: August 2008

Common name: Fragrant Honeysuckle

A. PRIORITY: 1

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Nonnative Bush Honeysuckles** (Williams, 2005):

“Nonnative bush honeysuckles are upright, generally deciduous shrubs that range from 6 to 15 feet in height. The 1-2 ½ inch, egg-shaped leaves are opposite along the stem and short-stalked. Older stems are often hollow. Pairs of fragrant, tubular flowers less than an inch long are borne along the stem in the leaf axils. Flower color is creamy white (in fragrant honeysuckle). Flowering generally occurs from early to late spring, but varies for each species and cultivar. The fruits are red to orange, many-seeded berries. Native bush honeysuckles may be confused with these nonnative species and cultivars, so proper identification is necessary. Unlike the nonnatives, most of our native bush honeysuckles have solid stems (Williams, 2006).”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Nonnative Bush Honeysuckles** (Williams, 2005):

“Nonnative bush honeysuckles can rapidly invade and overtake a site, forming a dense shrub layer that crowds and shades out native plant species. They alter habitats by decreasing light availability, by depleting soil moisture and nutrients, and possibly by releasing toxic chemicals that prevent other plant species from growing in the vicinity. Nonnative bush honeysuckles may compete with native bush honeysuckles for pollinators, resulting in reduced seed set for native species. In addition, the fruits of nonnative bush honeysuckles, while abundant and rich in carbohydrates, do not offer migrating birds the high-fat, nutrient-rich food sources needed for long flights, that are supplied by native plant species (Williams, 2006).”

D. CURRENT DISTRIBUTION ON THE SITE

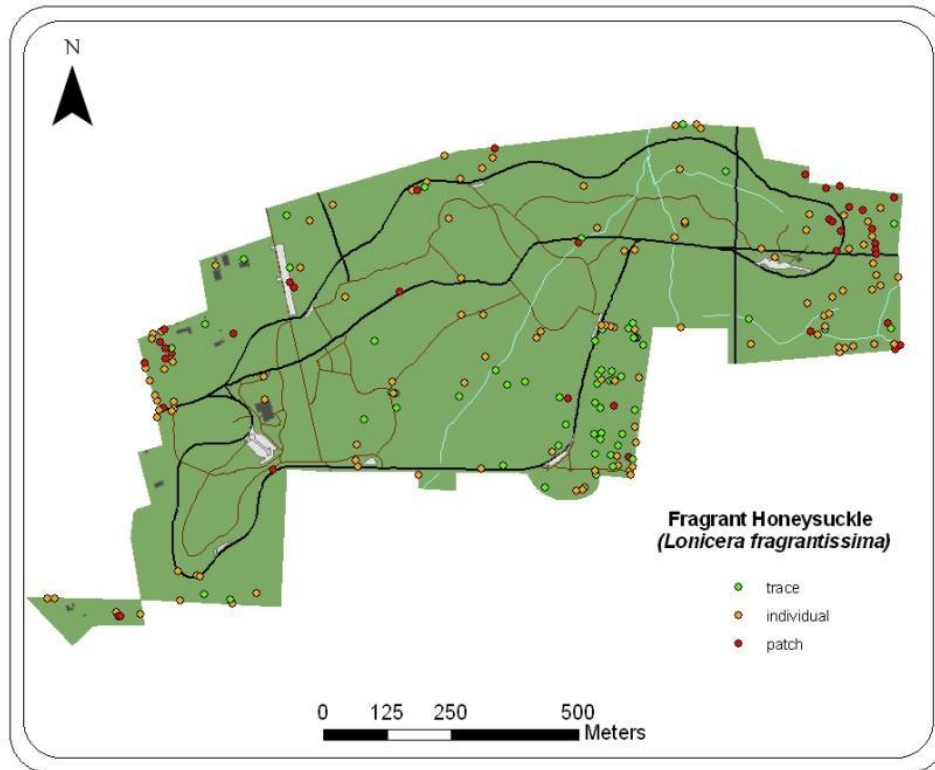


Figure 5. Distribution of Fragrant honeysuckle. This species occurs scattered throughout the park but is most abundant in the eastern half, especially in the area of the Drive-In and Petting Zoo Tracts. Although it is found mostly in successional forests and heavily disturbed sites, the species occurs within and adjacent to higher quality sites in the area of the northern parking lot.

E. OBJECTIVE (Measurable)

- 1) Locate and treat fragrant honeysuckle in areas where it is most abundant and/or threatening to high quality communities in the park.
- 2) Locate and treat fragrant honeysuckle in areas where it is less abundant or problematic.
- 3) Monitor these sites yearly for regeneration and new infestations, and re-treat as needed.
- 4) Provide information on invasive plants (including native alternatives in landscaping) to residents of nearby neighborhoods, especially in the community immediately north of the park where fragrant honeysuckle and other invasives occur in many yards.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Nonnative Bush Honeysuckles** (Williams, 2005):

“Mechanical and chemical methods are the primary means of control of nonnative bush honeysuckles. No biological control agents are currently available for these plants and any potential agents that might be considered would have to be specific to the nonnative species, for obvious reasons. Hand removal of seedlings or small plants may be useful for light infestations, but care should be taken not to disturb the soil any more than necessary. In shaded forest habitats, where nonnative bush honeysuckles tend to be less resilient, repeated clippings to ground level, during the growing season, may result in high mortality. Clipping must be repeated at least once yearly because bush honeysuckles that are cut once and left to grow will often form stands that are more dense and productive than they were prior to cutting.

Seedlings of nonnative bush honeysuckles can also be controlled by application of a systemic herbicide, like glyphosate (e.g., Roundup®), at a 1 percent solution, sprayed onto the foliage or applied by sponge. Well established stands of nonnative bush honeysuckles are probably best managed by cutting the stems to ground level and painting or spraying the stumps with a slightly higher rate of glyphosate (2-3%). Prescribed burning has shown some promise for nonnative bush honeysuckles growing in open habitats. In all instances, control should be initiated prior to the seed dispersal period (late summer to early autumn) to minimize reinvasion of treated habitats.”

G. ACTIONS PLANNED (Treatments and monitoring)

The following sites will be treated first: the area west of the Utility Building, the entire portion of the park east of the Martin Trespass Rd (the Drive-In Tract), and the old Petting Zoo site. Treatment methods will include foliar and cut-treat applications (depending on plant size) with an appropriate herbicide. In higher quality sites, seedlings will be repeatedly hand pulled and larger shrubs will be repeatedly clipped until control is achieved. This may require 3 to 5 years of repeated yearly treatments depending on the site. Seedlings will be located and removed throughout the growing season. Large infestations will be treated in the summer or early fall. In areas of dense infestation, native shrub species will be planted during the dormant season after fragrant honeysuckle has been treated.

Scientific name: *Ailanthus altissima*
Updated: August 2008

Common name: Tree of Heaven

A. PRIORITY: 1

B. DESCRIPTION

Tree of heaven is a medium sized deciduous tree to 80 feet (25 m) in height. Its large pinnately compound leaves have distinctive circular glands near leaflet bases and emit a strong odor, likened to peanuts, when crushed. The species is dioecious, and female trees produce prolific amounts of samara fruits for seed dispersal. Vegetative reproduction from root sprouts facilitates thicket formation. This species is native to Central China but was introduced to the United States via Europe in 1784 as an ornamental (Miller, 2003).

C. DAMAGE AND THREATS

Tree of heaven can form dense stands and thickets to the exclusion of native vegetation. The species is allelopathic, releasing root toxins that inhibit the growth of other species. Heavily infested sites can be nearly impenetrable. In addition, the species has very low wildlife value, and probably displaces more-important native species (Swearingen and Pannill, 2005).

D. CURRENT DISTRIBUTION ON THE SITE

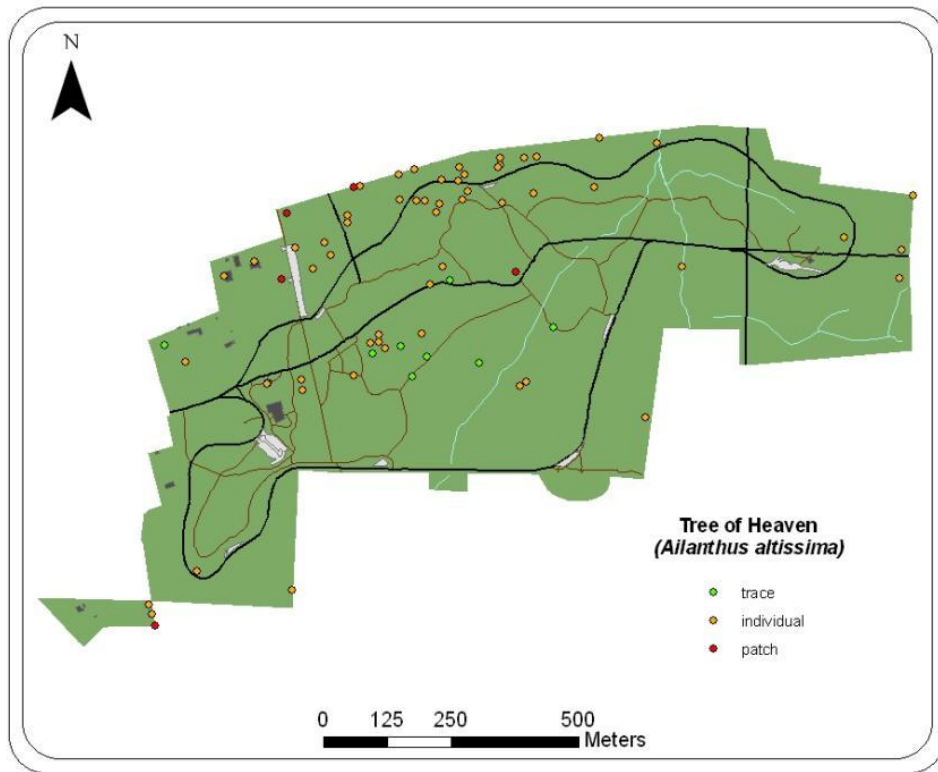


Figure 6. Distribution of tree of heaven. This species is most abundant in the area north and east of the northern parking lot on Old Battleground Road. It is also relatively abundant around the Andrews Tract property and in the southeast corner of the Kotis Tract. In other parts of the park it occurs mostly as scattered individuals or traces along forest edges and in small clearings within the interior.

E. OBJECTIVE (Measurable)

- 1) Locate and treat tree of heaven in areas where it is most abundant and/or threatening to high quality communities in the park.
- 2) Locate and remove tree of heaven from areas where it is less abundant or problematic.
- 3) Monitor treated sites yearly for regeneration and/or new infestations and re-treat as needed.
- 4) Provide information on invasive plants (including native alternatives in landscaping) to residents of nearby neighborhoods, especially in the community immediately north of the park where tree-of-heaven and other invasives occur in many yards.

F. MANAGEMENT OPTIONS

- 1) **Mechanical control.** Grub or hand pull seedlings in areas where herbicide use could cause excessive damage to nearby native vegetation (e.g., in the higher quality/diversity forest communities in the western portion of the park, beech slope communities, etc.) and/or the local population is small enough to make such methods feasible. All roots should be removed to avoid resprouting. Larger specimens and root sprouts will be difficult to remove effectively. Cutting alone is not recommended unless the infestation is very small and/or in an area of dense shade where repeated efforts will eventually exhaust the plants' reserves. Initial cutting may be most effective in early summer when root reserves are lowest (Swearingen and Pannill, 2005). Mechanical methods will need to be repeated at least yearly for many years and monitoring of treated sites will be ongoing.
- 2) **Chemical Control** [From **Nonnative Invasive Plants of Southern Forests** (Miller, 2003)]:
 - “Recommended control procedures:
Large trees. Make stem injections and then apply Garlon 3A, Pathway*, Pathfinder II, or Arsenal AC* in dilutions and cut spacings specified on the herbicide label (midsummer best, late winter somewhat less effective). For felled trees, apply these herbicides to stem and stump tops immediately after cutting.
Saplings. Apply Garlon 4 as a 20-percent solution in commercially available basal oil, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray.
Seedlings and saplings. Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC (note: non-target plants may be killed or injured by root uptake of this herbicides) as a 1-percent solution (4 ounces per 3-gallon mix), Krenite S as a 30-percent solution (3 quarts per 3-gallon mix), or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix).”

G. ACTIONS PLANNED (Treatments and monitoring)

Infestations in the area near the northern parking lot, in the Andrews Tract , and along the northern property line will be treated first. Mid-to-late summer applications of appropriate herbicides via stem injection and foliar application will be used. The Kotis Tract and the small infestation near Schenck's Field will be treated similarly after priority is first given to areas of greater concern. Park staff should be trained to properly identify this species and remove scattered individuals or traces whenever they are encountered. In areas of dense infestation, native trees and shrubs will be planted during the dormant season after treatment. Treated sites will be monitored yearly, beginning the following growing season.

Scientific name: *Elaeagnus pungens*
Updated: August 2008

Common name: Thorny olive

A. PRIORITY: 1

B. DESCRIPTION

From **Invasive.org weed fact sheet: thorny olive** (Bugwood Network, 2007):

“Thorny olive is a dense evergreen shrub that invades natural areas throughout the southeastern United States. The shrub is often multi-stemmed and short. Sharp shoots give it a thorny appearance. Shrubs can grow 3.3-26.3 ft. (1-8 m) tall. Shrubs are usually very dense with long shoots extending from the top. The leaves are alternate, oval to elliptical, with irregular wavy margins and silvery surfaces, 2-4 in. (5.1-10.2 cm) in length and thick... Small, sweet-smelling, white to brown flowers develop in the fall... Fruit are small, red and dotted with small brown scales. Thorny olive closely resembles... autumn olive and Russian olive. A high shade tolerance allows thorny olive to invade both in open areas and under forest canopies... Seeds are dispersed by animals, giving this plant the potential for rapid spread. Thorny olive is native to eastern Asia and was first introduced into the United States in 1830 as an ornamental.”

C. DAMAGE AND THREATS

Thorny olive invades forest interiors and shades-out native plant species under its dense, evergreen foliage. Herbaceous spring ephemerals could be impacted by increased shade from this and other evergreen species. As with other members of the genus, thorny olive is capable of nitrogen fixation, and may thereby affect larger ecosystem processes such as nutrient cycling (Ehrenfeld, 2003).

D. CURRENT DISTRIBUTION ON THE SITE

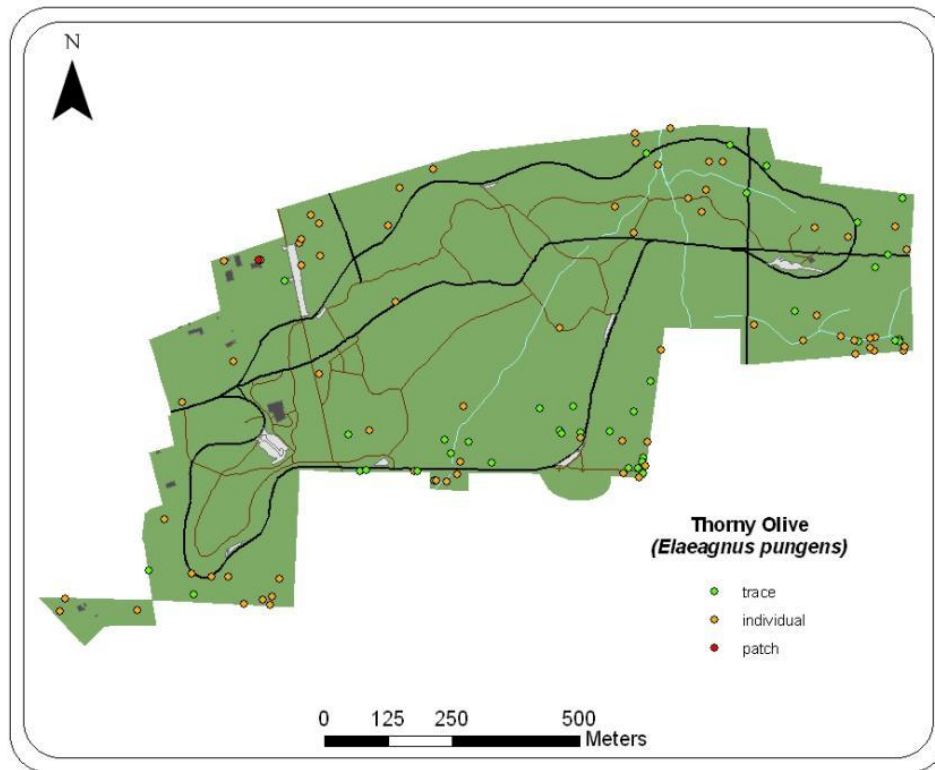


Figure 7. Distribution of thorny olive. This species occurs as scattered individuals in several sections of the park. Some of the largest examples are in the southeast corner of the park, the southwestern portion of the park adjacent to Old Battleground Road, and in the area near the northern parking lot, including the Andrews Tract.

E. OBJECTIVE (Measurable)

- 1) Locate and treat large specimens and patches of thorny olive in areas in/near high quality forest communities.
- 2) Locate and remove thorny from areas where it is less abundant or problematic.
- 3) Monitor treated sites yearly for regeneration and new infestations, and re-treat as needed.
- 4) Provide invasive plant information to local residents and work in coordination with nearby parks (e.g., Country Park) to remove and/or decrease the use of thorny olive in the surrounding area.

F. MANAGEMENT OPTIONS

- 1) Mechanical control.** Grub or hand pull seedlings in areas where herbicide use could cause excessive damage to nearby native vegetation (e.g., in the higher quality/diversity forest communities in the western portion of the park, beech slope communities, etc.) and/or the local population is small enough to make such methods feasible. All roots should be removed to avoid resprouting. Larger specimens in shaded areas may be cut repeatedly for several years until control is achieved. Initial cutting should be made in the early summer when root reserves are lowest.
- 2) Chemical Control** [From **Nonnative Invasive Plants of Southern Forests** (Miller, 2003)]:

“Thoroughly wet all leaves with Arsenal AC* or Vanquish* as a 1-percent solution in water (4 ounces per 3-gallon mix) with a surfactant (April to October). For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in commercially available basal oil, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray (January to February or May to October). Or, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC (note: non-target plants may be killed or injured by root uptake of this herbicide) as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix).”

G. ACTIONS PLANNED (Treatments and monitoring)

Large shrubs in the forests around the Visitor Center, the northern parking lot, and in the southeast corner of the park will be located and treated via cut-treat herbicide application during the summer or early fall. Small specimens will be located and removed mechanically or by foliar herbicide application throughout the growing season. All treated sites will be monitored yearly beginning the following growing season. Informational pamphlets will be adapted or created and distributed to neighboring communities where thorny olive is commonly used as an ornamental hedge shrub. Communication with managers at Country Park will be necessary to promote the removal and/or discontinuation of further planting of thorny olive in Country Park.

Scientific name: *Celastrus orbiculatus*
Updated: August 2008

Common name: Asiatic bittersweet

A. PRIORITY: 2

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Oriental Bittersweet** (Swearingen, 2006):

“Oriental bittersweet is a deciduous woody perennial plant which grows as a climbing vine and a trailing shrub. Stems of older plants 4 inches in diameter have been reported. The leaves are alternate, glossy, nearly as wide as they are long (round), with finely toothed margins. There are separate female (fruiting) and male (non-fruiting) plants. Female plants produce clusters of small greenish flowers in axillary clusters (from most leaf axils), and each plant can produce large numbers of fruits and seeds. The fruits are three-valved, yellow, globular capsules that at maturity split open to reveal three red-orange, fleshy arils each containing one or two seeds. The abundance of showy fruits have made Oriental bittersweet extremely popular for use in floral arrangements.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Oriental Bittersweet** (Swearingen, 2006):

“Oriental bittersweet is a vigorously growing vine that climbs over and smothers vegetation which may die from excessive shading or breakage. When bittersweet climbs high up on trees the increased weight can lead to uprooting and blow-over during high winds and heavy snowfalls. In addition, Oriental bittersweet is displacing our native American bittersweet (*Celastrus scandens*) through competition and hybridization.”

D. CURRENT DISTRIBUTION ON THE SITE

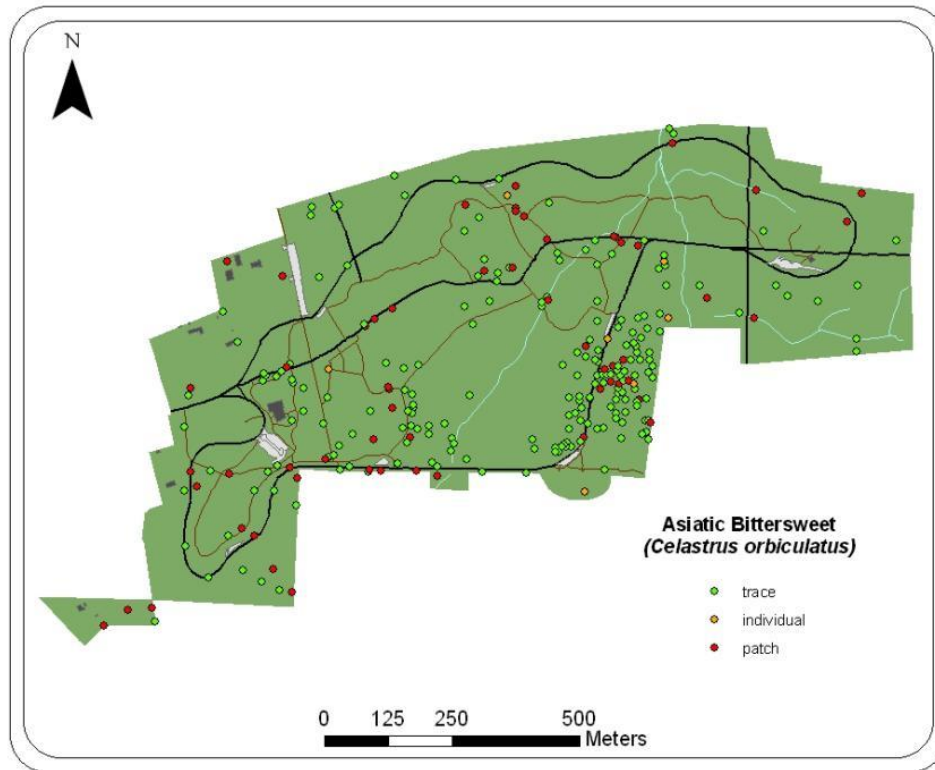


Figure 8. Distribution of Asiatic bittersweet. This species occurs scattered throughout the park as traces and patches of varying sizes. It is most abundant in the old Petting Zoo site (east of Tour Road, between Stops 4 & 5) but is also problematic in the general area of Schenck's Field, the Andrews Tract, and throughout the western portion of the park as small patches.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of Asiatic bittersweet in the high quality forests of the park's western half.
- 2) Treat patches and traces of bittersweet in the Petting Zoo area and around Schenck's Field.
- 3) As resources allow, locate and treat bittersweet in areas where it is less abundant or problematic.
- 4) Monitor these sites yearly for regeneration and new infestations, and re-treat as needed.
- 5) Plant native trees and shrubs in areas where native diversity/abundance has been reduced.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Oriental Bittersweet** (Swearingen, 2006):

- 1) **Mechanical control.** “Small infestations can be hand-pulled but the entire plant should be removed including all the root portions. If fruits are present, the vines should be bagged in plastic trash bags and disposed of in a landfill. Always wear gloves and long sleeves to protect your skin from poison ivy and barbed or spined plants. For climbing vines, first cut the vines near the ground at a comfortable height to kill upper portions and relieve the tree canopy. Vines can be cut using pruning snips or pruning saw for smaller stems or a hand axe or chain saw for larger vines. Try to minimize damage to the bark of the host tree. Rooted portions will remain alive and should be pulled, repeatedly cut to the ground or treated with herbicide. Cutting without herbicide treatment will require vigilance and repeated cutting because plants will resprout from the base.”
- 2) **Chemical Control.** “Systemic herbicides like triclopyr (e.g., Garlon® 3A and Garlon® 4) and glyphosate (e.g., Accord®, Glypro®, Rodeo®) are absorbed into plant tissues and carried to the roots, killing the entire plant within about a week. This method is most effective if the stems are first cut by hand or mowed and herbicide is applied immediately to cut stem tissue. Herbicide applications can be made any time of year as long as temperatures are above 55 or 60 degrees Fahrenheit for several days and rain is not expected for at least 24 hours. Fall and winter applications will avoid or minimize impacts to native plants and animals. Repeated treatments are likely to be needed. In areas where spring wildflowers or other native plants occur, application of herbicides should be conducted prior to their emergence, delayed until late summer or autumn, after the last killing frost occurs, or carefully targeted. Herbicidal contact with desirable plants should always be avoided. If native grasses are intermingled with the bittersweet, triclopyr should be used because it is selective for broad-leaved plants and will not harm grasses. Follow-up monitoring should be conducted to ensure effective control. Glyphosate products referred to in this fact sheet are sold under a variety of brand names (Accord®, Rodeo®, Roundup Pro® Concentrate) and in three concentrations (41.0, 50.2 and 53.8% active ingredient). Other glyphosate products sold at home improvement stores may be too dilute to obtain effective control. Triclopyr comes in two forms – triclopyr amine (e.g., Garlon® 3A, Brush-B-Gone®, Brush Killer®) and triclopyr ester (e.g., Garlon® 4, Pathfinder®, and Vinex®). Because Garlon® 3A is a water-soluble salt that can cause severe eye damage, it is imperative that you wear protective goggles to protect yourself from splashes. Garlon® 4 is soluble in oil or water, is highly volatile and can be extremely toxic to fish and aquatic invertebrates. It should not be used in or near water sources or wetlands and should only be applied under cool, calm conditions.
Basal bark application
Use a string trimmer or hand saw to remove some of the foliage in a band a few feet

from the ground at comfortable height. To the exposed stems, apply a 20% solution of triclopyr ester (Garlon® 4) (2.5 quarts per 3-gallon mix) in commercially available basal oil with a penetrant (check with herbicide distributor) to vine stems. As much as possible, avoid application of herbicide to the bark of the host tree. This can be done year-round although efficacy may vary seasonally; temperatures should be above 50°F for several days.

Cut stem application

Use this method in areas where vines are established within or around non-target plants or where vines have grown into the canopy. Cut each vine stem close to the ground (about 2 in. above ground) and immediately apply a 25% solution of glyphosate (e.g., Accord®) or triclopyr (e.g., Garlon® 3A) mixed with water to the cut surface of the stem. The glyphosate application is effective at temperatures as low as 40°F and a subsequent foliar application may be necessary. The triclopyr application remains effective at low temperatures (<60°F) as long as the ground is not frozen. A subsequent foliar application may be necessary to control new seedlings. Homeowners can apply products like Brush-B-Gone®, Brush Killer® and Roundup Pro® Concentrate undiluted to cut stems. Using a paint brush or a plastic spray bottle, apply herbicide to the cut surface.

Foliar application

Use this method to control extensive patches of solid bittersweet . It may be necessary to precede foliar applications with stump treatments to reduce the risk of damaging non-target species. During foliar applications some of the herbicide is also absorbed through the stem for additional (basal bark) effect. Apply a 2% solution (8 oz per 3 gal. mix) triclopyr ester (Garlon® 4) or triclopyr amine (Garlon® 3A) mixed in water with a non-ionic surfactant to the leaves. In Rhode Island, concentrations as low as 1% in mid-summer and 0.05% in September have been very effective. Thoroughly wet the foliage but not to the point of runoff. The ideal time to spray is after much of the 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. If the 2% rate is not effective try an increased rate of 3-5%. Ambient air temperature should be above 65°F.

For dense, low patches of bittersweet another alternative is to cut the entire patch to the ground early in the growing season. About one month later, apply 1-2% solution of triclopyr ester (Garlon® 4) or triclopyr salt (Garlon® 3A) in water to the previously cut patch using a backpack sprayer. This method has resulted in complete rootkill of the bittersweet and no off-target damage or root uptake by adjacent plants.”

G. ACTIONS PLANNED (Treatments and monitoring)

Patches of bittersweet in high priority forest communities will be located and treated in the summer or early fall. Small patches will be removed by hand, and larger patches will receive appropriate chemical treatment. Repeated applications and monitoring will begin the following growing season. Areas such as the old Petting Zoo site, where ephemerals are largely absent and the native understory appears relatively impoverished, will be

treated similarly but with less restrictions on timing and/or herbicide specificity because of the lower likelihood of damaging native plants. Care will be taken to avoid excessive soil disturbance. Areas of dense infestation where native vegetation is sparse will be replanted with native shrub/tree species during the dormant season after treatment. All sites will be monitored yearly for resprouting, invasion by other species, and native plant response to control measures.

Scientific name: *Elaeagnus umbellata*
Updated: August 2008

Common name: Autumn-olive

A. PRIORITY: 2

B. DESCRIPTION

From **Invasive.org weed fact sheet: autumn olive** (Bugwood Network, 2007):

“Autumn olive is a deciduous shrub from 3-20 ft. (0.9-6.1 m) in height. It is easily recognized by the silvery, dotted underside of the leaves. Leaves are alternate and 1 in. (2.5 cm) wide. Small, yellowish flowers are abundant and occur in clusters near the stems in May to June. Fruits are red, juicy, and edible. Fruits ripen from September to November. Autumn olive invades old fields, woodland edges, and other disturbed areas. (The species) is native to China and Japan and was introduced into North America in 1830. Since then, it has been widely planted for wildlife habitat, mine reclamation, and shelterbelts.”

C. DAMAGE AND THREATS

From **Element Stewardship Abstract for *Elaeagnus umbellata*** (Sather & Eckardt, 2001):

“*Elaeagnus umbellata* has the potential of becoming one of the most troublesome adventive shrubs in the central and eastern United States. It exhibits prolific fruiting, rapid growth, is widely disseminated by birds, and can easily adapt to many sites. It is vigorous and competitive against native species, and resprouts after cutting. Due to its nitrogen-fixing capabilities, it has the capacity to adversely affect the nitrogen cycle of native communities that may depend on infertile soils. *E. umbellata* is just beginning to be recognized as a potentially serious problem nonnative. Seeds are still distributed for wildlife plantings in some states such as Missouri, although the state conservation department is working to stop distribution.”

D. CURRENT DISTRIBUTION ON THE SITE

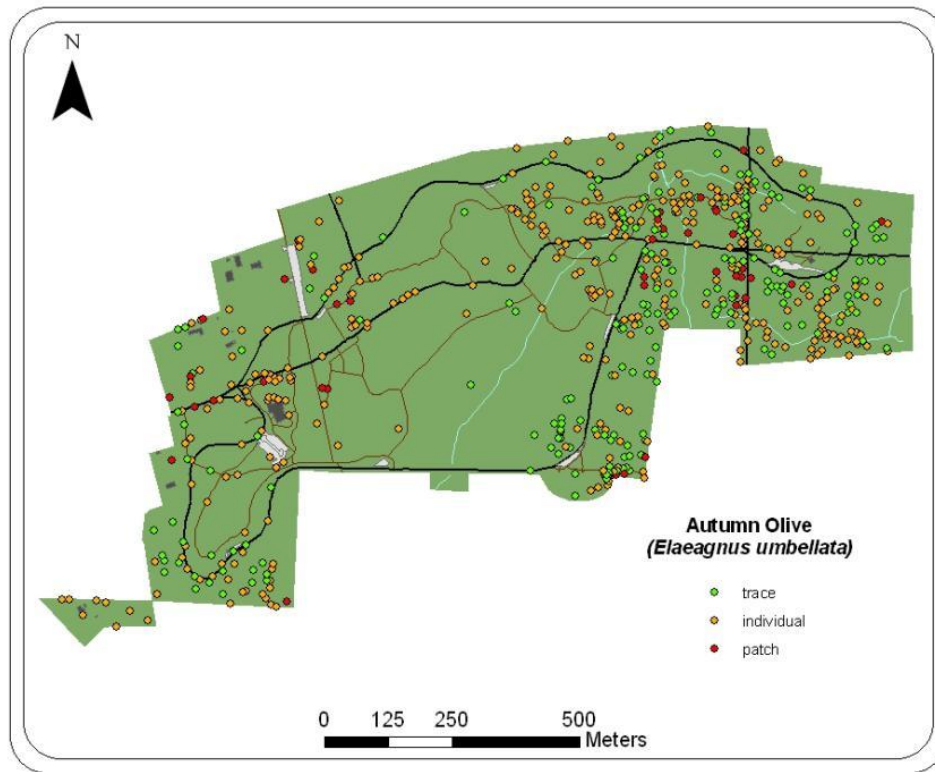


Figure 9. Distribution of autumn olive. This species occurs essentially throughout GUCO as individuals and patches of varying sizes. The eastern half of the park is heavily invaded, especially in the area around Tour Stop 6, but scattered individuals and occasional patches also occur in the more intact forest communities near the Visitor Center. The most problematic area in the western half of the park is the woodlot west of the Utility Building. Autumn olive is fairly uncommon in the central portion of the park, between the Greene Monument and Schenck's Field.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of autumn olive in high quality forests of the park's western half.
- 2) Locate and treat individuals and large infestations in the eastern half of the park.
- 3) Locate and treat autumn olive in areas where it is less abundant or problematic.
- 4) Monitor these sites yearly for regeneration and new infestations, and re-treat as needed.
- 5) Plant native species on sites where native diversity/abundance is low.

F. MANAGEMENT OPTIONS

From **Southeast Nonnative Pest Plant Council Invasive Plant Manual** (Remaley, 2003):

1) Mechanical control.

“Cutting: Cut trees at ground level with power or manual saws. Cutting is most effective when trees have begun to flower to prevent seed production. Because autumn olive 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 of resprouts.

Girdling: Use this method 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 15 cm (6 in) above the ground. Be sure that the cut goes well into or below 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: Autumn olive is effectively controlled by manual 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.”

2) Chemical Control.

“Foliar Spray Method: This method should be considered for large thickets of autumn olive seedlings where risk to non-target species is minimal. Air temperature should be above 65°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 autumn olive, triclopyr can be used without non-target damage.

Cut Stump Method: This control method should be considered when treating 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.

Glyphosate: Horizontally cut stems at or near ground level. Immediately apply a 50% solution of glyphosate and water to the cut stump, covering 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, covering the outer 20% of the stump.

Basal Bark Method: This 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 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.”

G. ACTIONS PLANNED (Treatments and monitoring)

Large individuals and infestation in the western half of the park will be located and treated first. Where damage to nearby native vegetation is a concern, cut-spray or mechanical control procedures will be used. Control efforts will be made in the summer to minimize damage to sensitive spring ephemerals and also prevent fruit/seed maturation of autumn olive. The woodlot west of the Utility Building, especially along service road/trail adjacent to the westernmost fence, will be a focal point in the western half of the park because of the extent of infestation there and the proximity to higher quality sites. Large infestations in the eastern half of the park will be treated similarly but with fewer restrictions on timing and/or herbicide specificity because of the generally-low native understory/groundlayer diversity in many areas where autumn olive is abundant. Removal of autumn olive from beech slope and small stream communities in the eastern half of the park, however, will be done with particular attention to adjacent native vegetation. Areas of dense infestation (e.g., adjacent to the Martin Trespass Road) will be planted with native shrubs during the dormant season after treatment. Monitoring of treated sites will begin the following growing season and continue annually until no re-growth is observed for 2 consecutive years.

Scientific name: *Ligustrum sinense*
Updated: August 2008

Common name: Chinese Privet

A. PRIORITY: 2

B. DESCRIPTION

From **Plant Invaders of Mid-Atlantic Natural Areas** (Swearingen et al., 2002):

“**Plant:** stout, many-branched shrubs in the olive family (Oleaceae); can grow to 15 feet tall. **Leaves:** oval to elliptical on short stalks, in pairs along stem; phenolic compounds in leaves protect against damage from insects. **Flowers, fruits and seeds:** small white flowers grow in clusters at ends of branches; fruits are small blue-black berries produced during late summer to early fall. **Spreads** by seed dispersed by birds and other wildlife that eat the fruits and excrete seeds undamaged; can also grow from stumps and stump sprouts.”

C. DAMAGE AND THREATS

From **Element Stewardship Abstract for *Ligustrum* spp.** (Batcher, 2000):

“*Ligustrum* spp. can form dense thickets that outcompete native vegetation. The privets can invade natural areas such as floodplain forests, woodlands, and disturbed agricultural fields. They generally expand along fence-rows, windbreaks and roadsides (Haragan 1996). In New Zealand, *L. sinense* may displace the shrub layer and marginal shrubs of alluvial forests, and remain persistent in these areas. *L. lucidum* replaces midcanopy trees in forests and may completely dominate an area of forest or forest fragments if not controlled (New Zealand Weeds Web Site 1999). *L. japonicum* and *L. sinense* invade woodlands in the eastern and southeastern U.S. (Faulkner et al. 1989; Stone 1997). Forest gaps can also become invaded since birds often disperse *Ligustrum* seeds.”

D. CURRENT DISTRIBUTION ON THE SITE

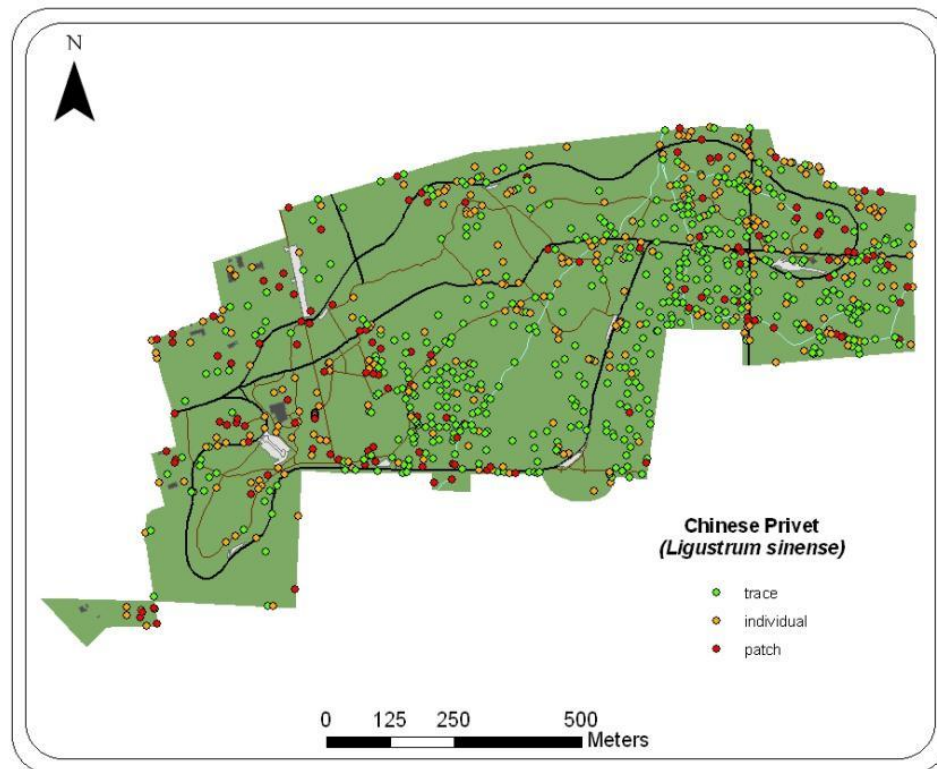


Figure 10. Distribution of Chinese privet. This species occurs throughout GUCO in a variety of habitats. It is present in all areas of the park, and only a few sections of higher quality forest communities are not heavily invaded. The entire western half of the park contains infestations that threaten the relatively intact oak-hickory communities in this sector. Privet is very common in the eastern half of the park; it has invaded the various successional forests and stream communities and threatens high quality beech slope communities.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of Chinese privet in high quality forests of the park's western half.
- 2) Locate and treat individuals and large infestations in the eastern half of the park.
- 3) Locate and treat Chinese privet in areas where it is less abundant or problematic.
- 4) Monitor treated sites yearly for regeneration and new infestations, and re-treat such as needed.
- 5) Plant native species on sites where native diversity/abundance is low.

F. MANAGEMENT OPTIONS

From **Southeast Nonnative Pest Plant Council Invasive Plant Manual** (Remaley, 2003):

1) Mechanical control.

“Mowing/Cutting: This method is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Repeated mowing or cutting will control the spread of privet, but will not eradicate it. Stems should be cut at least once per growing season as close to ground level as possible.

Hand Pulling: Privet is effectively controlled by manual 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. Larger stems, up to 6 cm (2.5 in), can be removed using a Weed Wrench or similar uprooting tools. The entire root must be removed since broken fragments may resprout.”

2) Chemical Control.

“Foliar Spray Method: This method should be considered for large thickets of privet where risk to non-target species is minimal. Air temperature should be above 65 °F to ensure absorption of herbicides. The ideal time to treat is in late fall or early spring when many native species are dormant.

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 privet triclopyr can be used without non-target damage.

Cut Stump Method: This control method should be considered when treating individual bushes or where the presence of desirable species preclude foliar application. This treatment is effective as long as the ground is not frozen.

Glyphosate: Horizontally cut privet 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 privet 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: This 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 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.”

G. ACTIONS PLANNED (Treatments and monitoring)

Large individuals and infestations in the western half of the park will be located and treated first. Where damage to nearby native vegetation is a concern, cut-spray or mechanical control methods will be used. Control efforts will be made in the summer or early fall to minimize damage to sensitive spring ephemerals and also prevent fruit/seed maturation of Chinese privet. Infestations that occur in or border high quality sites (e.g., the large infestation around Tour Stop 3) will be given highest priority. Large infestations in the eastern half of the park will be treated similarly but with fewer restrictions on timing and/or herbicide specificity because of the generally-low native understory/groundlayer diversity in many of the areas where Chinese privet is abundant. Removal of Chinese privet from beech slope and small stream communities in the eastern half of the park, however, will be done with particular attention to adjacent native vegetation. Areas of dense infestation will be planted with native trees and shrubs during the dormant season after the treatment. Yearly monitoring of treated sites will begin the following growing season and continue until no re-growth is observed for 2 consecutive years.

Scientific name: *Hedera helix*
Updated: August 2008

Common name: English Ivy

A. PRIORITY: 2

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: English Ivy** (Swearingen and Diedrich, 2006):

“English ivy is an evergreen climbing vine that attaches to the bark of trees, brickwork, and other surfaces by way of small rootlike structures...Older vines have been reported to reach 1 foot in diameter. Leaves are dark green with white veins, waxy to somewhat leathery, and arranged alternately along the stem. Leaf forms include a 3 to 5-lobed leaf (the most common) and an unlobed rounded leaf often found on mature plants in full sun that are ready to flower...Terminal clusters of small, pale yellow-green flowers are produced in the fall. The black-purple fruits...may persist through the winter if not eaten first.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: English Ivy** (Swearingen and Diedrich, 2006):

“English ivy is a vigorous growing vine that impacts all levels of disturbed and undisturbed forested areas, growing both as a ground cover and a climbing vine. As the ivy climbs in search of increased light, it engulfs and kills branches by blocking light from reaching the host tree’s leaves. Branch dieback proceeds from the lower to upper branches, often leaving the tree with just a small green “broccoli head.” The host tree eventually succumbs entirely from this insidious and steady weakening. In addition, the added weight of the vines makes infested trees much more susceptible to blow-over during high rain and wind events and heavy snowfalls. Trees heavily draped with ivy can be hazardous if near roads, walkways, homes and other peopled areas. On the ground, English ivy forms dense and extensive monocultures that exclude native plants. English ivy also serves as a reservoir for Bacterial Leaf Scorch (*Xylella fastidiosa*), a plant pathogen that is harmful to elms, oaks, maples and other native plants.”

D. CURRENT DISTRIBUTION ON THE SITE

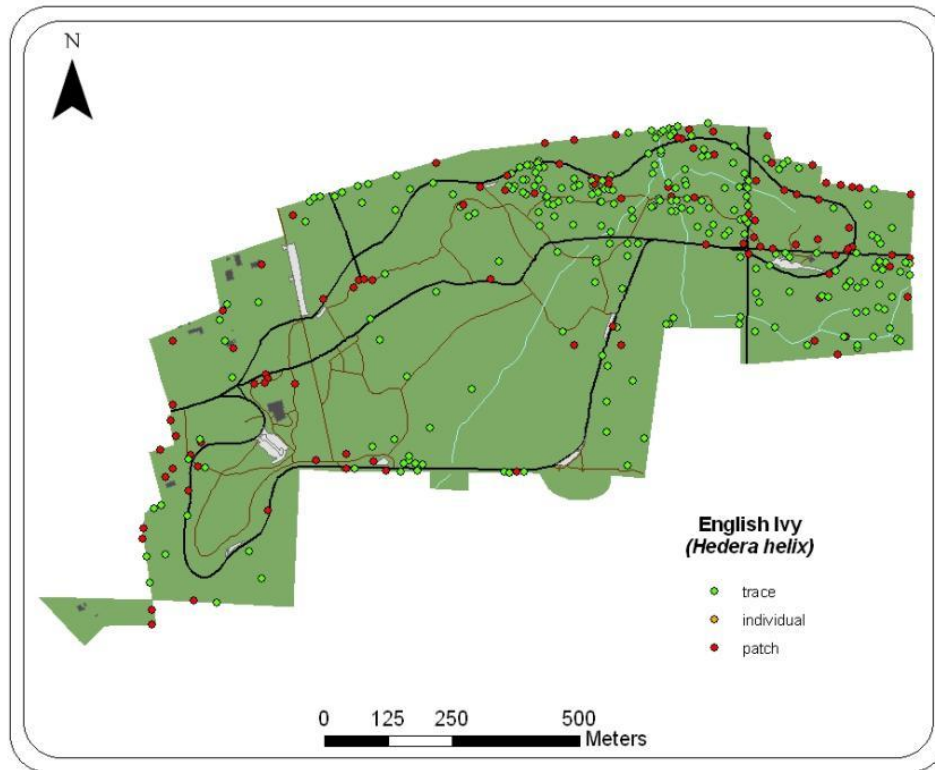


Figure 11. Distribution of English ivy. This species occurs throughout GUCO as traces and patches of varying sizes. It is most abundant in the eastern half of the park where it occurs in a variety of habitats, from bottomlands to uplands. The western half of the park is less heavily-infested but does contain several small to large patches. English ivy is relatively uncommon in the central portion of the park, from Greene Monument to Schenck's Field. Problem areas include the entire northern property line, the Drive-In Tract, and the forest northwest of Tour Stop 6.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of English ivy in areas of dense infestation or close proximity to high quality forest communities.
- 2) Locate and remove English ivy from areas where it is less abundant or problematic.
- 3) Monitor these sites yearly for regeneration and new infestations, and re-treat as needed.
- 4) Plant native species on sites where native diversity/abundance is low.
- 5) Provide information on invasive plants (including native alternatives in landscaping) to residents of nearby neighborhoods.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: English Ivy** (Swearingen and Diedrich, 2006):

1) Mechanical control.

“Vines growing as groundcover can be pulled up by hand... Always wear gloves and long sleeves ... For climbing vines, first cut the vines near the ground at a comfortable height to kill upper portions and relieve the tree canopy. A large screw driver or forked garden tool can be used to pry and snap the vines away from the tree trunks. Vines can be cut using a hand axe or pruning saw for larger vines or a pruning snips for smaller stems. Try to minimize damage to the bark of the host tree. Rooted portions will remain alive and should be pulled, repeatedly cut to the ground or treated with herbicide... vigilance is required to ensure long term control. Mulching may be an effective choice for smaller infestations when herbicides are not appropriate. Cover the entire infestation with several inches of mulch... Shredded or chipped wood may be the best option since hay and grass may potentially carry weed seeds. Covering the area with cardboard may improve the effectiveness and longevity of this method. The mulch should stay in place for at least two growing seasons and may need to be augmented several times. Mulching can also be done following herbicide treatment.”

2) Chemical Control.

“Systemic herbicides like triclopyr (e.g., Garlon® 3A and Garlon® 4) and glyphosate (e.g., Accord®, Glypro®, Rodeo®) are absorbed into plant tissues and carried to the roots, killing the entire plant within about a week. The evergreen nature of English ivy means that it continues to grow through the winter months although at a reduced rate. Herbicide applications can be made any time of year as long as temperatures are above 55 or 60 degrees Fahrenheit for several days and rain is not expected for at least 24 hours. Fall and winter applications will avoid or minimize impacts to native plants and animals. Repeated treatments are likely to be needed. Follow-up monitoring should be conducted to ensure effective control. Herbicidal contact with desirable plants should always be avoided. In areas where spring wildflowers or other native plants are interspersed, application of herbicides should be conducted prior to their emergence, or delayed until they have died back. If native grasses are intermingled with the ivy, triclopyr should be used because it is selective for broad-leaved plants and will not harm grasses. Glyphosate products referred to in this fact sheet are sold under a variety of brand names (Accord®, Rodeo®, Roundup Pro® Concentrate) and in three concentrations (41.0, 50.2 and 53.8% active ingredient). Other glyphosate products sold at home improvement stores may be too dilute to obtain effective control. Triclopyr comes in two forms – triclopyr amine (e.g.,

Garlon® 3A, Brush-B-Gone®, Brush Killer®) and triclopyr ester (e.g., Garlon® 4, Pathfinder®, and Vinex®). Because Garlon® 3A is a water-soluble salt that can cause severe eye damage, it is imperative that you wear protective goggles to protect yourself from splashes. Garlon® 4 is soluble in oil or water, is highly volatile and can be extremely toxic to fish and aquatic invertebrates. It should not be used in or near water sources or wetlands and should only be applied under cool, calm conditions.

Basal bark application: Use a string trimmer or hand saw to remove some of the foliage in a band a few feet from the ground at comfortable height. To the exposed stems, apply a 20% solution of triclopyr ester (Garlon® 4) (2.5 quarts per 3-gallon mix) in commercially available basal oil with a penetrant (check with herbicide distributor) to vine stems. As much as possible, avoid application of herbicide to the bark of the host tree. This can be done year-round although efficacy may vary seasonally; temperatures should be above 50 degrees F for several days.

Cut stem application: Cut each vine stem close to the ground or at a comfortable height and cut again a little higher up. Remove cut pieces to make a vine-free band around the tree trunk. The upper portions of cut vines will eventually die, rot and fall off the host tree. To the freshly cut surfaces of the living rooted stems apply a 25% solution of triclopyr amine (Garlon® 3A) or glyphosate (e.g., Accord®) mixed in water. Homeowners can apply products like Brush-B-Gone®, Brush Killer® and Roundup Pro® Concentrate undiluted to cut stems. Using a paint brush or a plastic spray bottle, apply herbicide to the cut surface especially the perimeter inside the bark which is the living portion of plant.

Foliar application: From summer to fall, apply 2 to 5% solution (8 to 20 oz. per 3-gallon mix) of triclopyr ester (Garlon® 4) mixed in water with a non-ionic surfactant to the leaves. Thoroughly wet the foliage but not to the point of runoff. Some control may be achieved with glyphosate as a 2 to 4-percent solution (8 to 16 oz. per 3-gallon mix) mixed in water with a 0.5 to 1.0 %non-ionic surfactant, but repeat applications are likely to be necessary. During foliar applications some of the herbicide is also absorbed through the stem for additional (basal bark) effect. Because English ivy is evergreen, the ideal time to treat it is during mild spells in winter when most native plants are dormant, to avoid affecting non-target species. However, winter treatments may be less effective than summer through fall applications.”

(Note: other studies (e.g., Neal & Skroch, 1985) indicate that foliar application of glyphosate is most effective in the spring, shortly after emergence of new growth.)

G. ACTIONS PLANNED (Treatments and monitoring)

Large infestations will be treated via foliar application of appropriate herbicides in the spring/summer when application is perhaps most effective. In areas where damage to nearby native vegetation is a major concern, treatment will be timed to avoid exposure for sensitive species (e.g., spring ephemerals) or limited to manual removal if the infestation is small enough. The northern property line and other areas of high density infestation (see species map) will be addressed first. Informational pamphlets will be distributed to nearby communities in an effort to raise awareness about this and other

invasive species. Native species will be planted at sites at where native diversity or abundance has been reduced. Treated sites will be monitored yearly beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Lonicera japonica*
Updated: August 2008

Common name: Japanese Honeysuckle

A. PRIORITY: 2

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Japanese Honeysuckle** (Bravo, 2005):
“Japanese honeysuckle is a perennial vine that climbs by twisting ... around vertical structures, including limbs and trunks of shrubs and small trees. Leaves are oblong to oval, sometimes lobed, have short stalks, and occur in pairs along the stem. In southern and mid-Atlantic states, Japanese honeysuckle often remains evergreen – its leaves remain attached through the winter. In colder northern climates, the leaves may fall off after exposure to prolonged winter temperatures. Flowers are tubular, with five fused petals, white to pink, turning yellow with age, very fragrant, and occur in pairs along the stem at leaf junctures. Stems and leaves are sometimes covered with fine, soft hairs. Japanese honeysuckle blooms from late April through July and sometimes into October. Small black fruits are produced in autumn, each containing 2-3 oval to oblong, dark brown seeds about 1/4 inch across.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Japanese Honeysuckle** (Bravo, 2005):
“In North America, Japanese honeysuckle spread(s) widely and out-compete(s) native plant species... Shrubs and young trees can be killed by girdling when vines twist tightly around stems Dense growths ... gradually kill plants by blocking sunlight ... Vigorous root competition ... helps Japanese honeysuckle ... displace native vegetation.”

D. CURRENT DISTRIBUTION ON THE SITE

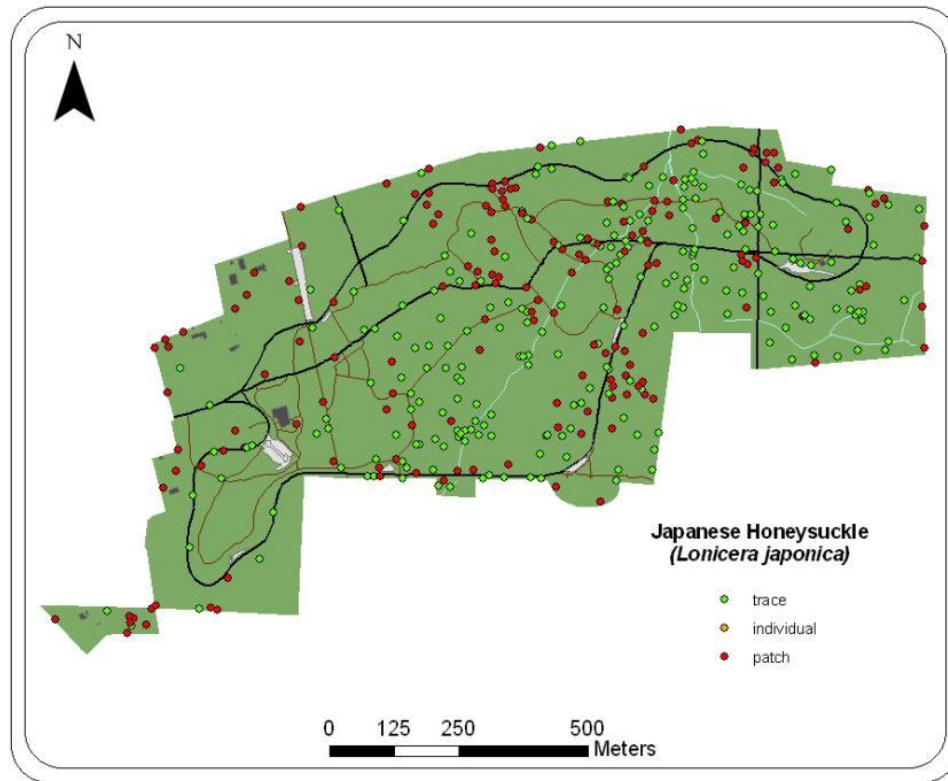


Figure 12. Distribution of Japanese honeysuckle. This species is found throughout GUCO. The species invades all community types, though it may be slightly less abundant in the western half of the park where it occurs primarily as small patches along forest edges and in highly disturbed sites.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of Japanese honeysuckle in areas of dense infestation or close proximity to high quality forest communities.
- 2) Locate and treat Japanese honeysuckle in areas where it is less abundant or problematic.
- 3) Monitor treated sites yearly for regeneration and new infestations, and re-treat as needed.
- 4) Plant native species on sites where native diversity/abundance is low.
- 5) Provide information on invasive plants (including native alternatives in landscaping) to residents of nearby neighborhoods.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Japanese Honeysuckle** (Bravo, 2005):

1) Mechanical control.

“For small patches, repeated pulling of entire vines and root systems may be effective. Hand pull seedlings and young plants when the soil is moist, holding low on the stem to remove the whole plant along with its roots. Monitor frequently and remove any new plants. Cut and remove twining vines to prevent them from girdling and killing shrubs and other plants. An effective method for removal of patches of honeysuckle covering the ground is to lift up and hold a portion of the vine mass with a rake and have a chain saw operator cut the stems low to the ground. Mowing large patches of honeysuckle may be useful if repeated regularly but is most effective when combined with herbicide application (see below). Mow at twice a year, first in mid-July and again in mid-September. Plants can also be grubbed out using a pulaski or similar digging tool, taking care to remove all roots and runners. Burning removes above ground vegetation but does not kill the underground rhizomes, which will continue to sprout.”

2) Chemical Control.

“In moderately cold climates, Japanese honeysuckle leaves continue to photosynthesize long after most other plants have lost their leaves. This allows for application of herbicides when many native species are dormant. However, for effective control with herbicides, healthy green leaves must be present at application time and temperatures must be sufficient for plant activity. Several systemic herbicides (e.g., glyphosate and triclopyr) move through the plant to the roots when applied to the leaves or stems and have been used effectively on Japanese honeysuckle. Following label guidelines, apply a 2.5% rate of glyphosate (e.g., Rodeo® for wetlands; Roundup® for uplands) mixed with water and an appropriate surfactant, to foliage from spring through fall. Alternatively, apply a 2% concentration of triclopyr (e.g., Garlon 3A) plus water to foliage, thoroughly wetting the leaves but not to the point of drip-off. A coarse, low-pressure spray should be used. Repeat applications may be needed. Treatment in the fall, when many non-target plants are going dormant, is best. Also, a 25% glyphosate or triclopyr solution mixed with water can be applied to cut stem surfaces any time of year as long as the ground is not frozen.”

G. ACTIONS PLANNED (Treatments and monitoring)

Because of the pervasiveness of this species within and around the park, control measures will only be taken in areas where infestations are clearly inhibiting native plant growth or threatening higher quality sites. Larger infestations along forest edges in the western half of the park will be located and treated via foliar application and/or cut – spray methods depending on characteristics of the infestation, including size and height of vines and

proximity to sensitive native vegetation. Small patches in forest interiors will be removed manually and monitored/re-treated regularly. Other infestations that border or occur in high quality/priority forest communities, such as beech slopes and small stream communities, will be treated similarly. Treatments will be applied in late spring/early summer with care taken to avoid native plant exposure to herbicides. Areas where native plant diversity and/or abundance are low will be planted with appropriate species during the dormant season after treatment. All treated sites will be monitored at least yearly beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years. Small infestations that are manually removed will be monitored and treated several times throughout the growing season until control is achieved.

Scientific name: *Vinca minor*
Updated: August 2008

Common name: Common Periwinkle

A. PRIORITY: 2

B. DESCRIPTION

“Evergreen to semievergreen vines, somewhat woody, trailing or scrambling to 3 feet (1 m) long and upright to 1 foot (30 cm). Violet pinwheel-shaped flowers. Introduced from Europe in 1700s. Ornamental ground cover, commonly sold and planted by gardeners. (Miller, 2003).” Periwinkle forms dense patches in areas where previously planted, spreading exclusively by vegetative means throughout its introduced range. Shade tolerant.

C. DAMAGE AND THREATS

“Common periwinkle poses a threat to native plants and communities because it grows vigorously, forming a dense monotypic evergreen groundcover that displaces and excludes most other plants, including native wildflowers (Swearingen et al., 2002).”

D. CURRENT DISTRIBUTION ON THE SITE

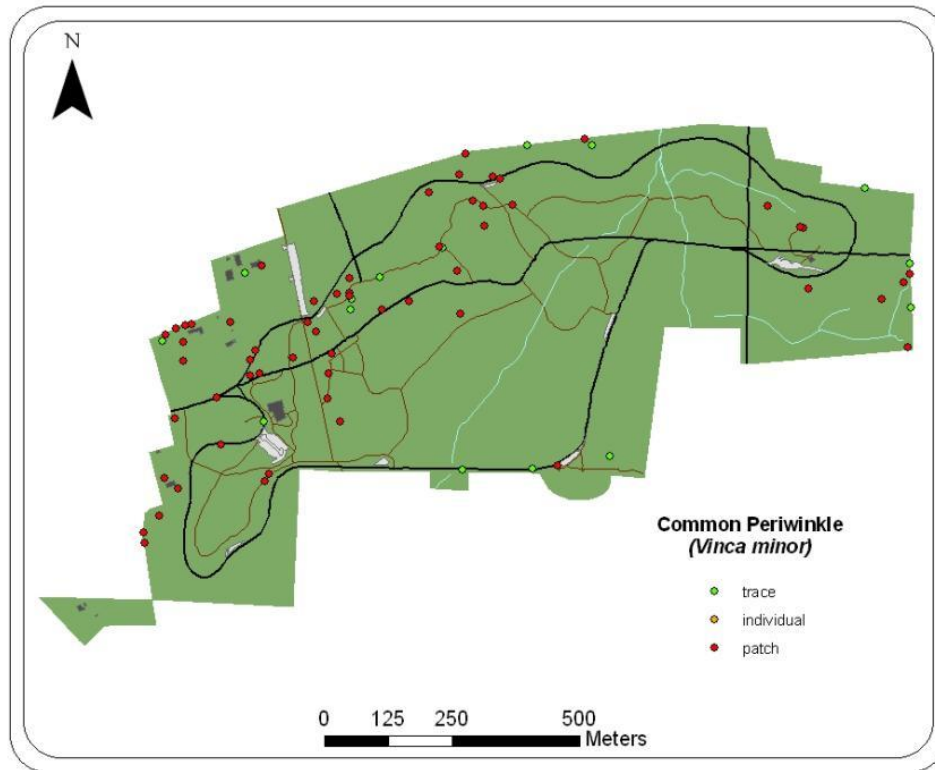


Figure 13. Distribution of common periwinkle. This species is most abundant in and adjacent to the oak-hickory forests of the park's western half. It mostly occurs as medium-to-large, high density patches. The largest patch in the park is just east of the northern parking lot; other problem areas include the southeast corner of the park, the northern property line, and the area around the Utility Building.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of common periwinkle in areas of dense infestation or close proximity to high quality forest communities.
- 2) Locate and treat common periwinkle in areas where it is less abundant or problematic.
- 3) Monitor treated sites yearly for regeneration and new infestations, and re-treat as needed.
- 4) Plant native species on sites where native diversity/abundance is low.
- 5) Provide information on invasive plants (including native alternatives in landscaping) to residents of nearby neighborhoods.

F. MANAGEMENT OPTIONS

- 1) **Mechanical control.**

“Periwinkle can be removed by digging, raising the runners with a rake, and mowing the plants. All of the plant must be removed. It can also be controlled by cutting the plants in the spring followed by applying a glyphosate herbicide to the regrowth (Swearingen et al., 2002).”

2) Chemical Control.

Text taken from **Nonnative Invasive Plants of Southern Forests** (Miller, 2003):

“Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant (July to October for successive years): Tordon 101* ‡ as a 3-percent solution (12 ounces per 3-gallon mix), Tordon K as a 2-percent solution (8 ounces per 3-gallon mix), or Garlon 4 as a 4-percent solution (15 ounces per 3-gallon mix). Or, during the growing season, repeatedly apply Garlon 4 or a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant. In winter, herbicide treatments should be limited to warm days.”

Note: in a recent herbicide trial conducted at GUCO, fall-applied glyphosate treatments of 2 and 4 lbs/acre were the most effective of 14 treatments (including various rates of triclopyr, picloram, and imazapyr formulations) for controlling *V. minor*. Fall application with glyphosate was more effective than spring application (O’Driscoll & Neal, Chapter 2).

G. ACTIONS PLANNED (Treatments and monitoring)

Due to their proximity to higher quality forest communities, large infestations in the western half of the park will be located and treated first. These will be treated via foliar application of an appropriate herbicide and/or mechanical removal if the patch is small enough. The few medium to large patches in the eastern half of the park will be treated similarly. Herbicide application will take place in the summer or early fall. Areas of dense infestation will be replanted with native species during the dormant season after treatment. All treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Microstegium vimineum*
Updated: August 2008

Common name: Japanese Stilt Grass

A. PRIORITY: 2

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Japanese Stiltgrass** (Swearingen and Adams, 2008):

“Japanese stiltgrass ... is an annual grass with a sprawling habit. It germinates in spring and grows slowly through the summer months, ultimately reaching heights of 2 to 3½ ft. The leaves are pale green, lance-shaped, asymmetrical, 1 to 3 in. long, and have a distinctive shiny midrib. Slender stalks of tiny flowers are produced in late summer (August through September-early October) and dry fruits called achenes are produced soon afterwards.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Japanese Stiltgrass** (Swearingen and Adams, 2008):

“Japanese stiltgrass ... threatens native plants and natural habitats in open to shady, and moist to dry locations. Stiltgrass spreads to form extensive patches, displacing native species that are not able to compete with it. Where white-tail deer are over-abundant, they may facilitate its invasion by feeding on native plant species and avoiding stiltgrass. Japanese stiltgrass may impact other plants by changing soil chemistry and shading other plants.”

D. CURRENT DISTRIBUTION ON THE SIT

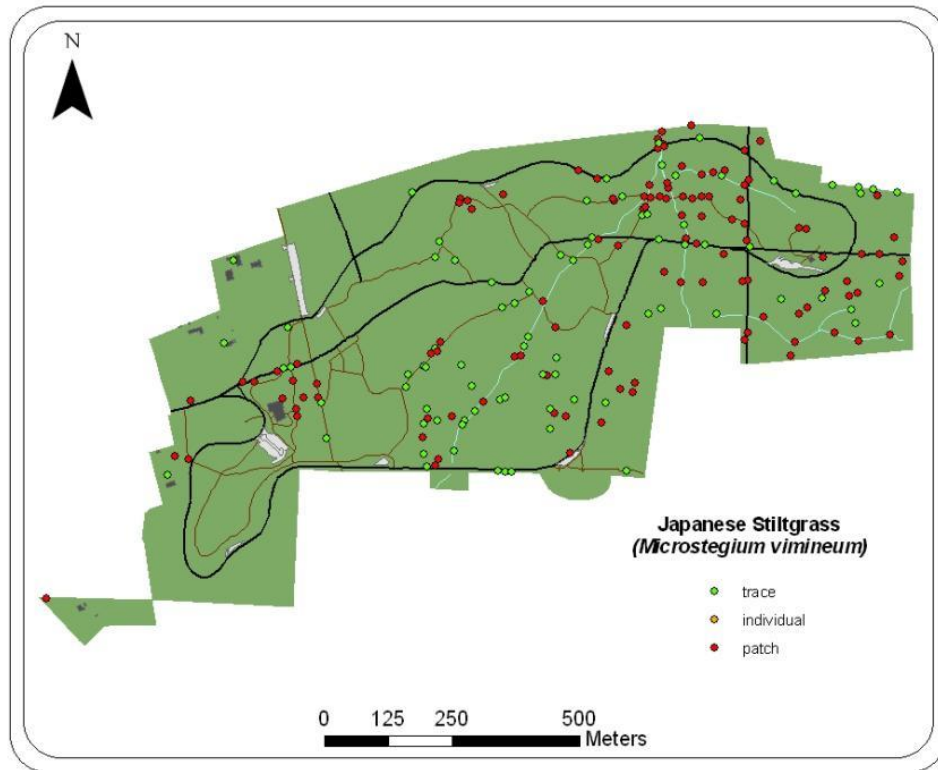


Figure 14. Distribution of Japanese stilt grass. This species occurs essentially throughout GUCO as traces and patches of varying sizes. It is most abundant in the eastern half of the park where it forms large patches in bottomlands and other areas with favorable soil moisture levels. Largest patches are located adjacent to the park's streams, within the old Petting Zoo site, and in the Drive-In Tract. It is largely absent from the upland oak-hickory forests of the park's western half.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of Japanese stilt grass in areas of dense infestation or close proximity to high quality forest communities.
- 2) Locate and treat Japanese stilt grass in areas where it is less abundant or problematic.
- 3) Monitor treated sites yearly for regeneration and new infestations, and re-treat as needed.
- 4) Plant native species on sites where native diversity/abundance is low.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Japanese Stiltgrass** (Swearingen and Adams, 2008):

1) Mechanical control.

“Stiltgrass ... can be pulled by hand throughout the growing season, especially when the soil is moist and entire plants with roots can be removed. Pulling is easier and probably more effective in mid-to-late summer when the plants are much taller and more branched. At this stage, entire plants can be easily removed by grabbing the basal portion of a plant and pulling firmly. In short time, a fair amount of stiltgrass can be pulled and piled up to dehydrate on site. If plants are already in the fruiting stage, they should be bagged and disposed of offsite to prevent dispersal of seed. Also, try to avoid pulling native grasses like Virginia cutgrass (*Leersia virginia*) that often grow intermingled with stiltgrass and may be difficult to distinguish from it. Because hand pulling plants disturbs the soil and may expose stiltgrass seed from previous seasons, late season pulling will avoid the likelihood of seed germination. Hand pulling of plants will need to be repeated and continued for many seasons until the seed bank is exhausted. Stiltgrass can be mowed in late summer (i.e., August through September) when the plants are flowering but preferably before seed is produced. This can be done using a lawn mower or "Weed Whacker" type machine or a scythe. Because stiltgrass is primarily an annual plant, cutting late in the season before the plants would die back naturally avoids the possibility of regrowth. Recent information suggests that stiltgrass plants that are cut early in the summer respond by regrowing and flowering soon after cutting, much earlier than they would normally flower. This is another reason to consider cutting in late summer to fall rather than during the early summer months.”

2) Chemical Control.

“For extensive stiltgrass infestations, use of a systemic herbicide such as glyphosate (e.g., Roundup Pro®) is a practical and effective method if used with some caution. Glyphosate is a non-specific herbicide that will kill or damage almost any herbaceous plant and possibly some woody plants it contacts. Roundup Pro® is surfactant-loaded (no additional surfactant needed) and the surfactant is not lethal to amphibians and aquatic invertebrates like the polyoxyethyleneamine surfactant in Roundup Classic® is. Roundup Pro® carries the 'Caution' signal word while Roundup Classic® carries 'Warning'. When treating stiltgrass in wetland sites, use Rodeo® or other formulation labeled for wetlands. Apply a 2% solution of Roundup® or Rodeo® mixed with water (8 oz. per 3 gals. mix) and a surfactant in late summer. Be careful to avoid application to non-target plants. Some researchers have also found success using the pre-emergent herbicide imazapic, which is the active ingredient found in Plateau® (for government use only), and Journey® (for all other applicators). Imazapic is most effective against stiltgrass when applied in March in the Mid-Atlantic states. The best rate for maximum selectivity is 4 oz. per acre, applied as a broadcast application with backpack sprayers. Sprayers should be fitted with an 8003E flat fan nozzle and calibrated at 15 to 20 gpa. Plateau® and Journey® can be applied continually through

germination of the stiltgrass and throughout the summer during its peak growth. No surfactant is necessary for pre-emergent applications. As germination nears, begin to add 1/4% non-ionic surfactant to the mixture. Another option that may be appropriate for certain situations is to apply a pre-emergent (only) treatment with Pendulum® Aquacap™ (active ingredient is pendimethalin) at 2.4 qts. to 4.8 qts. per acre (15 to 20 gpa). The higher rates have provided season long control.”

G. ACTIONS PLANNED (Treatments and monitoring)

Large infestations in and adjacent to stream communities will be located and treated first via appropriate chemical control procedures. Efforts will be made to limit native plant exposure to harmful herbicides when treating stilt grass infestations. Large infestations in lower quality successional forests will be located and treated similarly. Treatments will be applied in late spring or summer. Areas of large infestation will be replanted with native vegetation during the dormant season after treatment. All treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Wisteria floribunda*
Updated: August 2008

Common name: Japanese Wisteria

A. PRIORITY: 2

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Nonnative Wisterias** (Remaley, 2005A):

“Chinese and Japanese wisteria are ... woody ornamental vines ... Vines can climb trees ... and have been observed to reach 65 feet ... Both nonnative wisterias flower in the springtime (April-May) and produce a velvety seed pod. The fuzzy brown seed pods are 4-6 inches long, narrowed toward the base, with constrictions between the seeds. Stems of the nonnative wisterias can grow to 15 inches in diameter in older plants. White-barked Japanese wisteria vines twine clockwise around the host plant and Chinese wisteria twines counter-clockwise. The compound leaves, consisting of 7-13 (Chinese) or 13-19 (Japanese) ... leaflets, are about 1 foot long and alternate along the stem. Fragrant, violet to blue-violet flowers, ½ to 1 inch long, occur in showy, pendulous clusters.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Nonnative Wisterias** (Remaley, 2005A):

“Nonnative wisterias impair and overtake native shrubs and trees through strangling or shading. Climbing wisteria vines can kill sizable trees, opening the forest canopy and increasing sunlight to the forest floor, which in turn favors its aggressive growth. Chinese and Japanese wisterias are hardy and aggressive, capable of forming thickets so dense that little else grows.

D. CURRENT DISTRIBUTION ON THE SITE

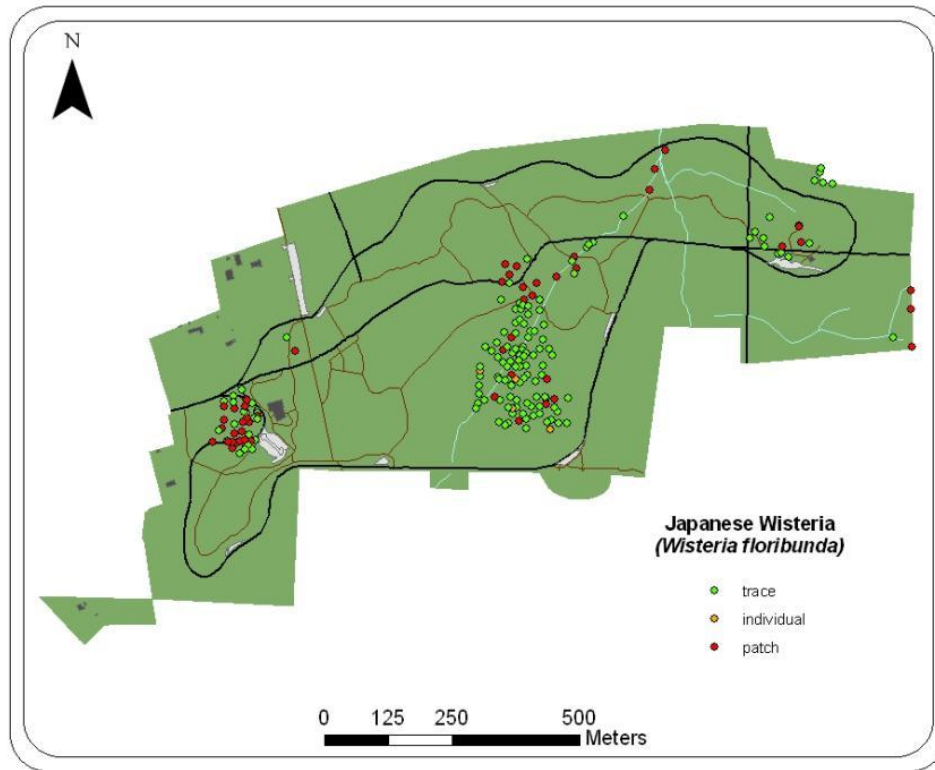


Figure 15. Distribution of wisteria. This species is relatively contained within GUCO but has at least three well-established infestations. It occurs in forest interiors as well as along edges, in bottomlands and uplands. Though reduced in size and density through recent control efforts, the infestation in the old lake bed site is still the most extensive within the park. Patches along the forest edge in the southeast corner of the park may become more troublesome if left untreated.

E. OBJECTIVE (Measurable)

- 1) Treat the three major areas of infestation within the park.
- 2) Treat the potentially problematic infestation in the southeast corner of the park.
- 3) Locate and treat smaller patches and traces via mechanical and chemical control methods.
- 4) Monitor treated sites yearly for regeneration and new infestations, and re-treat as needed.
- 5) Plant native species on treated sites where native diversity/abundance is low.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Nonnative Wisterias** (Remaley, 2005A):

1) Mechanical control.

“The only practical methods currently available for control of nonnative wisterias are mechanical and chemical. Cut climbing or trailing vines as close to the root collar as possible. This technique, while labor intensive, is feasible for small populations, as a pretreatment for large impenetrable infestations, or for areas where herbicide use is not desirable. Wisteria will continue to resprout after cutting until its root stores are exhausted. For this reason, cutting should begin early in the growing season and, if possible, sprouts cut every few weeks until autumn. Cutting will stop the growth of existing vines and prevent seed production. However, cut vines left coiled around trunks may eventually girdle trees and shrubs as they continue to grow and increase in girth. For this reason, the vines should be removed entirely or at least cut periodically along their length. Grubbing, removal of entire plants from the roots up, is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Using a pulaski, weed wrench 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 may resprout. All plant parts (including mature fruit) should be bagged and disposed of in a trash dumpster to prevent reestablishment.”

2) Chemical Control.

Cut stump application

“Cut stump treatment, using a systemic herbicide, is effective in areas where vines are established within or around desirable native plants or where they have grown into the canopy. This treatment is effective as long as the ground is not frozen. Cut the stem as close to ground level as possible. Immediately apply a 25% solution of glyphosate (e.g., Roundup®) or triclopyr (e.g., Garlon) and water to the cross section of the stem. Retreatment with a foliar application of glyphosate may be necessary for any sprouts.

Foliar application

Use foliar spray herbicide treatments to control large infestations of nonnative wisterias. It may be necessary to precede foliar applications with stump treatments to reduce the risk of damaging non-target species. Apply a 2% concentration of glyphosate (e.g. Roundup®) or triclopyr (e.g. Garlon) and water, plus a 0.5% non-ionic surfactant to thoroughly wet all foliage. Chlorpyralid (e.g. Transline) is effective at a concentration of 0.5% and is selective to plants in the aster, buckwheat, and pea families. Caution should be taken with chlorpyralid as groundwater pollution through leaching can be a problem with certain soil types. Do not apply spray so heavily that herbicide drips off the leaves. Glyphosate is a non-selective systemic herbicide that may kill non-target plants that are only partially contacted by spray. Triclopyr is

selective to broadleaved species and is a better choice if native grasses are present. Ambient air temperature should be above 65°F for all foliar treatments.”

G. ACTIONS PLANNED (Treatments and monitoring)

The three main infestations of wisteria will be treated in the late spring or early summer via foliar and cut stump applications of appropriate herbicides (see above). Care will be taken to avoid damage to desirable native vegetation and limit soil disturbance during treatment. Large vines will be cut and pulled from trees to eliminate possibility of further growth inhibition. The infestation in the southeast corner of the park will be treated similarly after actions have been taken in the areas of larger/denser infestation. Outlier traces and small patches will be located and removed manually. Areas of dense infestation such as the drained lake bed site will be replanted with a variety of native trees and shrubs at some point in the dormant season after wisteria has been treated. All treated sites will be monitored to assess effectiveness of control actions, subsequent invasion by other nonnative species, and native plant response to wisteria removal. Large wisteria patches near GUCO’s southern boundary line in Country Park will be monitored and or treated with permission of park managers at Country Park. Informational pamphlets detailing the threats from wisteria and other invasives, as well as potential native landscaping alternatives, will be distributed in nearby residential communities.

Scientific name: *Rosa multiflora*
Updated: August 2008

Common name: Multiflora Rose

A. PRIORITY: 2

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Multiflora Rose** (Bergmann & Swearingen, 2005):

“Multiflora rose is a thorny, perennial shrub with arching stems (canes), and leaves divided into five to eleven sharply toothed leaflets. The base of each leaf stalk bears a pair of fringed bracts. Beginning in May or June, clusters of showy, fragrant, white to pink flowers appear, each about an inch across. Small bright red fruits, or rose hips, develop during the summer, becoming leathery, and remain on the plant through the winter.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Multiflora Rose** (Bergmann & Swearingen, 2005):

“Multiflora rose ... can form impenetrable thickets that exclude native plant species. This nonnative rose readily invades open woodlands, forest edges, successional fields, savannas and prairies that have been subjected to land disturbance.”

D. CURRENT DISTRIBUTION ON THE SITE

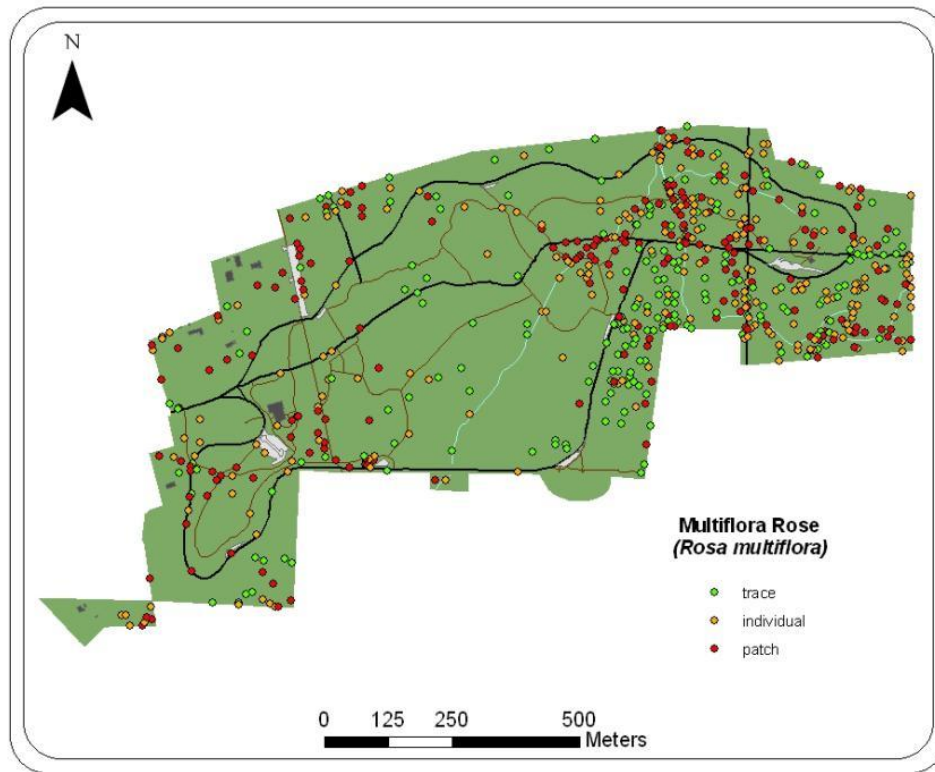


Figure 16. Distribution of multiflora rose. This species occurs essentially throughout GUCO, though it appears most abundant in the eastern half of the park. The Drive-In tract contains perhaps the largest infestation, and certainly the largest individuals, some of which climb in trees to at least 20 feet. Other problematic areas include the northern parking lot/Andrews Tract vicinity, floodplains of both streams in the northern half of the park, and the Lake Caldwell pond bed area.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of multiflora rose in and adjacent to high quality forest communities.
- 2) Locate and treat dense infestations in lower quality sites, e.g., the Drive-in Tract, the Andrews Tract, and the Kotis Tract.
- 3) Locate and treat smaller patches and traces via mechanical and chemical control methods.
- 4) Monitor treated sites yearly for regeneration and new infestations, and re-treat as needed.
- 5) Plant native species on treated sites where native diversity/abundance is low.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Multiflora Rose** (Bergmann & Swearingen, 2005):

1) Mechanical control.

“Frequent, repeated cutting or mowing at the rate of three to six times per growing season, for two to four years, has been shown to be effective in achieving high mortality of multiflora rose. In high quality natural communities, cutting of individual plants is preferred to site mowing to minimize habitat disturbance.”

2) Chemical Control.

“Various herbicides have been used successfully in controlling multiflora rose but, because of the long-lived stores of seed in the soil, follow-up treatments are likely to be necessary. Application of systemic herbicides (e.g., glyphosate) to freshly cut stumps or to regrowth may be the most effective methods, especially if conducted late in the growing season. Plant growth regulators have been used to control the spread of multiflora rose by preventing fruit set.”

3) Biological Control

“Biological control is not yet available for management of multiflora rose. However, researchers are investigating several options, including a native viral pathogen (rose-rosette disease), which is spread by a tiny native mite, and a seed-infesting wasp, the European rose chalcid. Rose-rosette disease, native to the western U.S., has been spreading easterwardly at a slow pace and is thought to hold the potential for eliminating multiflora rose in areas where it grows in dense patches. An important drawback to both the rose rosette fungus and the European rose chalcid is their potential impact to other rose species and cultivars.”

G. ACTIONS PLANNED (Treatments and monitoring)

Large infestations in areas of high conservation concern will be treated first in late spring or early summer via foliar or cut stump application of appropriate herbicides. Where herbicide use could damage nearby native vegetation and infestations are small enough, multiflora rose will be treated by repeatedly cutting until control is achieved. Areas of dense infestation in lower quality successional forests (e.g., the Drive-in Tract) will be treated similarly: large individuals will be treated via-cut spray and smaller bushes by foliar application of appropriate herbicides. Areas of dense infestation will be replanted with appropriate native trees and shrubs during the dormant season after the site is treated. Treated sites will be monitored yearly beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Mahonia bealei*
Updated: August 2008

Common name: Beale's Barberry

A. PRIORITY: 3

B. DESCRIPTION

From **Invasive.org weed fact sheet: leatherleaf mahonia** (Bugwood Network, 2007):
“Leatherleaf mahonia (aka Beale’s barberry) is an evergreen shrub that can grow from 5-10 ft. (1.5-3 m) tall. Leaves are pinnately compound, 18 in. (46 cm) long, with 9-13 holly-like leaflets. Leaflets are 2-4 in. (5-10 cm) long and 1-2 in. (2.5-5.1 cm) wide. Flowering occurs in late winter and early spring, when fragrant, lemon-yellow flowers develop. The fruits are green berries, about a half inch long, that turn bluish black with a grayish bloom. Fruits hang in grapelike clusters. Leatherleaf mahonia is native to China.”

C. DAMAGE AND THREATS

Mahonia bealei is listed as a rank 2 (significant threat) nonnative by the Southeast Nonnative Pest Plant Council (SE-EPPC, www.se-eppc.org). Rank 2 species possess invasive characteristics but do not easily invade intact natural communities (Allen et al., 2006). In GUCO, the species is present and spreading in forest interiors of “natural” communities (White et al., 2003) as well as more-disturbed successional ones. The shrub’s evergreen habit may contribute to shading of early spring ephemerals. The species stands out considerably because of its unique foliage and striking flowers/fruits, and is therefore an obvious distraction from historically accurate landscape/ecological interpretation at the park.

D. CURRENT DISTRIBUTION ON THE SITE

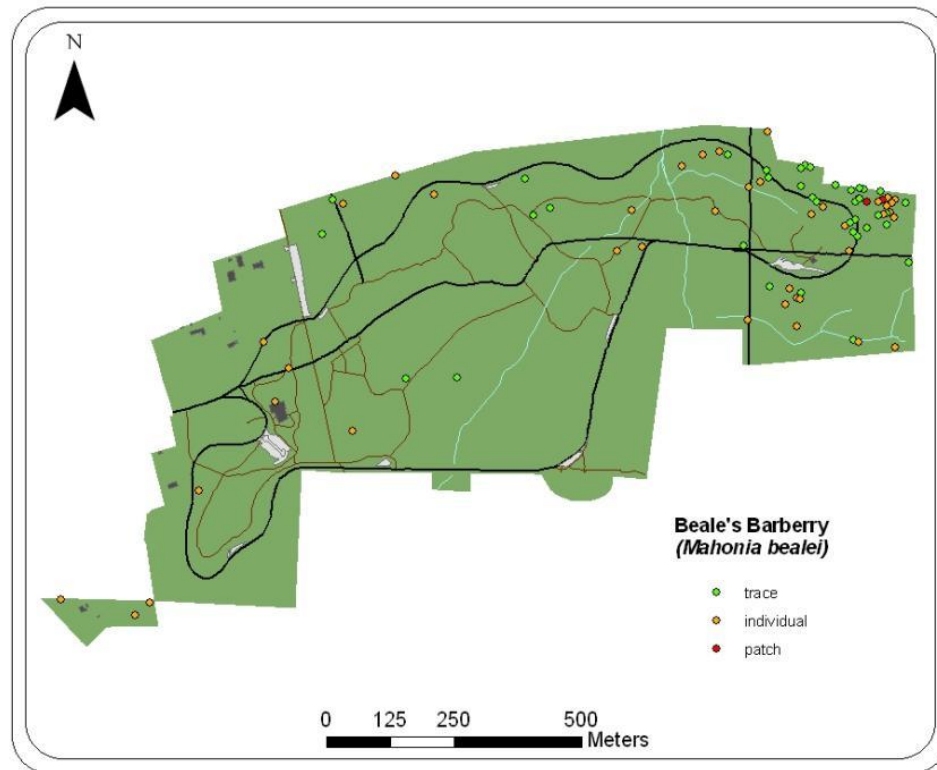


Figure 17. Distribution of Beale's barberry. This species is not very common in GUCO but does occur as occasional individuals and one medium sized infestation within the park's forested communities. The species is most common in the northeast corner of the park where it is likely seeding in from plants in the nearby residential community.

E. OBJECTIVE (Measurable)

- 1) Treat the patch in the northeast corner.
- 2) Locate and treat individuals and traces elsewhere in the park.
- 3) Monitor treated sites yearly for regeneration and new infestations, and re-treat as needed.
- 4) Plant native species on treated sites where native diversity/abundance is low.
- 5) Distribute informational pamphlets on invasive plants, and potential landscaping alternatives, in surrounding neighborhoods.

F. MANAGEMENT OPTIONS

Information on control options for *Mahonia bealei* is not widely available. The following recommendations are based on information for two other invasive nonnatives in the barberry family (Berberidaceae), *Nandina domestica* and *Berberis thunbergii*:

1) Mechanical Control

Hand pulling may be effective for controlling small infestations but care must be taken to remove all root fragments to avoid re-sprouting. Repeated cutting may also be effective, especially in shaded situations. Stems should be cut close to the ground at least once a year in the growing season. Plants with fruits should be bagged and disposed of to prevent seed dispersal. Both methods require repeated treatments and monitoring to control spread via underground runners.

2) Chemical Control

Miller (2003) recommends the following control procedures for *Nandina domestica*, an evergreen shrub in the barberry family:

“Thoroughly wet all leaves with glyphosate herbicide as a 1-percent solution in water (4 ounces per 3-gallon mix) with a surfactant (August to October). Or, apply Garlon 4 as a 20-percent solution in commercially available basal oil, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray. For stems too tall for foliar sprays, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC* as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix). Collect and destroy fruit.”

G. ACTIONS PLANNED (Treatments and monitoring)

The main infestation in the northeast corner will be treated via foliar and/or cut-spray applications of appropriate herbicides in the late spring or summer. Individuals and traces elsewhere in the park will be located and removed via mechanical or chemical procedures depending on plant size, proximity to sensitive native species, etc. Treated sites will be monitored yearly beginning the following growing season. As this species is likely seeding in from neighbors north of the park, information on invasives and potential landscape alternatives will be distributed to local residents.

Scientific name: *Vinca major*
Updated: August 2008

Common name: Bigleaf Periwinkle

A. PRIORITY: 3

B. DESCRIPTION

From **Element Stewardship Abstract for *Vinca major*** (Bean and Russo, 1988):

“*Vinca major*, ... (Apocynaceae), is a perennial, evergreen herb with erect flowering stems (0.25-0.5 m long) and trailing non-flowering stems (1 m long), which root at the nodes (Gilkey 1957). The stems contain a milky latex. The shiny, dark green leaves are 2-3 cm long, opposite, round-ovate, and pinnately veined ... The blades have a cordate base and are acute to obtuse at the apex ... The flowers, which are regular and solitary, are borne in the axil of every other leaf. The slender pedicels are 3-5 cm long. The calyx is five-parted with essentially equal lobes of about 1 cm long. The violet or blue corolla (2.5-3 cm long) is salverform, equally fiveparted, and with the tube pubescent within.”

C. DAMAGE AND THREATS

From **Element Stewardship Abstract for *Vinca major*** (Bean and Russo, 1988):

“Once established, "it forms a dense carpet to the exclusion of other herbs" (Bailey 1914). This creates a problem where it is competing in areas with native flora (McClintock1985). It appears to be quite stable in the environment; dry or cold weather may temporarily set growth back, but *Vinca* quickly resprouts and regains lost ground coverage. Rate of spread is not known from the literature, but usually it spreads only from the point of planting along shady corridors.”

D. CURRENT DISTRIBUTION ON THE SITE

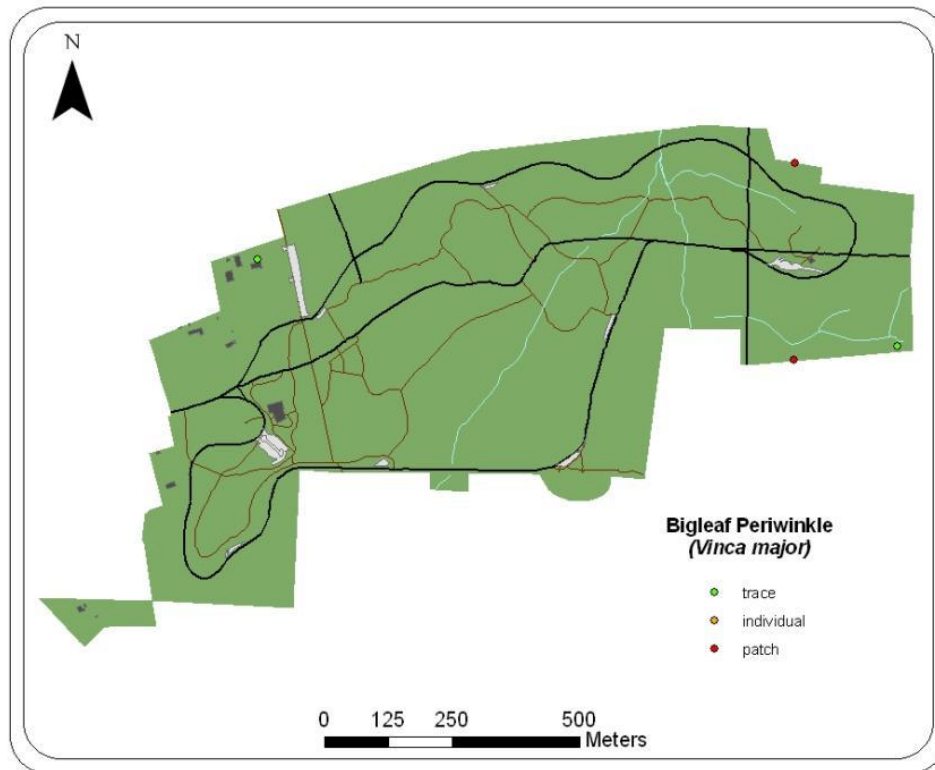


Figure 18. Distribution of bigleaf periwinkle. This species occurs as 2 medium sized patches (both smaller than 200 m² and with ~60% cover) and 2 traces at separate locations in the park. The patch along the northern property line is of the variegated, ornamental variety and is likely spreading from a nearby yard. Both patches occur along the forest edge. The trace in the southeast corner is within a large a patch of common periwinkle.

E. OBJECTIVE (Measurable)

- 1) Treat the two main patches of bigleaf periwinkle.
- 2) Manually remove traces of bigleaf periwinkle.
- 3) Monitor treated sites yearly for regeneration and new infestations, and re-treat as needed.
- 4) Plant native species on treated sites where native diversity/abundance is low.
- 5) Distribute informational pamphlets on threats of invasives, and potential landscaping alternatives, in surrounding neighborhoods.

F. MANAGEMENT OPTIONS

- 1) **Mechanical control.**

“Periwinkle can be removed by digging, raising the runners with a rake, and mowing the plants. All of the plant must be removed. It can also be controlled by cutting the plants in the spring followed by applying a glyphosate herbicide to the regrowth (Swearingen et al., 2002).”

2) Chemical Control.

Text taken from **Nonnative Invasive Plants of Southern Forests** (Miller, 2003):

“Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant (July to October for successive years): Tordon 101* ‡ as a 3-percent solution (12 ounces per 3-gallon mix), Tordon K* ‡ as a 2-percent solution (8 ounces per 3-gallon mix), or Garlon 4 as a 4-percent solution (15 ounces per 3-gallon mix). Or, during the growing season, repeatedly apply Garlon 4 or a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant. In winter, herbicide treatments should be limited to warm days.”

Note: in a recent herbicide trial conducted on *Vinca minor* at GUCO, fall-applied glyphosate treatments of 2 and 4 lbs/acre were the most effective of 14 treatments tested. Fall application was more effective than spring application. *V. major* is closely related to *V. minor* and may exhibit similar susceptibility to glyphosate, though this hypothesis has not been tested (O’Driscoll & Neal, Chapter 2).

G. ACTIONS PLANNED (Treatments and monitoring)

The two patches of bigleaf periwinkle will be treated via foliar application of appropriate herbicides late in the growing season. Traces of bigleaf periwinkle will be located and removed and/or monitored as resources allow. Native species may be planted at the treated sites during the dormant season following treatment. Treated sites will be monitored annually beginning the following growing season and continuing until no regrowth is observed for 2 consecutive years.

Scientific name: *Spiraea prunifolia*
Updated: August 2008

Common name: Bridalwreath Spiraea

A. PRIORITY: 3

B. DESCRIPTION

Bridalwreath spiraea is a small-to-medium sized shrub (to 6 ft tall) in the rose family (Rosaceae). Leaves are alternate, simple, ovate to elliptical in shape, 1-2 in. long, and deciduous. This species produces distinctive white, double flowers in early spring. It is native to eastern Asia and is planted extensively as an ornamental throughout the eastern United States. Bridalwreath spiraea is sometimes found in natural areas persisting from earlier plantings or occasionally volunteering on disturbed sites.

C. DAMAGE AND THREATS

This species is not listed as invasive in the southeastern United States and probably does not pose a major threat to ecosystems at GUCO. It does, however, occur in forest interiors at GUCO and could become more problematic in the future. Potential threats to native vegetation include competitive displacement and/or excessive shading. The showy spring flowers are attractive but incongruous with the historical interpretation of the battleground vegetation.

D. CURRENT DISTRIBUTION ON THE SITE

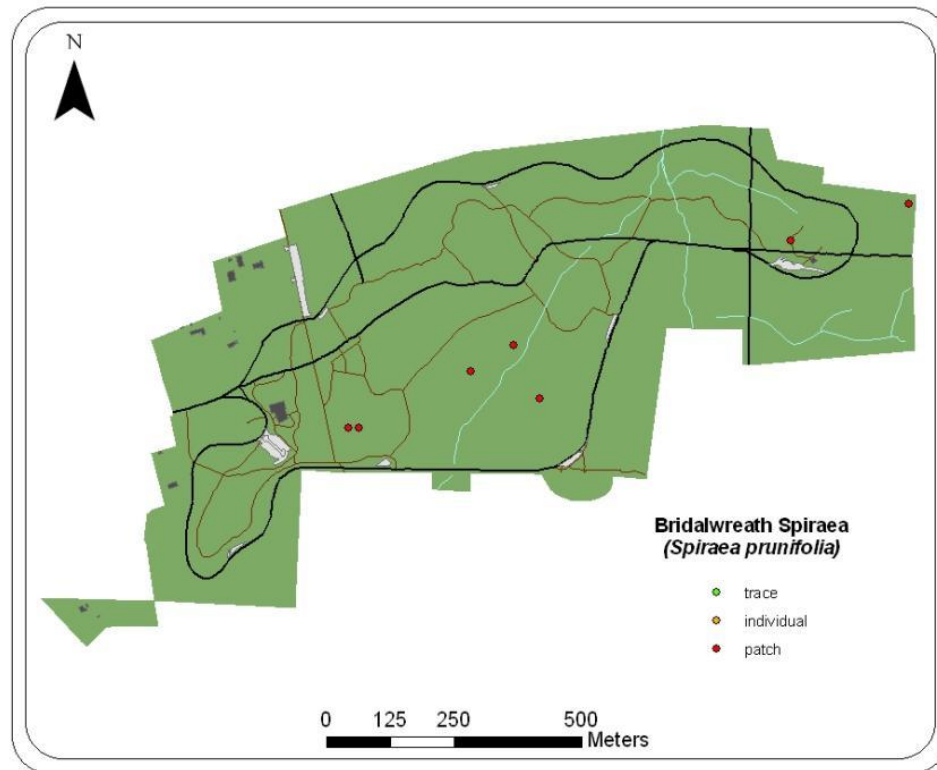


Figure 19. Distribution of bridalwreath spiraea. This species occurs as several small (each < 90 m²) patches within GUCO. The two patches in the northeastern corner occur essentially along the forest edge while the others are in forest interiors. The two westernmost patches are in a relatively intact oak-hickory forest while the others are in more-disturbed successional forests.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of bridalwreath spiraea in order of decreasing area.
- 2) Monitor treated sites yearly for regeneration and new infestations, and re-treat as needed.
- 3) Plant native species on treated sites where native diversity/abundance is low.

F. MANAGEMENT OPTIONS

The Southeast Nonnative Pest Plant Council (Remaley, 2003) recommends the following control procedures for the related invasive, Japanese spiraea (*Spiraea japonica*):

1) Mechanical control.

“**Mowing/Cutting:** This method is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Repeated mowing

or cutting will control the spread of spiraea, but it may not eradicate it. Stems should be cut at least once per growing season prior to seed production and as close to ground level as possible.”

2) Chemical Control.

“Foliar Spray Method: This method should be considered for large thickets of Japanese spiraea where risk to non-target species is minimal. Air temperature should be above 65°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 partially-sprayed non-target 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 spiraea, triclopyr can be used without non-target damage.

Cut Stump Method: This control method should be considered when treating individual bushes or where the presence of desirable species precludes foliar application. This treatment is effective as long as the ground is not frozen.

Glyphosate: Horizontally cut spiraea 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 spiraea 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.”

G. ACTIONS PLANNED (Treatments and monitoring)

The largest patch of spiraea (~90 m²), just west of Tour Stop 6, will be treated first via foliar application of appropriate herbicides in late spring or summer. This area also contains a large infestation of wisteria so both species may be treated simultaneously. Other infestations are much smaller (20 m² or less) and may not warrant immediate attention, so they will be treated as resources become available or when other more problematic species are being treated nearby. The patch near Tour Stop 6 will be replanted with native shrubs and trees during the dormant season after treatment. All treated patches will be monitored annually for regrowth, invasion by other nonnatives, and native species response beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Euonymus alatus*
Updated: August 2008

Common name: Burning Bush

A. PRIORITY: 3

B. DESCRIPTION

From USDA Forest Service fact sheet, **Weed of the Week: Winged Burning Bush** (USDA Forest Service, 2005A):

“A deciduous bushy shrub in the bittersweet family (Celastraceae) that grows to 15 to 20 feet tall and equally as wide. It is multi-stemmed with a broad closed crown. The green to brown stems have two to four prominent corky wings. The elliptic leaves are simple, opposite or sub-opposite, 1 to 3 inches long and 1/2 to 1 1/4 inches wide and have fine toothed margins. The leaves turn a bright red in the fall before dropping. Small green inconspicuous flowers have 4-petals and occur from May to early June. Small smooth red-orange fruits appear as stemmed pairs in leaf axils and turn purple in fall.”

C. DAMAGE AND THREATS

From USDA Forest Service fact sheet, **Weed of the Week: Winged Burning Bush** (USDA Forest Service, 2005A):

“(Burning bush) has been widely planted as an ornamental shrub for its spectacular red autumn foliage and along roadsides for its tolerance to salt. It may spread by seed from where it is used as an ornamental shrub. It colonizes by root suckers and spreads by animal-dispersed seeds. It shades out native herbs and crowds out native shrubs. The shrub may become a troublesome plant because of the ease with which seeds are spread, the readiness of germination, the adaptability to various soils, and tolerance of full shade.”

D. CURRENT DISTRIBUTION ON THE SITE

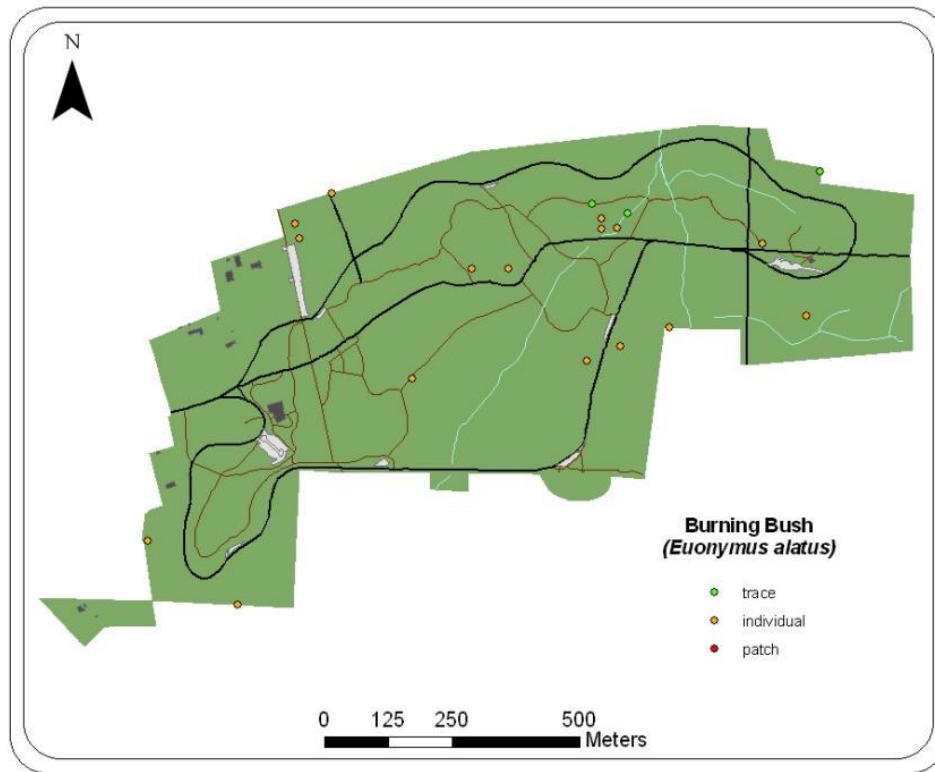


Figure 20. Distribution of burning bush. This species occurs as isolated individuals and a few traces in several sections of GUCO. It was encountered primarily along forest edges, though a few large, fruiting specimens were also seen in the interior. It occurs in recently disturbed successional forests as well as some of the highest quality sites in GUCO.

E. OBJECTIVE (Measurable)

- 1) Locate and remove all burning bush plants in GUCO.
- 2) Monitor treated plants and treat all subsequent regrowth.

F. MANAGEMENT OPTIONS

From USDA Forest Service fact sheet, **Weed of the Week: Winged Burning Bush** (USDA Forest Service, 2005 A):

1) Mechanical control.

“Hand-pull seedlings up to 2 feet tall; cut or dig out larger plants; root systems can be removed with a spading fork or pull with a weed wrench; ground out stump and paint with glyphosate immediately after cutting.”

2) Chemical Control.

“It can be effectively controlled using any of several readily available general use herbicides such as glyphosate, imazapyr, or triclopyr. Cut stumps can be sprayed or painted with glyphosate. Follow label and state requirements.”

G. ACTIONS PLANNED (Treatments and monitoring)

Shrubs will be located and treated via cut-spray application of appropriate herbicides in late spring or summer. Because they are somewhat isolated and widely dispersed, plants will be treated when other, more-problematic species are being treated nearby. Treated individuals will be monitored yearly for regrowth and re-treated as needed until no regrowth is observed for 2 consecutive years.

Scientific name: *Pyrus calleryana*
Updated: August 2008

Common name: Callery Pear

A. PRIORITY: 3

B. DESCRIPTION

From USDA Forest Service fact sheet, **Weed of the Week: Callery Pear / Bradford Pear** (USDA Forest Service, 2005 B):

“A deciduous tree in the rose family (Rosaceae) growing 30 to 50 feet in height and 20 to 30 feet in width. The overall shape of the tree is often described as a tear-drop with the trunk frequently splitting into many smaller branches. Leaves are alternate, simple, and shiny with wavy, slightly-toothed margins. Leaves turn yellow, orange and red in late autumn. Five-petal white flowers occur early in the spring before leaves appear. Small ½ inch, round, and green to brown fruits appear during late spring and summer. It spreads vegetatively and freely by seeds that are dispersed to new locations by birds that eat the fruit.”

C. DAMAGE AND THREATS

From USDA Forest Service fact sheet, **Weed of the Week: Callery Pear / Bradford Pear** (USDA Forest Service, 2005 B):

“Callery Pear is often found growing in the company of many other nonnative plants and competes with both the native and nonnative species. This tree has a tendency to split, fall apart or uproot under wind glaze and snow events.

D. CURRENT DISTRIBUTION ON THE SITE

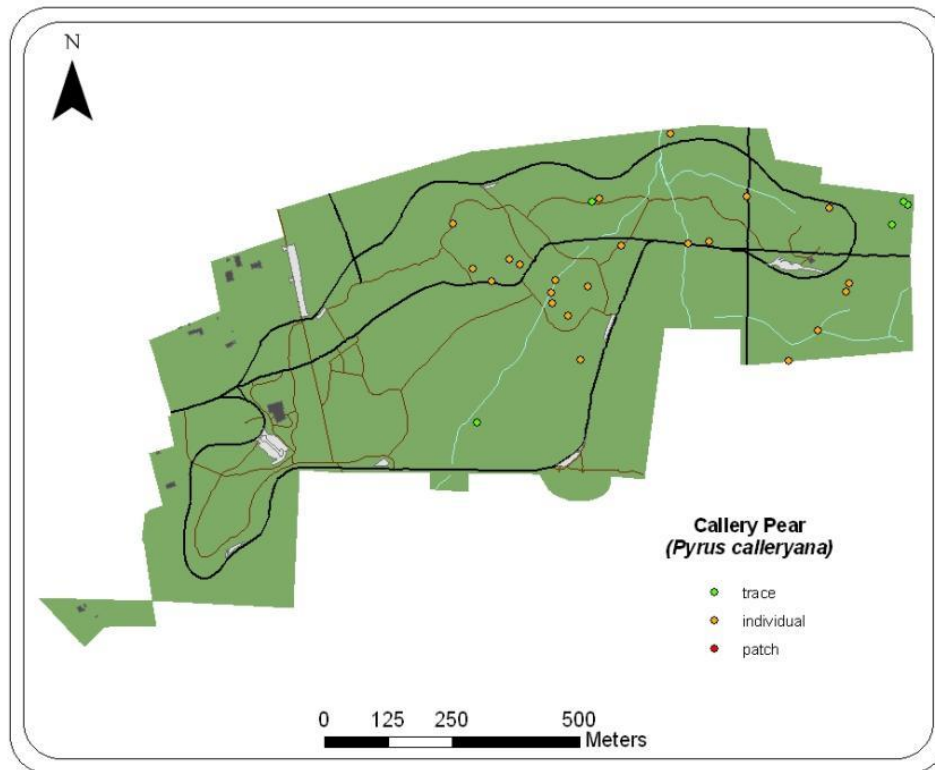


Figure 21. Distribution of Callery pear. This species occurs as individuals and a few traces in the central and eastern sections of the park. 27 records were made for the species but some of these may have actually been common pear (*Pyrus communis*). Callery pear was found primarily in successional forests and other highly modified areas.

E. OBJECTIVE (Measurable)

- 1) Locate and remove Callery pear trees.
- 2) Monitor treated plants and treat all subsequent regrowth.

F. MANAGEMENT OPTIONS

From USDA Forest Service fact sheet, **Weed of the Week: Callery Pear / Bradford Pear** (USDA Forest Service, 2005 B):

1) Mechanical control.

“Seedlings and shallow-rooted plants can be pulled when soil is moist. Dig small trees up or pull out using a Weed Wrench®, ensuring removal of the root system. If cutting is not possible, trees can be girdled during the spring and summer, by cutting through the bark all around the trunk, about 6" above the ground.”

2) Chemical Control

“Large trees should be cut down and stumps treated with an appropriate systemic herbicide (e.g., glyphosate or triclopyr), following label directions, or ground up to prevent re-sprouting.”

G. ACTIONS PLANNED (Treatments and monitoring)

Trees will be located and treated via cut-spray application of appropriate herbicides in late spring or summer. Because they are somewhat isolated and widely dispersed, plants will be treated when other, more-problematic species are being treated nearby. Treated individuals will be monitored yearly for regrowth and re-treated as needed until no re-growth is observed for 2 consecutive years.

Scientific name: *Dioscorea oppositifolia*
Updated: August 2008

Common name: Chinese yam

A. PRIORITY: 3

B. DESCRIPTION

From **Nonnative Invasive Plants of Southern Forests** (Miller, 2003):

“Herbaceous, high climbing vines to 65 feet (20 m) long, infestations covering shrubs and trees. Twining and sprawling stems with long-petioled heart-shaped leaves. (Chinese yam has opposite leaves). Spreading by dangling potato-like tubers (bulbils) at leaf axils and underground tubers. Monocots.”

C. DAMAGE AND THREATS

Chinese yam grows rapidly on upright vegetation to form dense infestations that shade out lower strata and otherwise impair growth of plants below. It is often found along riparian corridors where it may form blanket-like infestations. This species threatens one of the park’s highest priority community types, the small stream sweetgum forest.

D. CURRENT DISTRIBUTION ON THE SITE

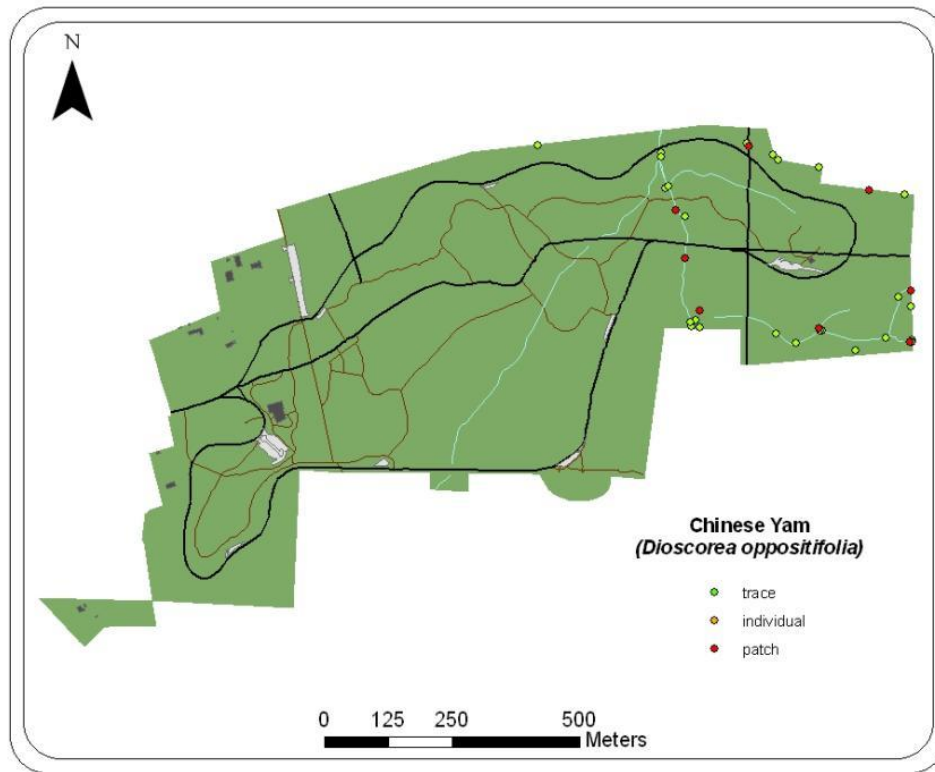


Figure 22. Distribution of Chinese yam. This species occurs along the floodplain of Hunting Creek and its small tributary in the southeast corner of the park. Several traces and small patches were also observed along the northern fence line where they are likely spreading from infestations and/or plantings in the adjacent neighborhood. All infestations occur within or adjacent to forest communities that have experienced significant human-induced disturbance over the past century.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of Chinese yam.
- 2) Monitor treated sites and re-treat new growth as needed.

F. MANAGEMENT OPTIONS

From **Southeast Nonnative Pest Plant Council Invasive Plant Manual** (Remaley, 2003):

1) Mechanical control

“Mowing/Cutting: This method is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Mowing or cutting will control the spread of Chinese yam, but will not eradicate it unless it is continued

for several growing seasons or until the root reserves are exhausted. Stems should be cut at least once per growing season as close to ground level as possible. Treatment should be completed prior to bulbil production typically in July. **Grubbing:** This method 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 bulbils (if present). Juvenile plants can be hand pulled depending on soil conditions and root development. Any portions of the root system not removed will potentially resprout. **Mulching:** Mulching is an effective control on small infestations or in areas where herbicides cannot be used. Cover the entire infestation with several inches of mulch. This may include wood chips, grass clippings, hay or similar degradable plant material. Shredded or chipped wood may be the best option since hay and grass may potentially carry weed seeds. Covering the area with cardboard may improve the effectiveness and longevity of this method. The mulch should stay in place for at least two growing season and may need to be augmented several times.”

2) Chemical Control

“**Foliar Spray Method:** Use this method to control large populations. The most effective time to treat plants is after the leaves are fully expanded but before the aerial tubers are ripe. **Glyphosate:** Apply a 4% solution of glyphosate and water plus 0.5%-1% 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°F. **Triclopyr:** If native grasses are intermingled with the Chinese yam, triclopyr is preferred since it is selective to broadleaved plants. Apply a 4% solution of triclopyr and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. A 0.5%-1% non-ionic surfactant is recommended in order to penetrate the leaf cuticle, and ambient air temperature should be above 65°F.”

G. ACTIONS PLANNED

Infestations along Hunting Creek and its small tributary in the southeast corner of the park will be treated first via foliar application of appropriate herbicides in the summer or fall. Traces and small patches along the northern fence line will be manually removal or sprayed. Treated patches in the Lake Caldwell pond bed area will be replanted with native shrubs and trees. All treated sites will be monitored and re-treated annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Akebia quinata*
Updated: August 2008

Common name: Chocolate Vine

A. PRIORITY: 3

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Fiveleaf Akebia** (Swearingen et al., 2006):

“Fiveleaf akebia, also known as chocolate vine, is a woody perennial plant that grows either as a twining vine or a groundcover. It has slender stems that are green when young and brown at maturity. The leaves are dull blue-green in color and alternate along the stem. Each leaf is divided into five stalked leaflets that meet at a central juncture. Leaflets are 1½ to 3 inches long and are notched at the tip. The flowers are reddish to purple-brown, about 1 inch across, and have a sweet fragrance likened to chocolate. Flowering occurs in springtime (March-April). The fruits, if produced at all, are large, soft, edible sausage-shaped pods 2¼ to 4 inches in length, that ripen in late September to early October. The inside of the pod has a whitish pulpy core with many tiny black seeds. Akebia is deciduous in cooler climates but may remain evergreen in warmer regions, such as Louisiana.”

C. DAMAGE AND THREATS

From USDA Forest Service fact sheet, **Weed of the Week: Chocolate Vine** (USDA Forest Service, 2005 C):

“The dense mat of vines formed can displace native understory species. It can also climb into, smother, and kill small trees and shrubs. It grows so quickly that, if left unmanaged, it can kill off existing ground level vegetation, understory shrubs and trees, and even some canopy trees, by overtopping and smothering them. Once established, its dense growth prevents seed germination and seedling establishment of native plants.”

D. CURRENT DISTRIBUTION ON THE SITE

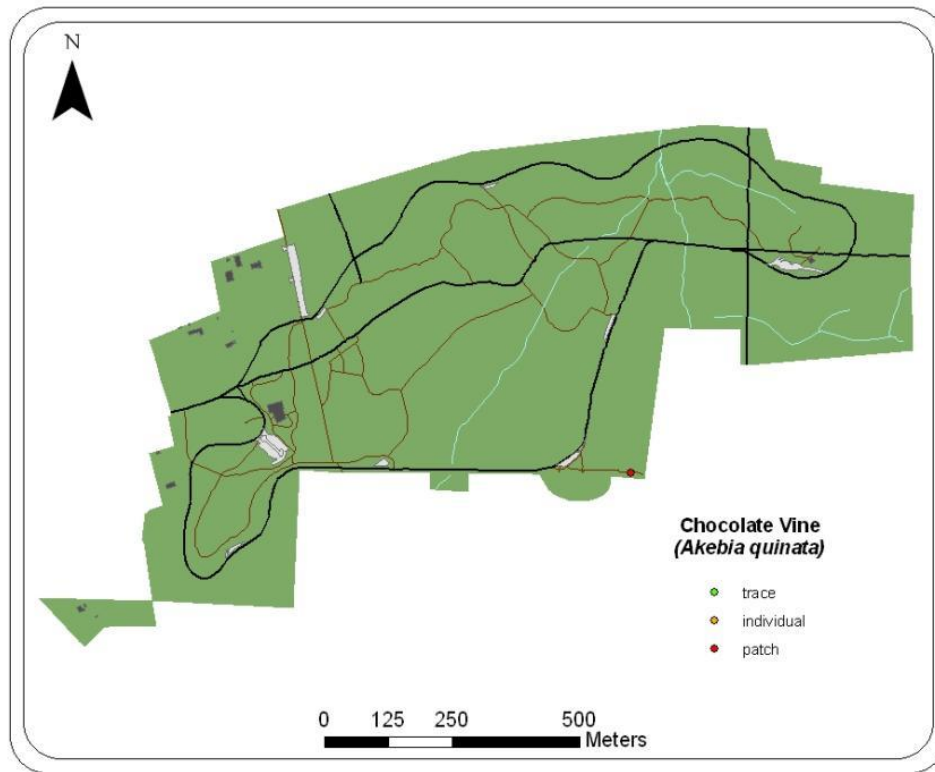


Figure 23. Distribution of chocolate vine. This species occurs as a small patch (~12 m²) of ~30% cover within GUCO. It is located along the south side of the paved trail connecting Tour Stop 4 to Country Park. The patch is growing on and around a small sweetgum tree in the mowed area adjacent to the trail.

E. OBJECTIVE (Measurable)

- 1) Locate and treat the patch of chocolate vine.
- 2) Monitor treated sites and re-treat new growth as needed.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Fiveleaf Akebia** (Swearingen et al., 2006):

“Control options must be determined on a site-by-site basis. Manual, mechanical and chemical control methods are all effective for control of (chocolate vine). Employing a combination of methods often yields the best results and may reduce potential impacts to native plants, animals and people. The method you select depends on the extent and type of infestation, the amount of native vegetation on the site, and the time, labor and other resources available to you. For small or scattered infestations manual and mechanical

methods may suffice. Systemic herbicides or a combination of manual, mechanical and chemical are probably more effective and practical for large infestations. Whenever possible and especially for vines climbing up trees or buildings, a combination of cutting followed by application of concentrated systemic herbicide to rooted, living cut surfaces is likely to be the most effective approach. For large infestations of ivy spanning extensive areas of ground, a foliar herbicide may be the best choice to minimize soil disturbance that could lead to reinfestation.”

1) Mechanical Control

“Vines growing as groundcover can be pulled up by hand and left on-site or bagged and disposed of as trash. Always wear gloves and long sleeves to protect your skin from poison ivy and barbed or spined plants. For climbing vines, first cut the vines near the ground using pruning snips at a comfortable height to kill upper portions and relieve the tree canopy. Rooted portions will remain alive and should be pulled, repeatedly cut to the ground or treated with herbicide. Because cutting will likely result in vigorous regrowth repeated cutting is needed to ensure long term control. Cutting can be done any time of year using a weed whip or mower. Cut vines to the ground and repeat as needed until no regrowth occurs. If time or resources are limited, akebia should be cut back to the ground once each year at the end of the summer at a minimum. Mulching may be an effective choice for smaller ground-cover infestations and when herbicides are not appropriate. Cover the entire infestation with several inches of mulch. This may include wood chips, grass clippings, hay or similar degradable plant material. Shredded or chipped wood may be the best option since hay and grass may potentially carry weed seeds. Covering the area with cardboard may improve the effectiveness and longevity of this method. The mulch should stay in place for at least two growing seasons and may need to be augmented several times. Mulching can also be done following herbicide treatment.”

2) Chemical Control

“Systemic herbicides like triclopyr (e.g., Garlon® 3A and Garlon® 4) and glyphosate (e.g., Accord®, Glypro®, Rodeo®) are absorbed into plant tissues and carried to the roots, killing the entire plant within about a week. Herbicide applications can be made any time of year as long as temperatures are between about 50 and 85 degrees Fahrenheit for several days and rain is not expected for 24 hours. Repeated treatments are likely to be needed. Follow-up monitoring should be conducted to ensure effective control. Herbicidal contact with desirable plants should always be avoided. In areas where spring wildflowers or other native plants are interspersed, application of herbicides should be conducted prior to their emergence, or delayed until they have died back. If desirable native grasses are intermingled with akebia, triclopyr should be used because it is selective for broad-leaved plants and will not harm grasses. Glyphosate products referred to in this fact sheet are sold under a variety of brand names (Accord®, Rodeo®, Roundup Pro® Concentrate) and in three concentrations

(41.0, 50.2 and 53.8% active ingredient). Other glyphosate products sold at home improvement stores may be too dilute to obtain effective control. Triclopyr comes in two forms – triclopyr amine (e.g., Garlon® 3A, Brush-B-Gone®, Brush Killer®) and triclopyr ester (e.g., Garlon® 4, Pathfinder®, and Vinex®). Because Garlon® 3A is a water-soluble salt that can cause severe eye damage, it is imperative that you wear protective goggles to protect yourself from splashes. Garlon® 4 is soluble in oil or water, is highly volatile and can be extremely toxic to fish and aquatic invertebrates. It should not be used in or near water sources or wetlands and should only be applied under cool, calm conditions. **Basal bark application:** Use a string trimmer, pruning snips or hand saw, remove some of the foliage in a band a few feet from the ground at comfortable height. To the exposed stems, apply a 20% solution of triclopyr ester (Garlon® 4) (2.5 quarts per 3-gallon mix) in commercially available basal oil with a penetrant (check with herbicide distributor) to vine stems. As much as possible, avoid application of herbicide to the bark of the host tree. This can be done year-round although efficacy may vary seasonally; temperatures should be above 50°F for several days. **Cut stem application:** Cut each vine stem close to the ground or at a comfortable height and cut again a little higher up. Remove cut pieces to make a vine-free band around the tree trunk. The upper portions of cut vines will eventually die, rot and fall off the host tree. To the freshly cut surfaces of the living rooted stems apply a 25% solution of triclopyr amine (Garlon® 3A) or glyphosate (e.g., Accord®) mixed in water. Homeowners can apply products like Brush-B-Gone®, Brush Killer® and Roundup Pro® Concentrate undiluted to cut stems. Using a paint brush or a plastic spray bottle, apply herbicide to the cut surface especially the perimeter inside the bark which is the living portion of plant. **Foliar application:** From summer to fall, apply 2 to 5% solution (8 to 20 oz. per 3-gallon mix) of triclopyr ester (Garlon® 4) mixed in water with a non-ionic surfactant to the leaves. Thoroughly wet the foliage but not to the point of runoff. Some control may be achieved with glyphosate as a 2 to 4-percent solution (8 to 16 oz. per 3-gallon mix) mixed in water with a 0.5 to 1.0 %non-ionic surfactant, but repeat applications are likely to be necessary. During foliar applications some of the herbicide is also absorbed through the stem for additional (basal bark) effect.”

G. ACTIONS PLANNED

The chocolate vine patch will be located and treated via mechanical or chemical control procedures in the late spring or early summer. The patch is small enough that mechanical/manual removal may be appropriate, but, because there is little desirable native vegetation in the area, herbicide application can be used to ensure effective control. Climbing vines will be cut and treated basally with appropriate herbicides; creeping vines will be treated via foliar application. The patch will be monitored and re-treated yearly until no new growth is observed for 2 consecutive years.

Scientific name: *Liriope spicata*
Updated: August 2008

Common name: Creeping Liriope

A. PRIORITY: 3

B. DESCRIPTION

Creeping liriope is a perennial, evergreen, grass-like groundcover in the lily family (Liliaceae). It grows to a height of ~1 tall at maturity and spreads by rhizomes to form dense turf-like mats. White or violet flowers are borne in spikes in the summer. It produces small fleshy fruits with viable seeds. This species is a popular ornamental and is sold/planted widely in the Southeast.

C. DAMAGE AND THREATS

Dense mats of creeping liriope compete with native species for soil resources and light. The evergreen foliage may reduce light available to spring ephemerals. Mats of creeping liriope in natural areas reduce the historical accuracy of the battlefield.

D. CURRENT DISTRIBUTION ON THE SITE

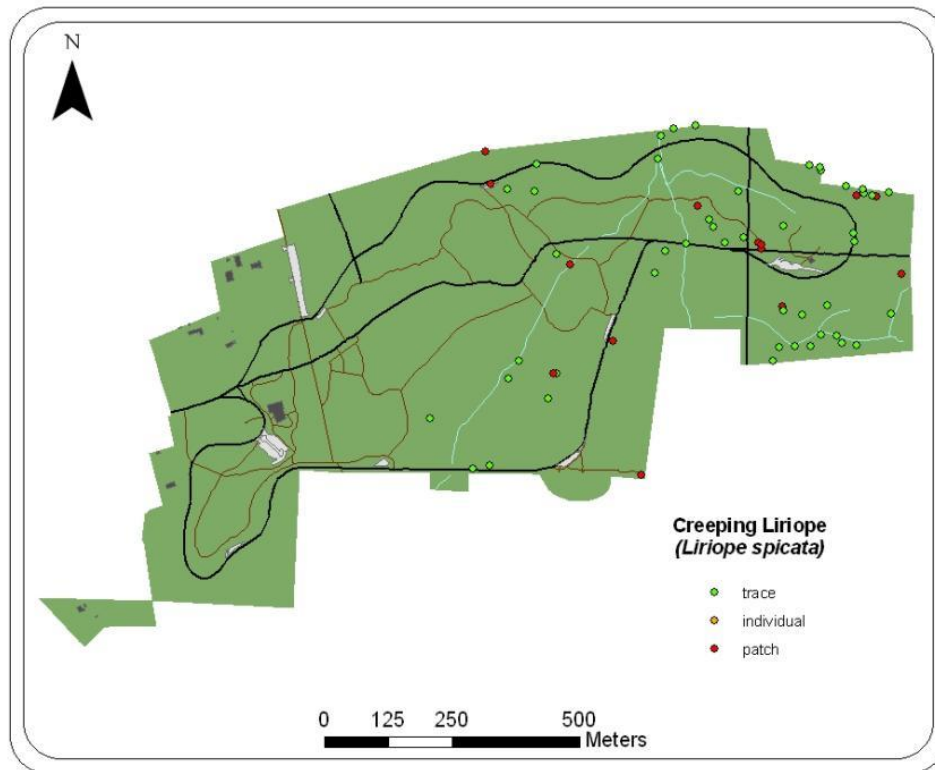


Figure 24. Distribution of creeping liriopse. This species occurs as several small patches ($< 60 \text{ m}^2$) and traces primarily in the eastern half of the park. The largest infestations are in highly disturbed areas or along forest edges, and traces are more common within forest interiors. Areas along the northern fence line and adjacent to Tour Stop 6 have relatively large patches with high percent cover.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches of creeping liriopse.
- 2) Locate and remove traces of creeping liriopse.
- 3) Monitor treated sites and re-treat new growth as needed.
- 4) Distribute informational pamphlets on invasives plants to residents in adjacent communities.

F. MANAGEMENT OPTIONS

1) Mechanical/Manual Control.

Small patches and traces of creeping liriopse can be hand pulled. All roots/rhizomes should be removed with plants and disposed of properly to avoid resprouting and propagule dispersal.

2) Chemical Control.

Relatively little information is available on the most effective chemical control options for creeping liriop. Neal and Skroch (1985) saw highest % injury to liriop using over-the-top treatment of glyphosate at a rate of 3 kg/ha applied in June. Spring and fall treatments were less effective. Cutting leaves and then spraying new growth with an appropriate rate of glyphosate (see herbicide label) may also be appropriate. The herbicide Monument (trifloxy-sulfuron sodium) has provided good control in container experiments but repeated testing is needed (Joe Neal, personal communication).

G. ACTIONS PLANNED

The patch of liriop north of Stop 7, adjacent to the foot trail, will be treated first via foliar application of an appropriate herbicide in the summer. The other relatively large patch near Stop 6 will then be treated similarly. As resources permit, small patches and traces will be located and removed by manual or chemical control procedures. All treated sites will be monitored annually and re-growth will be treated appropriately. Pamphlets on invasive plants and potential landscape alternatives will be adapted or created and distributed among residents in the communities north of the park where liriop and other species are commonly planted.

Scientific name: *Phyllostachys aurea*
Updated: August 2008

Common name: Golden Bamboo

A. PRIORITY: 3

B. DESCRIPTION

From **Nonnative Invasive Plants of Southern Forests** (Miller, 2003):

“Perennial infestation-forming bamboos, 16 to 40 feet (5 to 12 m) in height, with jointed cane stems and bushy tops of lanceolate leaves in fan clusters on grasslike stems, often golden green. Plants arising from branched rhizomes.”

C. DAMAGE AND THREATS

Golden bamboo spreads rapidly from old plantings to form dense thickets to the exclusion of native vegetation. The species can be difficult to eradicate once established. It is currently restricted to a single site in the park and does not directly threaten high quality communities but is nonetheless problematic from an interpretive/ecological perspective.

D. CURRENT DISTRIBUTION ON THE SITE

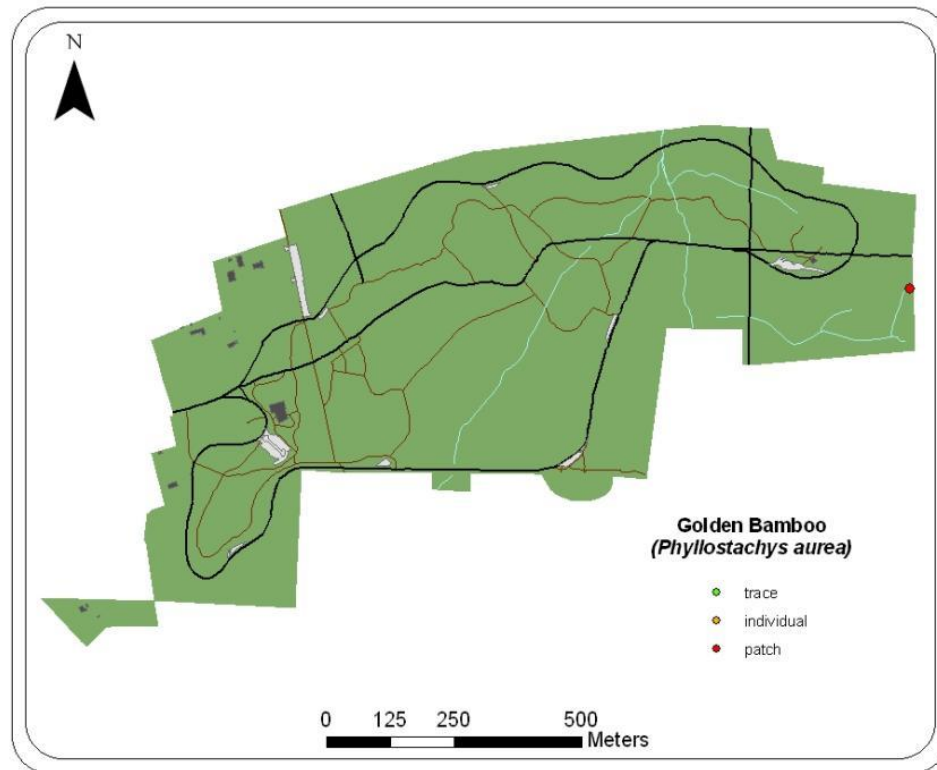


Figure 25. Distribution of golden bamboo. This species is present as a single infestation along the eastern edge of the park. This patch is located just south of the service road, at its intersection with Lawndale Dr. Patch size is approximately 80 m² at ~30 percent cover. This is a highly disturbed site on the edge of successional pine forest.

E. OBJECTIVE (Measurable)

- 1) Treat patch of golden bamboo.
- 2) Plant native species in area of infestation.
- 3) Monitor treated sites and re-treat new growth as needed.

F. MANAGEMENT OPTIONS

From **Southeast Nonnative Pest Plant Council Invasive Plant Manual** (Remaley, 2003):

1) Mechanical Control

“Cutting/Mowing: This method can be used on small infestations or where herbicides cannot be used. Cut plants as close to the ground as possible. Repeat several times throughout the growing season as plants resprout. Monitoring and re-

treatment will be necessary for several growing seasons until the energy reserves in the rhizomes are exhausted.”

2) Chemical Control

“Foliar Spray Method: This method should be considered for large areas of bamboo where risk to non-target species is minimal. Air temperature should be above 65°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.

Cut Stump Method: This control method should be considered when treating individual trees 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 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.”

G. ACTIONS PLANNED

The patch of golden bamboo will be treated via foliar application of an appropriate herbicide (see above) in the late spring or summer. The area of infestation is co-dominated by several other invasive species, so damage to nearby vegetation will be a minor concern. Appropriate native shrubs and trees will be planted at the site during the dormant season after treatment. The site will be monitored yearly beginning the following growing season and continuing until no re-growth is observed for 2 consecutive growing seasons.

Scientific name: *Ilex crenata*
Updated: August 2008

Common name: Japanese Holly

A. PRIORITY: 3

B. DESCRIPTION

Japanese holly is a small-to-medium sized, evergreen shrub in the Holly Family (Aquifoliaceae). The species is dioecious, with female plants producing black drupe fruits. It spreads from bird-dispersed seeds and root sprouts. Native to eastern Asia, Japanese holly was introduced to the United States as an ornamental plant, primarily for its dense evergreen foliage. It is commonly sold and planted as an ornamental in the Southeast.

C. DAMAGE AND THREATS

This species is not widely reported as an invasive in the Southeast [it has only been reported as such in Virginia and D.C (PCA, 2008)] and information on potential threats is limited. The species may shade out native vegetation below its dense, evergreen foliage. It is highly visible and therefore distracting within the context of historical accuracy/interpretation.

D. CURRENT DISTRIBUTION ON THE SITE

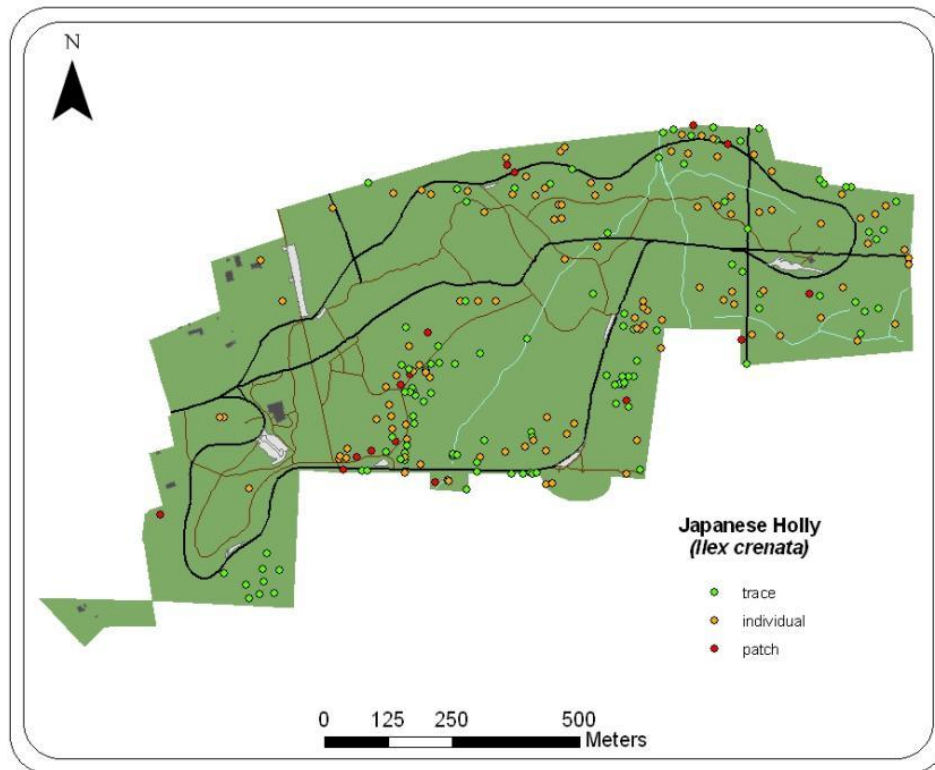


Figure 26. Distribution of Japanese holly. This species is widely distributed within GUCO, occurring mostly as individuals and traces with some small patches. It is fairly abundant in the central and eastern sections of the park, but only occasional in the western third of the park. Areas of concern for this species include: the forest north of Stop 3, the old Petting Zoo site, the Drive-in Tract, and the northeast corner of the park.

E. OBJECTIVE (Measurable)

- 1) Locate and treat large individuals and patches.
- 2) Locate and remove smaller individuals and traces.
- 3) Monitor treated sites and re-treat new growth as needed.

F. MANAGEMENT OPTIONS

1) Mechanical Control.

Small patches, individuals and traces can be removed manually by digging/pulling up stems and all roots. Repeated cutting until plant death is also a viable option.

2) Chemical Control.

Information on chemical control of Japanese holly is not widely available. The closely related English holly (*Ilex aquifolium*), which is somewhat invasive in the northwestern United States, is usually treated via cut stem application of a concentrated systemic herbicide such as glyphosate. Foliar application is largely ineffective due to the thick, waxy leaf surface which limits absorption.

G. ACTIONS PLANNED

Japanese holly will be treated first in areas where it is relatively abundant, visible, or occurring within or adjacent to high quality sites. Such areas include the forest immediately north of Tour Stop 3, the forest just south of Tour Stop 6 (Drive-in Tract), and several sections along the northern fence line. Treatment will consist of cut-spray application of an appropriate herbicide in the late spring or summer. Smaller individuals and traces will be located and removed manually or cut repeatedly until control is achieved. All treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Ligustrum japonicum*
Updated: August 2008

Common name: Japanese Privet

A. PRIORITY: 3

B. DESCRIPTION

From **Nonnative Invasive Plants of Southern Forests** (Miller, 2003):

“Evergreen to 20 feet (6 m) in height ... with spreading crown, thick opposite leaves, conical clusters of white flowers in spring, and green to purple-black fruit in summer and winter... Single plants or thicket-forming, occurring in the same habitats as Chinese privet, but generally not as abundant, depending upon location. Invade both lowland and upland habitats, but usually more prevalent in lowlands. Shade tolerant. Colonize by root sprouts and spread by abundant bird- and other animal-dispersed seeds... Introduced from Japan ... in 1845.... Widely planted as ornamentals and escaped.”

C. DAMAGE AND THREATS

From **Element Stewardship Abstract for *Ligustrum* spp.** (Batcher, 2000):

“*Ligustrum* spp. can form dense thickets that outcompete native vegetation. The privets can invade natural areas such as floodplain forests, woodlands, and disturbed agricultural fields ... Forest gaps can also become invaded since birds often disperse *Ligustrum* seeds.”

D. CURRENT DISTRIBUTION ON THE SITE

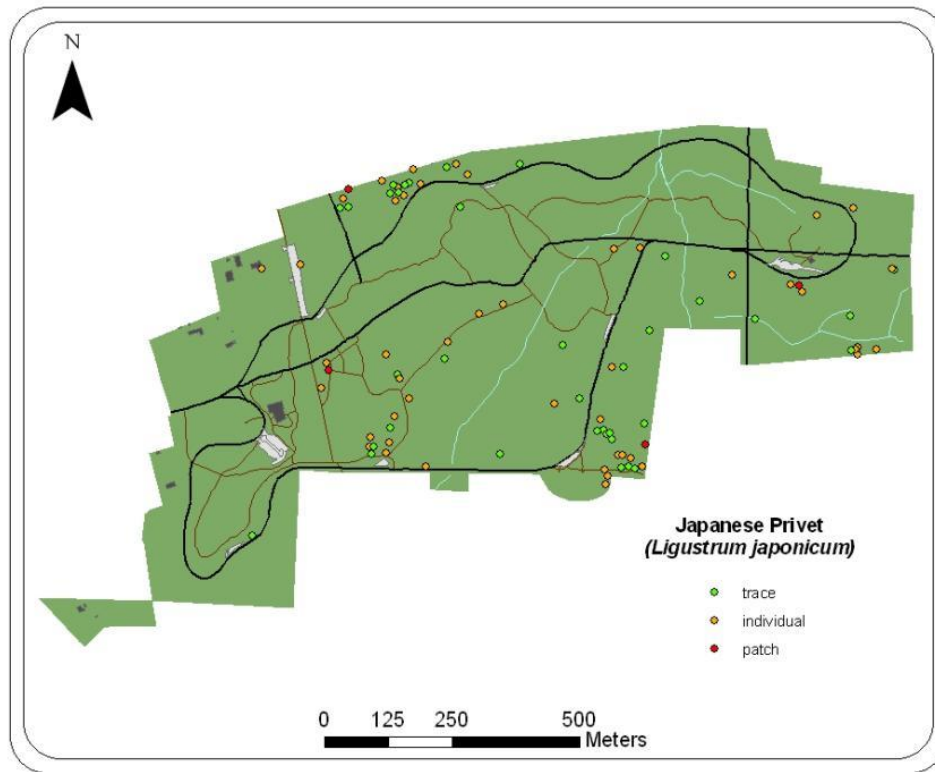


Figure 27. Distribution of Japanese privet. This species is present mostly as individuals and traces, with a few small patches, in several sections of GUCO. It mostly occurs on disturbed sites and in successional forests but is also present to some extent along edges of higher quality sites in the western half of the park. Areas of greatest concern for this species are the old petting zoo site, the Drive-in Tract, and along the northern property line.

E. OBJECTIVE (Measurable)

- 1) Locate and treat large individuals and patches.
- 2) Locate and remove smaller individuals and traces.
- 3) Monitor treated sites and retreat new growth as needed.

F. MANAGEMENT OPTIONS

From **Southeast Nonnative Pest Plant Council Invasive Plant Manual** (Remaley, 2003):

- 1) **Mechanical control.**

“Mowing/Cutting: This method is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Repeated mowing or cutting will control the spread of privet, but will not eradicate it. Stems should be cut at least once per growing season as close to ground level as possible. **Hand Pulling:** Privet is effectively controlled by manual 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. Larger stems, up to 6 cm (2.5 in), can be removed using a Weed Wrench or similar uprooting tools. The entire root must be removed since broken fragments may resprout.”

2) Chemical Control.

“Foliar Spray Method: This method should be considered for large thickets of privet where risk to non-target species is minimal. Air temperature should be above 65°F to ensure absorption of herbicides. The ideal time to treat is in late fall or early spring when many native species are dormant. **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 privet triclopyr can be used without non-target damage.

Cut Stump Method: This control method should be considered when treating individual bushes or where the presence of desirable species precludes foliar application. This treatment is effective as long as the ground is not frozen.

Glyphosate: Horizontally cut privet 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 privet 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: This 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 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.”

G. ACTIONS PLANNED

Japanese privet will be treated first in areas where it is relatively abundant, visible, and/or occurring within or adjacent to high quality sites. Such areas include along the northern

property line between Stops 7 & 8, adjacent to the path between Stop 4 and Country Park, and the area just south of Stop 6. Since it is mostly present as occasional individuals (as opposed to dense thickets), treatment will consist primarily of the cut-stump method using an appropriate herbicide in the late spring or summer. Smaller individuals and traces will be located and removed manually or cut repeatedly until control is achieved. Informational pamphlets will be distributed to residents in the neighborhoods north of the park where Japanese privet is commonly planted. All treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Broussonetia papyrifera*
Updated: August 2008

Common name: Paper Mulberry

A. PRIORITY: 3

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Paper Mulberry** (Swearingen, 2005):
“Paper mulberry is a deciduous tree with milky sap that grows to a maximum height of about 45 ft. (15 m.). The twigs of paper mulberry are hairy reddish brown, the bark is tan and smooth to moderately furrowed ... The leaves are densely gray-pubescent, often lobed or mitten-shaped, and are alternate, opposite or whorled along the stem. The leaf margin is sharply toothed, the leaf base is heart-shaped to rounded with pointed tips, and the upper leaf surface is rough feeling. Separate male and female flowers appear in the spring. Male flower clusters are elongate, pendulous, 2 ½ to 3 in. (6-8 cm) long, and composed of many individual flowers. Female flowers are globular and about 1 in. (2cm) in diameter. The fruits are reddish purple to orange, ¾-1 in. (1.5-2.0 cm) in diameter, and appear in summer. Paper mulberry may be confused with the nonnative white mulberry and native trees such as red mulberry, sassafras, basswood, and white poplar.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Paper Mulberry** (Swearingen, 2005):
“Paper mulberry exhibits aggressive growth and quickly invades disturbed lands, displacing native plants. It has a shallow root system that makes the trees susceptible to blow over during high winds.”

D. CURRENT DISTRIBUTION ON THE SITE

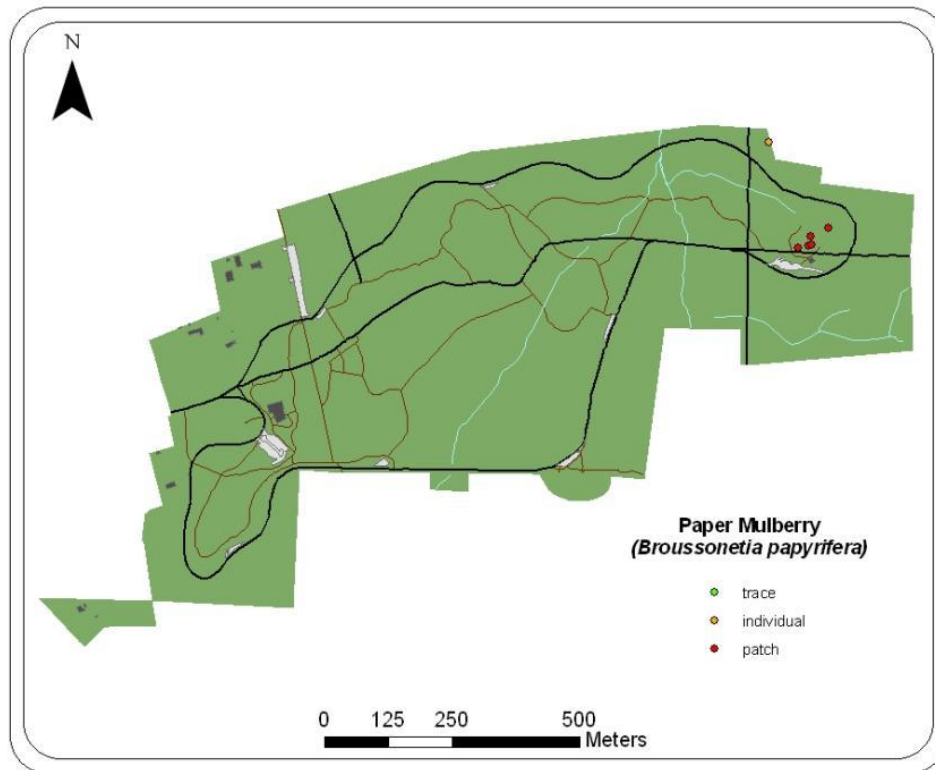


Figure 28. Distribution of paper mulberry. This species is mostly restricted to the area within and around the meadow at Tour Stop 6. In this area it forms several small (< 100 m²) thickets. An isolated individual was recorded along the northern fence line.

E. OBJECTIVE (Measurable)

- 1) Cut and treat thickets in the area of Tour Stop 6 and the isolated individual along the fence line.
- 2) Plant native trees in place of thickets.
- 3) Monitor treated sites and re-treat new growth as needed.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Paper Mulberry** (Swearingen, 2005):

1) Mechanical control.

“Pull seedlings by hand when the ground is moist. Cut young plants to the ground, repeating as necessary to control regrowth from sprouts.”

2) Chemical Control.

“Basal bark, cut-stem, hack-and-squirt, or injection methods of herbicide application are recommended because these methods, if used properly, focus applications to target species, minimize the overall amount of herbicide applied, and reduce environmental impacts. Basal bark application of the systemic herbicide Garlon® 4 (triclopyr ester @ 61.6% a.i.) with a 15-20% mix in horticultural oil will achieve effective control. Garlon® 3A (triclopyr amine @ 44.4% a.i.) may be used with a 50% mix in water for cut stump applications. Herbicide can also be applied using a hatchet to make angled cuts into the trunk, into which concentrated herbicide is squirted from a hand-held spray bottle. For this method, use a 10% mixture of Garlon® 4 in horticultural oil, or a 15% rate for larger trees. Triclopyr products such as Brush-B-Gon® are available at many garden and hardware stores.”

G. ACTIONS PLANNED

The paper mulberry thickets at Tour Stop 6 will be cut down in the late spring or summer, and fresh-cut stumps will be treated with an appropriate herbicide. The isolated tree along the northern fence line is not a major priority and so will be treated similarly only when time and resources permit. One or several native shade trees will be planted in place of each thicket within the meadow at Stop 6. Treated sites will be monitored yearly beginning in the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Paulownia tomentosa*
Updated: August 2008

Common name: Princess Tree

A. PRIORITY: 3

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Princess Tree** (Remaley, 2005B):

“Princess tree ... is a small to medium sized tree that may reach 30-60 feet in height. The bark is rough, gray-brown, and interlaced with shiny, smooth areas. Stems are olive-brown to dark brown, hairy ... Leaves are large, broadly oval to heart-shaped ... and noticeably hairy on the lower leaf surfaces. They are arranged in pairs along the stem ... Upright clusters of showy, pale violet, fragrant flowers open in the spring. The fruit is a dry brown capsule with four compartments that may contain several thousand tiny winged seeds.”

C. DAMAGE AND THREATS

“Princess tree is an aggressive ornamental tree that grows rapidly in disturbed natural areas, including forests, streambanks, and steep rocky slopes (Remaley, 2005 B).”
Though not presently common in the park, larger individuals have been treated at GUCO in the recent past (Roop, 2003), and given its invasive tendencies throughout the region, princess tree represents at least a minor threat to the park’s ecosystems.

D. CURRENT DISTRIBUTION ON THE SITE

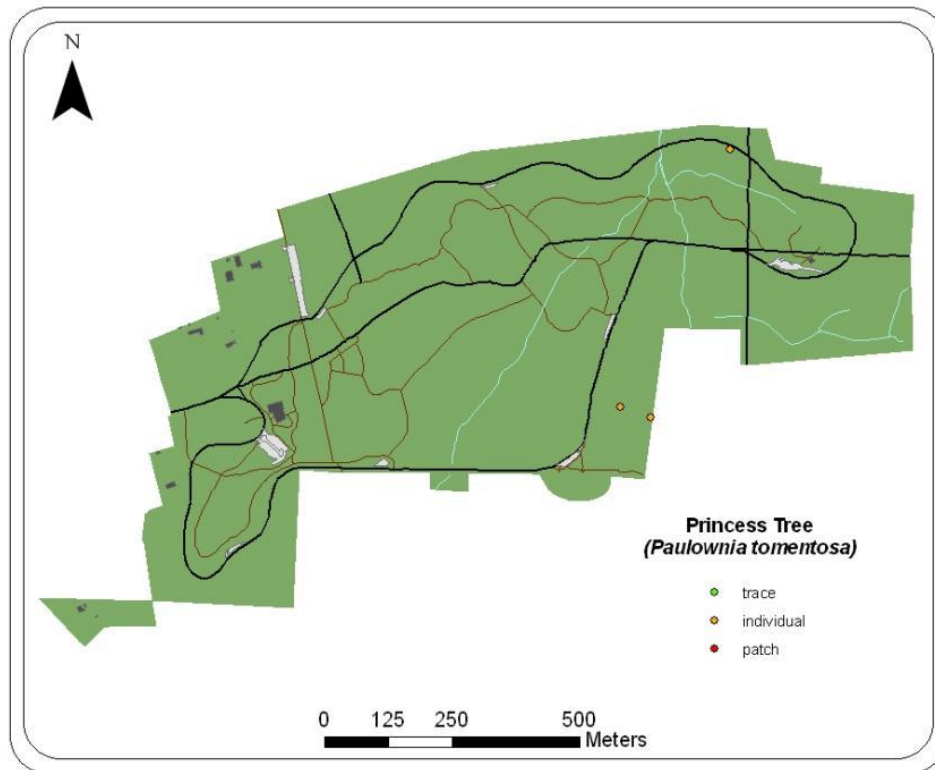


Figure 29. Distribution of princess tree. This species was observed as three saplings (≤ 10 ft in height) in separate locations within GUCO. All occur in or adjacent to upland successional forest. Note: another princess tree sapling was noted recently just south of the Visitor Center, within the walled section where the air conditioning unit is.

E. OBJECTIVE (Measurable)

- 1) Locate and remove princess tree saplings.
- 2) Monitor areas of removal.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Princess Tree** (Remaley, 2005 B):

1) Mechanical control.

“Hand pulling may be effective for young seedlings. Plants should be pulled as soon as they are large enough to grasp. Seedlings are best pulled after a rain when the soil is loose. The entire root must be removed since broken fragments may resprout. Trees can be cut at ground level with power or manual saws. Cutting is most

effective when trees have begun to flower to prevent seed production. Because Princess tree spreads by suckering, resprouts are common after cutting. Cutting should be considered an initial control measure that will require either repeated cutting of resprouts or an herbicidal treatment.”

2) Chemical Control.

“Princess tree seedlings and small trees can be controlled by applying a 2% solution of glyphosate (e.g., Roundup®) or triclopyr (e.g., Garlon) and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce damage from spray drift on non-target species. Glyphosate is a non-selective systemic herbicide that may kill non-target plants that are only partially sprayed. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing, triclopyr can be used with minimal non-target damage. Girdling is effective on large trees where the use of herbicides is impractical. Using a hatchet, make a cut through the bark encircling the base of the tree, approximately six inches above the ground. Be sure that the cut goes well below the bark. This method will kill the top of the tree but resprouts are common and may require a follow-up treatment with a foliar herbicide.

Cut stump application

The cut stump method, that is applying herbicide to freshly cut stumps, should be considered for individual trees or when desirable plants are nearby that might be impacted by foliar applications. Stump treatments can be used as long as the ground is not frozen. Begin treatments by horizontally cutting stems at or near ground level. Immediately apply a 50% solution of glyphosate or triclopyr and water to the cut stump making sure to cover the outer 20% of the stump. Basal bark applications are effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the base of the tree trunk to a height of 12-15 inches from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.”

G. ACTIONS PLANNED

The three princess tree records will be located in the field and removed manually or treated via foliar application of an appropriate herbicide in late spring or summer. These sites will be annually monitored until no re-growth is observed for 2 consecutive years.

Scientific name: *Rosa* spp.
Updated: August 2008

Common name: Nonnative Roses

A. PRIORITY: 3

B. DESCRIPTION

From **Nonnative Invasive Plants of Southern Forests** (Miller, 2003):

“Evergreen ...erect, climbing, arching, or trailing shrubs to 10 feet (3 m) in height or length. Clump forming. Pinnately compound leaves, frequent recurved and straight thorns, clustered or single white flowers in early summer, and red rose hips in fall to winter.”

C. DAMAGE AND THREATS

Damage and threats from some of these nonnative rose species (e.g., the suspected Macartney rose and possibly-present Cherokee rose, *R. laevigata*) may be similar to those posed by multiflora rose, though the latter is usually regarded as more problematic. All of these species can form thickets that exclude native vegetation, restrict access, and detract from the overall appearance of the forest understory.

D. CURRENT DISTRIBUTION ON THE SITE

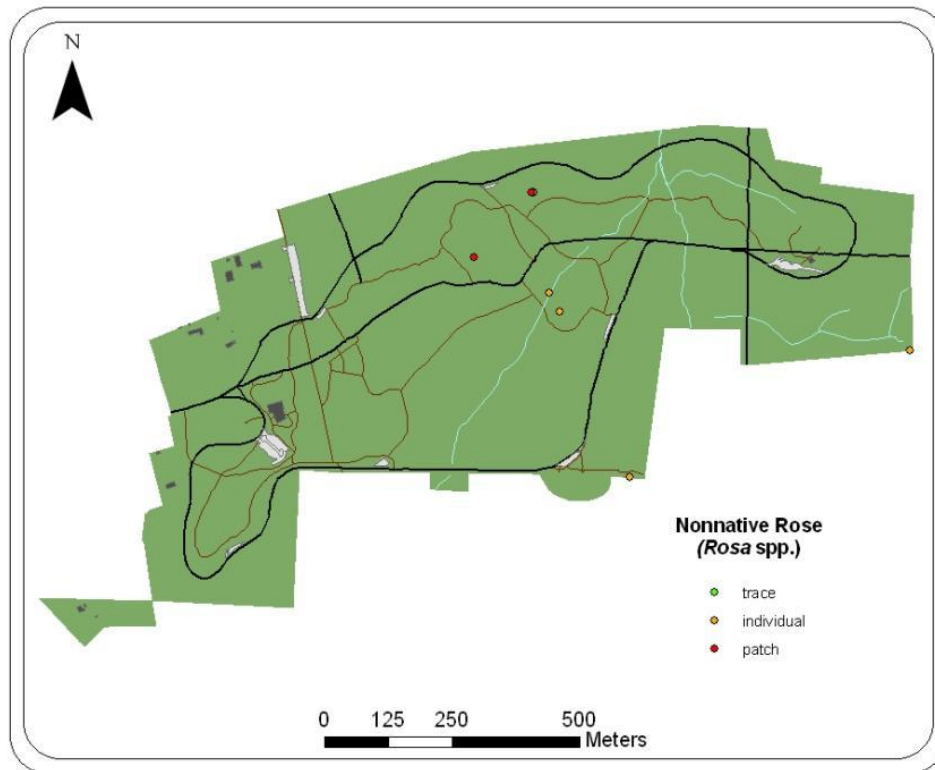


Figure 30. Distribution of nonnative roses. Several individuals and small patches (<40 m²) of unidentified nonnative roses are present in various sections of the park. One of the patches may be of Macartney rose (*Rosa bracteata*) but positive identification was not reached. All records occur within/adjacent to successional forests or in the park's central meadow.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patches.
- 2) Locate and remove individuals.
- 3) Monitor treated sites.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Multiflora Rose** (Bergmann & Swearingen, 2005):

1) Mechanical control.

“Frequent, repeated cutting or mowing at the rate of three to six times per growing season, for two to four years, has been shown to be effective in achieving high

mortality of multiflora rose. In high quality natural communities, cutting of individual plants is preferred to site mowing to minimize habitat disturbance.”

2) Chemical Control.

“Various herbicides have been used successfully in controlling multiflora rose but, because of the long-lived stores of seed in the soil, follow-up treatments are likely to be necessary. Application of systemic herbicides (e.g., glyphosate) to freshly cut stumps or to regrowth may be the most effective methods, especially if conducted late in the growing season. Plant growth regulators have been used to control the spread of multiflora rose by preventing fruit set.”

3) Biological Control

“Biological control is not yet available for management of multiflora rose. However, researchers are investigating several options, including a native viral pathogen (rose-rosette disease), which is spread by a tiny native mite, and a seed-infesting wasp, the European rose chalcid. Rose-rosette disease, native to the western U.S., has been spreading easterwardly at a slow pace and is thought to hold the potential for eliminating multiflora rose in areas where it grows in dense patches. An important drawback to both the rose rosette fungus and the European rose chalcid is their potential impact to other rose species and cultivars.”

G. ACTIONS PLANNED

The two small patches of nonnative roses will be located and treated via cut stump application of an appropriate herbicide in the late spring, summer, or fall. The three isolated individuals do not pose an immediate threat; these will be located and treated when resources permit. Treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Nandina domestica*
Updated: August 2008

Common name: Sacred Bamboo

A. PRIORITY: 3

B. DESCRIPTION

From USDA Forest Service fact sheet, **Weed of the Week: Nandina** (USDA Forest Service, 2006):

“Evergreen erect shrub in the barberry family (Berberidaceae) that grows to a height of 6-10 feet and width of 3 to 5 feet ... The plant has multiple bushy cane-like stems that resemble bamboo. The alternate leaves are bi-pinnately compound dividing into many 1 to 2-inch, pointed, oval leaflets ... The foliage can be tinged red in winter. Early summer terminal clusters of tiny white-to-pink flowers. Each flower is ¼ to ½ inch across, appearing in loose, erect, 6 to 12 inch clusters at the end of the branches. If plants are grouped, shiny red spherical berries, 1/3 inch in diameter, follow the flowers in fall and winter. Single plants seldom fruit heavily. It spreads both vegetatively through underground sprouts from roots and by seeds.”

C. DAMAGE AND THREATS

From USDA Forest Service fact sheet, **Weed of the Week: Nandina** (USDA Forest Service, 2006):

“(Sacred bamboo) has naturalized and invaded habitats. It colonizes by spreading underground root sprouts and by animal-dispersed seeds. It can persist as a seedling for several years before maturing. It can displace native species and disrupt plant communities.”

D. CURRENT DISTRIBUTION ON THE SITE

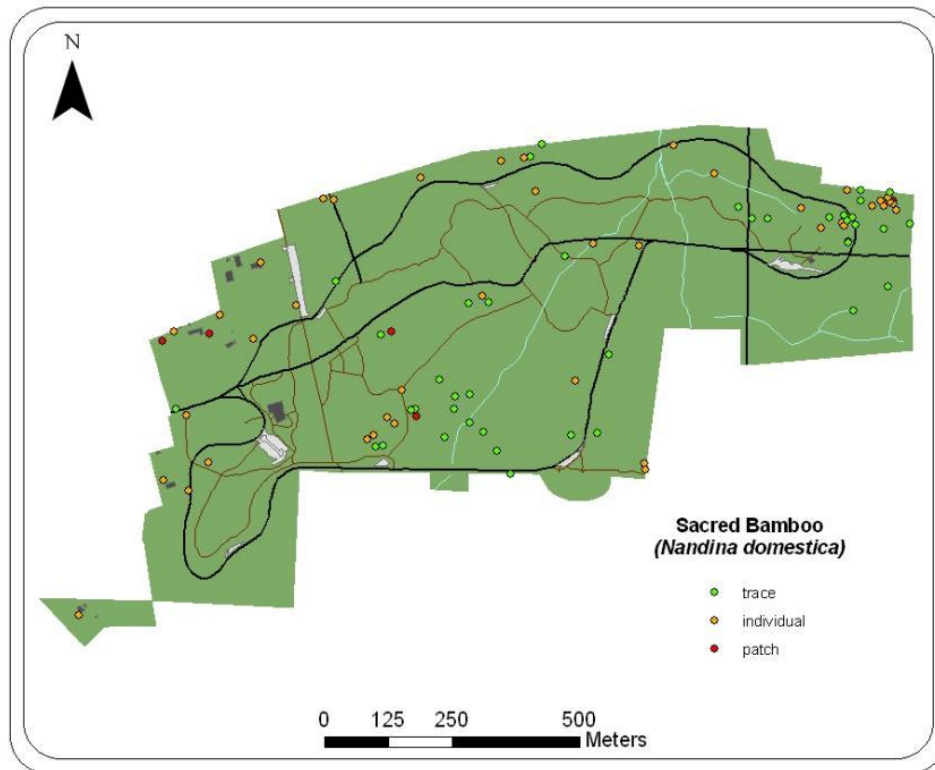


Figure 31. Distribution of sacred bamboo. This species occurs throughout GUCO as isolated individuals or traces and occasionally as small patches. It is most abundant in the northeast corner of the park and in the forest just north of Tour Stop 3. It occurs in successional forests and recently disturbed sites.

E. OBJECTIVE (Measurable)

- 1) Locate and treat areas of highest density.
- 2) Locate and remove isolated individuals and traces.
- 3) Monitor treated sites.
- 4) Inform local resident on threats from invasive plants.

F. MANAGEMENT OPTIONS

1) Mechanical control.

Small patches and individuals can be removed by hand pulling but care must be taken to remove all roots as these will readily sprout back. Repeated cutting may also be effective but, again, sprouting from roots must also be watched for and treated.

2) Chemical Control.

Text taken from **Nonnative Invasive Plants of the Southeast** (Miller, 2003):

“Thoroughly wet all leaves with glyphosate herbicide as a 1-percent solution in water (4 ounces per 3-gallon mix) with a surfactant (August to October). Or, apply Garlon 4 as a 20-percent solution in commercially available basal oil, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray. For stems too tall for foliar sprays, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC* as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix). Collect and destroy fruit.”

G. ACTIONS PLANNED

Sacred bamboo will be treated first in the northeast corner of the park and then in the forest north of Tour Stop 3 where it is also somewhat common. None of these plants are very tall, so they will be treated primarily via foliar application of an appropriate herbicide. Application time will be late summer to fall. As resources permit, isolated individuals and traces elsewhere in the park will be located and removed manually or spot sprayed with herbicide. All treated sites will be monitored yearly beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years. Informational pamphlets will be created or adapted and distributed in nearby communities to inform residents about invasive plants and offer native landscaping alternatives.

Scientific name: *Ulmus pumila*
Updated: August 2008

Common name: Siberian Elm

A. PRIORITY: 3

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Siberian Elm** (Wieseler, 2005):

“Siberian elm is a fast-growing tree in the elm family (Ulmaceae) distinguished by small toothed leaves about 1-2½ in (3-7 cm) long and half as wide, and pointed at the tip. Unlike other elms, the leaf base is usually symmetrical, forming a nearly even "V". Leaves are smooth and dark green above, paler and nearly hairless beneath, and alternate from side to side along twigs. Mature trees reach a height of 50-70 ft. (16-22 m.), with a round crown of slender, spreading branches. The bark is rough, gray or brown, and shallowly furrowed at maturity. Twigs are nearly hairless with small, blunt buds. Flowering occurs in the springtime. The small greenish flowers lack petals and occur in drooping clusters of 2 to 5. After flowering, a single seed forms in the center of each smooth, flattened, circular, ½ in (10-15 mm) wide fruit.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Siberian Elm** (Wieseler, 2005):

“Thickets of seedlings ... form around seed-producing trees, bare ground areas, animal and insect mounds, and other disturbed areas. Wind carries seed to distant areas where new colonies can form. This tough nonnative survives under conditions not easily tolerated by other species, allowing it to take advantage of open ground and resources otherwise used by native plants. Fast growing seedlings of Siberian elm quickly overtake native vegetation, especially shade-intolerant species. This often leads to invasion by additional weedy species, compounding the problem.”

D. CURRENT DISTRIBUTION ON THE SITE

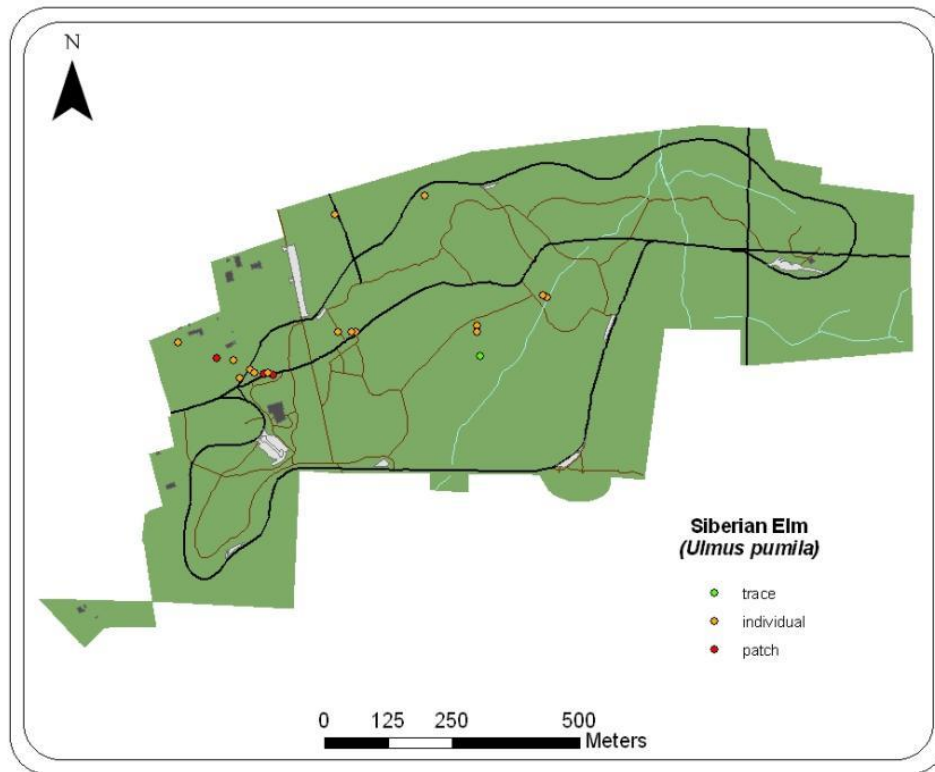


Figure 32. Distribution of Siberian elm. This species is most common in and along the forest between the Visitor Center and the Utility Building. The woodlot immediately north of Historic New Garden Road near the main entrance to the park has the highest density of sapling and adult trees. Elsewhere in the park, it occurs uncommonly as isolated individuals both in forest interiors and along edges.

E. OBJECTIVE (Measurable)

- 1) Locate and treat areas of highest density.
- 2) Locate and remove isolated individuals and traces.
- 3) Monitor treated sites.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Siberian Elm** (Wieseler, 2005):

1) Mechanical control.

“During the growing season, seedlings can be hand pulled and small trees carefully removed by a grub hoe or weed wrench. Trees girdled in mid-May to early July will die over 1-2 years without sprouting if cut properly. To remove a band of bark from

the wood, make two parallel cuts 3-4 inches apart, then knock bark off with a blunt object such as the back of an axe head or dull end of a girdling bar. The xylem must remain intact; if girdled too deeply the tree will respond as if cut down and will resprout. On sites with few seed sources, the large trees can be cut down and resprouts trimmed as needed.”

2) Chemical Control.

“To avoid resprouts after cutting or girdling, cut stumps may be treated with systemic herbicides such as glyphosate (e.g., Roundup®) and triclopyr (e.g., Garlon). After spring sap flow ceases and during the growing season, Minnesota DNR State Parks Southern Region Resource Management apply 4 parts water to 1 part glyphosate (based on 41% active ingredient glyphosate concentrate) with a hand sprayer to cut stumps. The entire stump should be saturated with the herbicide to achieve the most effective control. Garlon® 4 (triclopyr ester formulation) can be applied as a cut stump or basal bark treatment. For basal bark, apply a 20-percent solution in horticultural oil (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray in winter (January to February) or summer-fall (June to October). Cut stems can be immediately treated with glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix) in water with a surfactant.”

G. ACTIONS PLANNED

Elm trees in the area north of the Visitor Center will be treated first in the late spring or summer via appropriate manual or chemical control procedures depending on the size of the tree, proximity to desirable native vegetation, and human safety risk. Smaller saplings will be treated via foliar or cut-treat applications of appropriate herbicides. Large trees will be girdled or treated via stem injection and left standing to serve as wildlife habitat unless such treatment poses safety risks to visitors, workers, etc., in which case they will be completely removed. As resources permit, isolated trees elsewhere in the park will be located and treated similarly. All treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Albizia julibrissin*
Updated: August 2008

Common name: Silk Tree

A. PRIORITY: 3

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Silk Tree** (Remaley, 2005 C):

“Silk tree ... is a small to medium-sized tree that can grow up to 20-40 feet tall. The bark is light brown, nearly smooth, and generally thin ... Leaves of mimosa are finely divided, 5-8 inches long by about 3-4 inches wide, and alternate along the stems. Silk tree has showy and fragrant pink flowers, about 1½ inches long, ... arranged in panicles at the ends of branches. Fruits are flat, straw-colored pods about 6 inches long containing light brown oval-shaped seeds about ½ inch in length. Pods ripen in August to September ... but remain on the trees into winter.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Silk Tree** (Remaley, 2005 C):

“Because silk tree can grow in a variety of soils, produce large seed crops, and resprout when damaged, it is a strong competitor to native trees and shrubs in open areas or forest edges. Dense stands of mimosa severely reduce the sunlight and nutrients available for other plants.”

D. CURRENT DISTRIBUTION ON THE SITE

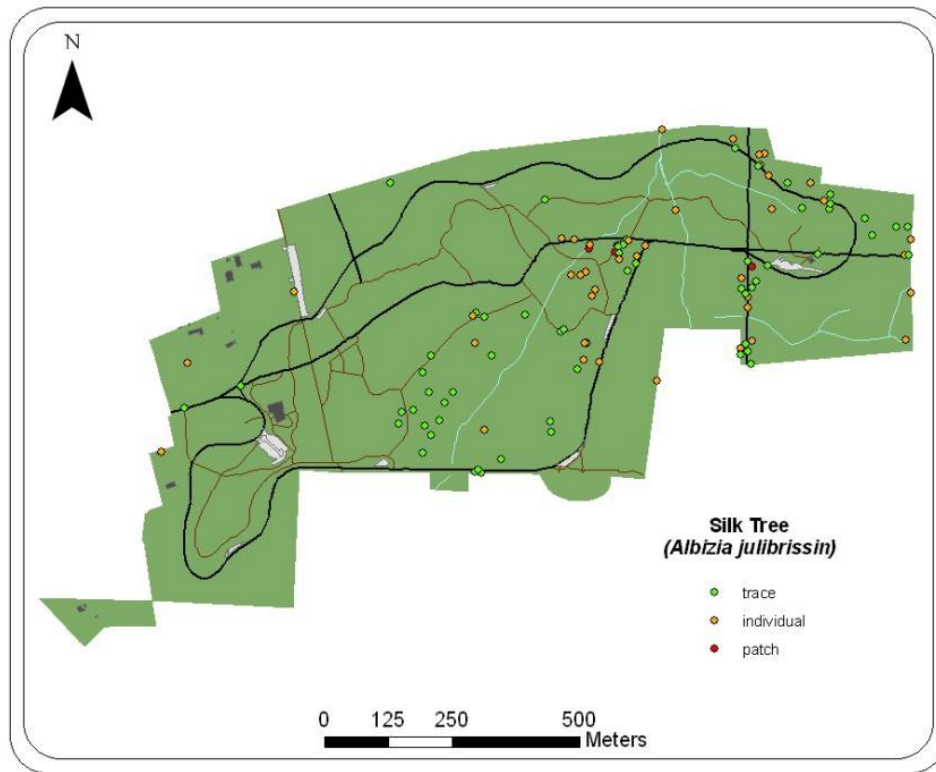


Figure 33. Distribution of silk tree. This species is found in several sections of GUCO but is most abundant in the forests adjacent to Schenck's Field, the northeastern section of the park, and trailside along the Martin Trespass Road. It occurs primarily as traces and individuals of varying sizes, with occasional patches of seedlings, in and adjacent to successional forests in the park.

E. OBJECTIVE (Measurable)

- 1) Locate and treat areas of highest density.
- 2) Locate and remove isolated individuals and traces.
- 3) Monitor treated sites.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Silk Tree** (Remaley, 2005 C):

1) Mechanical control.

“Trees can be cut at ground level with power or manual saws. Cutting is most effective when trees have begun to flower to prevent seed production. Because mimosa spreads by suckering, resprouts are common after treatment. Cutting is an

initial control measure and will require either an herbicidal control or repeated cutting for resprouts. Girdling is effective on large trees where the use of herbicides is impractical. Using a hatchet, make a cut through the bark encircling the base of the tree, approximately six inches above the ground. Be sure that the cut goes well below the bark. This method will kill the top of the tree but resprouts are common and may require a follow-up treatment with a foliar herbicide. Hand pulling will effectively control young seedlings. Plants should be pulled as soon as they are large enough to grasp, but before they are old enough to flower. Seedlings are best pulled after a rain when the soil is loose. The entire root must be removed since broken fragments may resprout.”

2) Chemical Control.

“Silk tree seedlings and small trees can be controlled by applying a 2% solution of glyphosate (e.g., Roundup®) or triclopyr (e.g., Garlon) and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves ... Use a low pressure and a coarse spray pattern to reduce damage from spray drift on non-target species ... Glyphosate is a non-selective herbicide that may kill non-target plants that are only partially contacted. Triclopyr is a selective herbicide for many broad-leaved plant species and should be considered for sites where native or other desirable grasses are meant to be conserved. The cut-stump and basal bark herbicidal methods should be considered when treating 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. Horizontally cut stems at or near ground level. Immediately apply a 25% solution of glyphosate or triclopyr and water to the cut stump making sure to cover the outer 20% of the stump. Basal bark applications are effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the base of the tree trunk to a height of 12-15 inches from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.”

G. ACTIONS PLANNED

Silk tree will be treated first in areas of greatest abundance using appropriate mechanical or chemical control procedures. Treatments will be applied in the late spring, summer, or early fall. Large trees will be girdled or stem injected and left standing to serve as snags unless they pose a safety risk, in which case they will be cut down. Small saplings and patches of seedlings will be treated by foliar application. Treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Clematis terniflora*
Updated: August 2008

Common name: Sweet Autumn Virginsbower

A. PRIORITY: 3

B. DESCRIPTION

From **Invasive.org weed fact sheet: sweet autumn virginsbower** (Bugwood Network, 2007):

“Sweet autumn virginsbower is a climbing, semi-evergreen, ornamental vine. The leaves are opposite, compound (with 3-5 leaflets), and the margins are entire. Leaflets are each 2-3 in. (5-7.6 cm) long. White, fragrant, four-petaled flowers appear in the late summer through the fall. Seeds are also showy and production is prolific. Seed heads have long, silvery-gray, feather-like hairs attached. The native species (*C. virginiana*) is very similar (margins of leaves of the native tend to be toothed), but not as prone to self-seeding and spreading. Sweet autumn virginsbower prefers sun to partial shade and is found invading forest edges, rights of ways and urban green space especially near creeks. It is native to Japan and China and was introduced into the United States as an ornamental plant.”

C. DAMAGE AND THREATS

From **The Global Invasive Species Database** (2008):

“*C. terniflora* has the potential to climb 7.6-9.1 metres and smother fully grown trees, or, if necessary support structure is absent, to sprawl along the ground 15-30cm tall and 3 metres wide. Ground cover form of *C. terniflora* will choke out weeds or other plants trying to spring from ground.”

Within GUCO, *C. terniflora* poses a threat to the stream community along Hunting Creek south of the Tour Road (Old Lake Caldwell site). This section has experienced high levels of disturbance and contains many nonnatives in addition to a relatively diverse native flora. Nonnatives in this area may affect the successional trajectory and ecological functioning of this community.

D. CURRENT DISTRIBUTION ON THE SITE

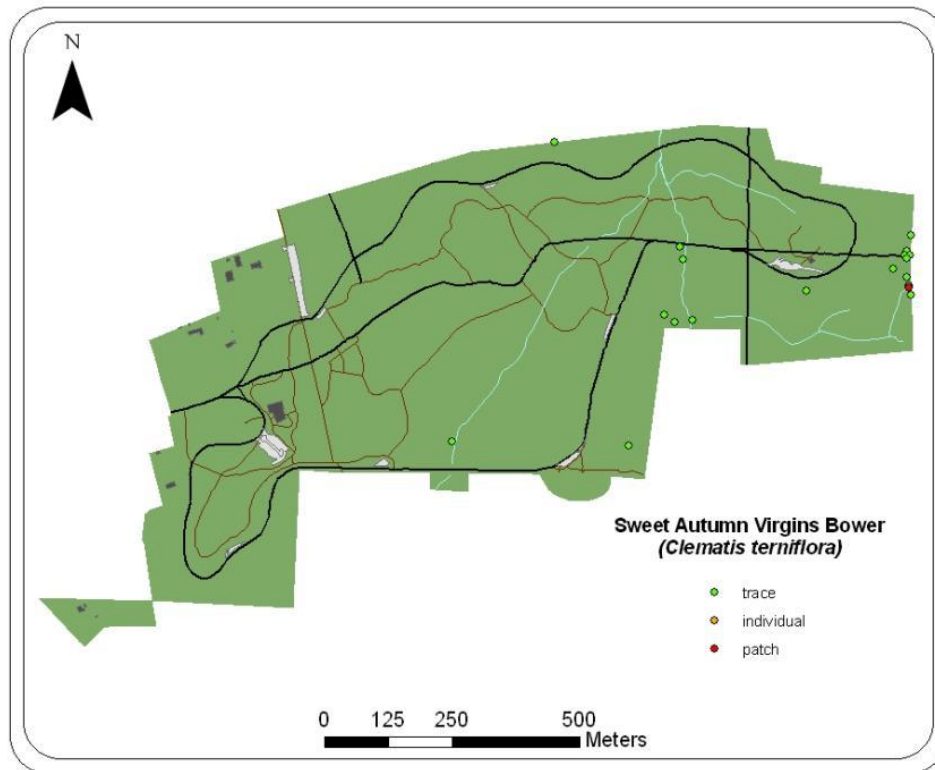


Figure 34. Distribution of sweet autumn virginsbower. This species occurs primarily as traces in several parts of GUCO. One small patch (< 30 m²) with low percent cover (20%) is present near the intersection of the service road and Lawndale Drive, among the patch of bamboo. The species is mostly encountered in open, disturbed, edge habitat but a few traces were recorded within successional forest interiors.

E. OBJECTIVE (Measurable)

- 1) Locate and treat small patch.
- 2) Locate and remove traces in highest priority communities.
- 3) Monitor treated sites.

F. MANAGEMENT OPTIONS

The Florida Cooperative Extension Service at the University of Florida (Meisenburg et al., 2008) recommends the following control procedures:

1) Mechanical control.

“Seedlings may be hand-pulled or mowed. Mature plants can be cut by hand or mowed. Plants must be cut back enough and dug up to ensure complete removal.”

2) Chemical Control.

“Current chemical-control methods include foliar applications of triclopyr amine (e.g. 2-3% Garlon 3A) and triclopyr ester (e.g. 15% Garlon 4 oil) for basal-bark applications. Either formulation, applied to cut stump, is effective in controlling the plant. Foliar application of glyphosate (e.g. 3% Roundup) provides good, but short-term control. For basal-bark applications, be sure to locate where the vine is rooted. Clematis vines will sometimes grow up one tree, trail back down to the ground, and climb up another tree. Applying herbicide to a trailing vine will only kill the distal part; another treatment will later be required.”

G. ACTIONS PLANNED

The one recorded patch of sweet autumn virginsbower will be treated first via foliar application of an appropriate herbicide at some point during the growing season. As there are a number of other invasive plants in the area, herbicide application will be timed to coincide with treatment of nearby nonnatives, e.g., bamboo, English ivy, and common periwinkle. Traces of *C. terniflora* along Hunting creek will likewise be located and treated when other more extensive infestations are treated in the area. Isolated traces elsewhere in the park will be located and removed as resources permit. All treated sites will be monitored annually until no re-growth is observed for 2 consecutive years.

Scientific name: *Prunus avium*
Updated: August 2008

Common name: Sweet Cherry

A. PRIORITY: 3

B. DESCRIPTION

Sweet cherry is a medium-to-large tree (to 30m tall) with excurrent form. Bark is medium gray with prominent horizontal lenticels, exfoliating with age. Leaves are alternate and simple with a pair of red glands on the petiole. Produces a red drupe fruit that is eaten by a variety of animals, including humans. This species is native to Europe, northwest Africa and western Asia. Planted in the United States as an ornamental and for fruit production.

C. DAMAGE AND THREATS

From **Invasive Plants: Guide to Identification and the Impacts and Control of Common North American Species** (Kaufman and Kaufman, 2007):

“Most of the nonnative cherries are not significant threats to native vegetation and do not make large changes in natural areas. Local exceptions may occur where stands of cherry become dense. The Emerald Chapter of the Native Plant Society of Oregon lists (sweet) cherry as a high impact invasive that is ‘an enormous, widespread problem.’ Most of the cherries, native and foreign, provide food for birds, chipmunks, and other animals.”

Sweet cherry is not very problematic in GUCO, but its ability to persist and spread within relatively intact forest is of some concern. These areas contain native species of high conservation concern for the park. Space and resources taken up by sweet cherry may mean less available for native species.

D. CURRENT DISTRIBUTION ON THE SITE

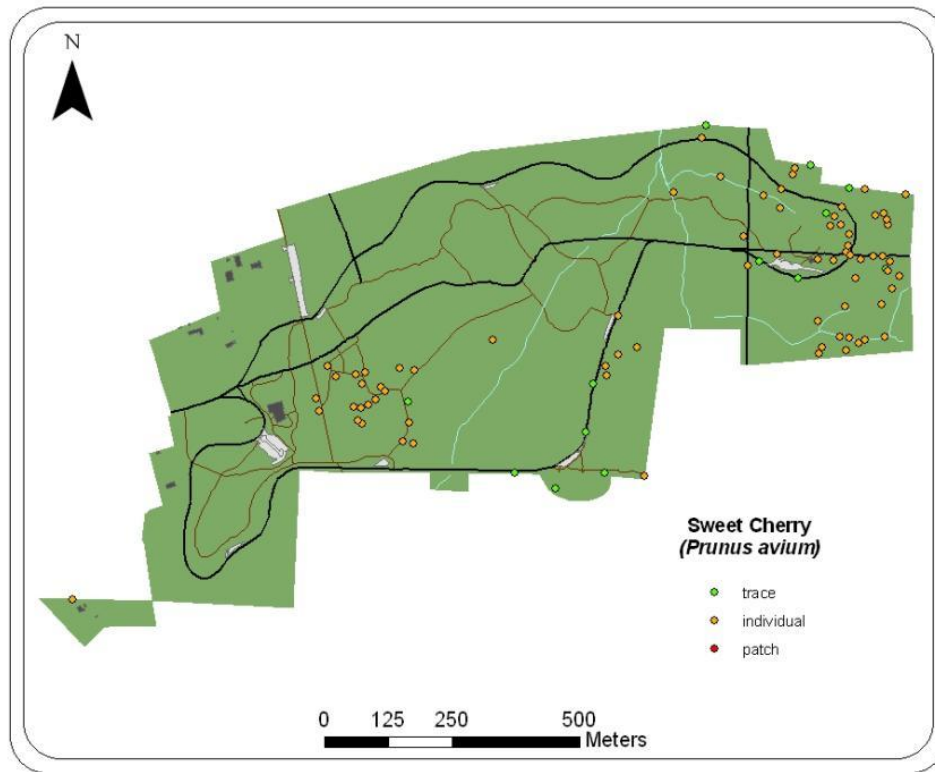


Figure 35. Distribution of sweet cherry. This species occurs as small and medium sized trees and a few seedlings in several sections of the park. The largest trees are found in the oak – hickory forest around the Greene Monument. The Drive-in Tract and the northeast corner of the park also contain relatively large specimens. This species is found in mixed successional forests as well as higher quality forest communities within GUCO.

E. OBJECTIVE (Measurable)

- 1) Locate and treat trees in high quality forest communities.
- 2) Locate and treat trees in eastern half of park.
- 3) Monitor treated sites.

F. MANAGEMENT OPTIONS

1) Mechanical control

Seedlings and small trees can be hand pulled or dug up. Large trees can be girdled near the base.

2) Chemical Control.

Seedlings and small trees can be treated by foliar application of glyphosate as a 2-percent solution in water with a surfactant. Larger trees can be treated by stem injection of concentrated systemic herbicide. Freshly-cut stumps can be treated similarly.

G. ACTIONS PLANNED

Large trees in the forest near the Greene Monument will be treated first by girdling or stem injection of concentrated herbicides in summer. Most of these trees will be left in place to produce snags for wildlife. Trees near trails will be removed completely. The eastern half of the park will be treated similarly when resources permit. Seedlings will be manually removed whenever they are encountered during other management activities. All treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Rubus phoenicolasius*
Updated: August 2008

Common name: Wine Raspberry

A. PRIORITY: 3

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Wineberry** (Spencer, 2005):

“Wineberry, or wine raspberry, is a typical species in the genus *Rubus*, which contains blackberry and raspberry. The name *Rubus phoenicolasius* translates as "blackberry with purple hairs." The mature plant has long stems (canes) that are upright and arching and covered with distinctive glandular red hairs and small spines. The hairs give the canes a reddish color when seen from a distance. Under favorable conditions, canes may grow to a length of 9 feet. Leaves consist of three heart-shaped, serrated leaflets with purplish veins and are silvery white tomentose on the underside. Small greenish flowers with white petals and reddish hairs occur in Spring. The very edible raspberry like fruit is bright red and ripens during June and July.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Wineberry** (Spencer, 2005):

“Wineberry is a vigorous grower and can form dense thickets covering large areas, displacing many native plants in the process. Wineberry poses a threat to the native plants that grow in forest, field, stream and wetland edge habitats, open woods, and savannas and prairies.”

D. CURRENT DISTRIBUTION ON THE SITE

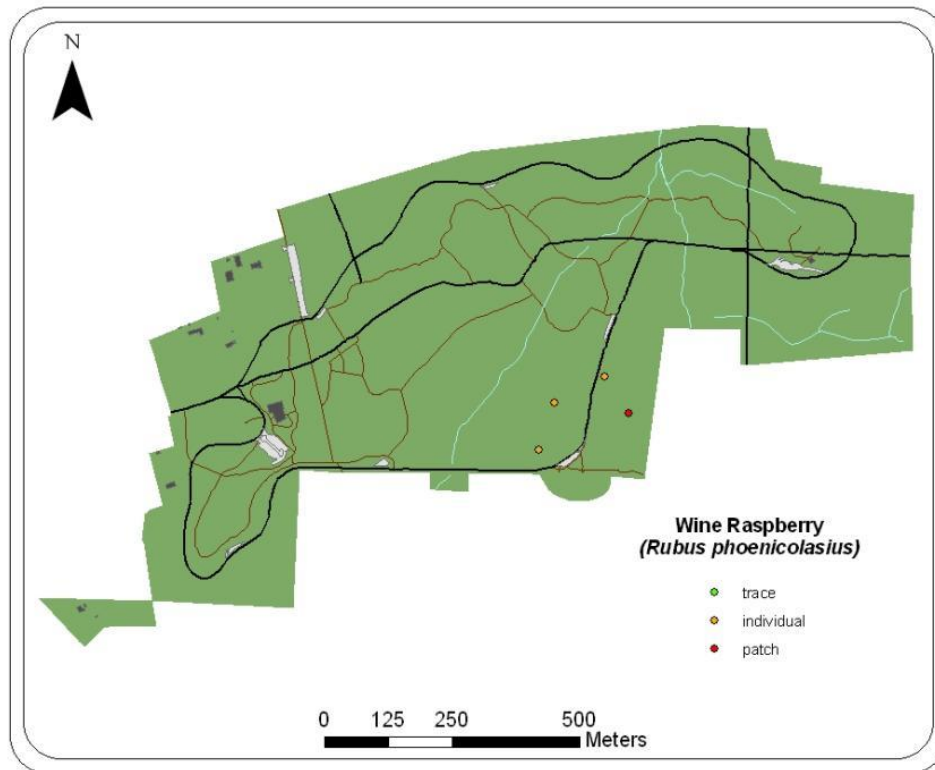


Figure 36. Distribution of wine raspberry. This species has a restricted distribution in GUCO, occurring sparsely in the successional forest on the old petting zoo site and adjacent to the Lake Wilfong site. Three small individuals and one small patch (25 m² at 90% cover) were recorded at separate locations within these sites. Only the patch was observed fruiting.

E. OBJECTIVE (Measurable)

- 1) Locate and treat patch.
- 2) Locate and treat wine raspberry elsewhere in park.
- 3) Monitor treated sites.

F. MANAGEMENT OPTIONS

1) Mechanical control

Individual plants can be hand pulled or dug out. Care should be taken to remove all roots and fragments and dispose properly so as not to inadvertently spread propagules.

2) Chemical Control.

Foliar application of glyphosate or triclopyr formulations has been effective. Cut and spray application of concentrated systemic herbicides can be effective, especially in the fall (Wisconsin DNR, 2004). Resprouts can be treated by foliar application of glyphosate or triclopyr.

G. ACTIONS PLANNED

The patch of wine raspberry will be treated by cut-spray application of appropriate herbicides in the fall or foliar application in the late spring or summer. Small individuals will be located and removed manually or spot sprayed with appropriate herbicides, as resources permit. Treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

Scientific name: *Euonymus fortunei*
Updated: August 2008

Common name: Winter Creeper

A. PRIORITY: 4

B. DESCRIPTION

From **Plant Conservation Alliance Fact Sheet: Climbing Euonymus** (Remaley, 2005 D):

“Climbing euonymus ... is an evergreen, clinging vine. It can form a dense groundcover or shrub to 3 feet in height, or climb 40-70 foot high vertical surfaces with the aid of aerial roots. Dark green, shiny, egg-shaped leaves, from 1-2 ½ inches long, with toothed margins and silvery veins, occur in pairs along the stems. Stems are narrow, minutely warty, and have abundant rootlets or trailing roots. Clusters of ... green-white flowers are produced ... from June to July and are followed in the autumn by pinkish to red capsules that split open to expose seeds adorned with a fleshy orange seed coat, or aril.”

C. DAMAGE AND THREATS

From **Plant Conservation Alliance Fact Sheet: Climbing Euonymus** (Remaley, 2005 D):

“Climbing euonymus can outcompete native vegetation by depleting soil moisture and nutrients, blocking sunlight, and by forming a dense vegetative mat that impedes the growth of seedlings of native species. Vines on trees continue climbing and can eventually overtop them, covering the leaves and preventing photosynthesis.”

D. CURRENT DISTRIBUTION ON THE SITE

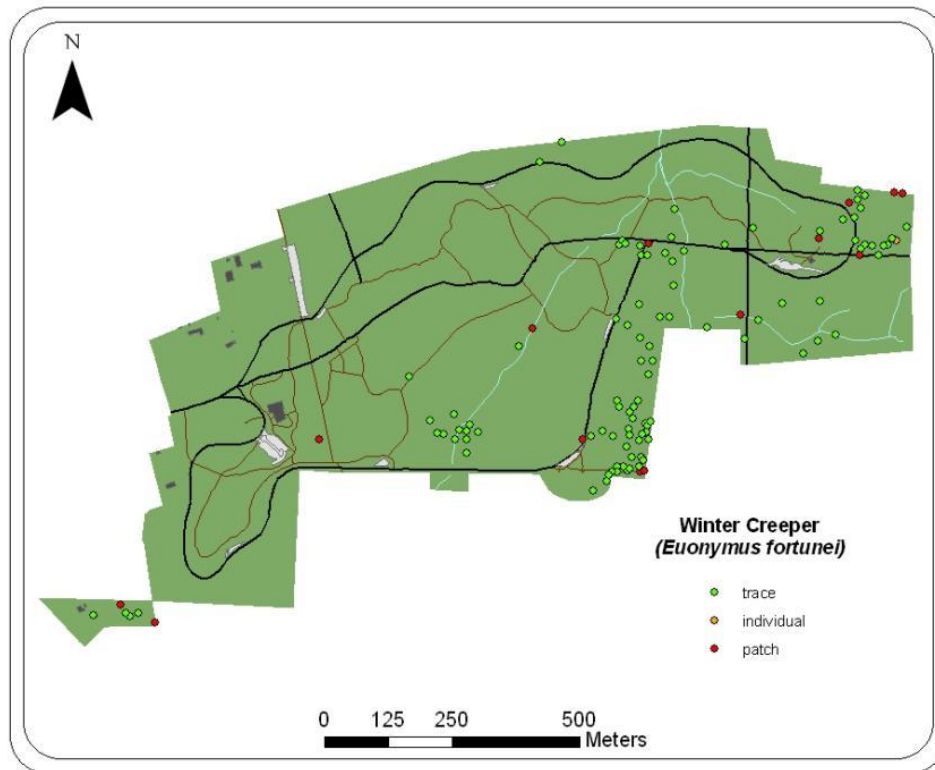


Figure 37. Distribution of winter creeper. This species occurs as traces and several small to medium sized patches (largest is ~100 m²) in GUCO, especially throughout the eastern half of the park. The species occurs in disturbed sites and within successional forests and along their edges. It is fairly common in the successional forests of the old petting zoo site and the northeast corner of the park.

E. OBJECTIVE (Measurable)

- 1) Locate and treat largest patches.
- 2) Monitor treated sites.
- 3) Monitor high priority forest communities for presence of winter creeper.

F. MANAGEMENT OPTIONS

From **Plant Conservation Alliance Fact Sheet: Climbing Euonymus** (Remaley, 2005 D):

1) Mechanical control

“Grubbing ... is effective for small 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 when the soil is moist and root systems are small. Any portions of the root system remaining may resprout. All plant parts including stem fragments and mature fruits should be bagged and disposed of in a trash dumpster to prevent reestablishment.”

2) Chemical Control.

“Cut stem treatment, using systemic herbicides applied to freshly cut stems, is effective in areas where vines are well established on or around non-target plants, or where they have grown into tree canopies or other vertical surfaces. Cut the stem as close to the ground as possible and immediately apply a 25% solution of glyphosate (e.g., Roundup®) or triclopyr (e.g., Garlon) and water to the cut stem. This procedure is effective at temperatures as low as 40° F. Subsequent foliar application of these herbicides may be required. Cutting without the application of herbicides is generally not recommended because this will lead to root sprouting.

Foliar applications of herbicide can be used to control large populations. It may be necessary to precede foliar sprays with cut stem treatments to reduce the risk of damage to non-target plants. Apply a 2% solution of glyphosate or triclopyr and water plus a 0.5% non-ionic surfactant to thoroughly wet all foliage but not so heavily that it drips off leaves where it may affect desirable plants. Glyphosate is a non-selective systemic (i.e., travels through the plant vessels) herbicide that may kill even partially sprayed plants. Triclopyr is selective to broad leaf species and is a better choice if desirable native grasses are present. Ambient air temperature should be above 65° F.”

G. ACTIONS PLANNED

Patches of winter creeper that are adjacent to high quality forest communities will be treated by foliar application of appropriate herbicides in the summer or fall. Other patches will be treated similarly, resource permitting. The many traces of winter creeper elsewhere in the park will not be treated but will be monitored annually to assess the spread of this species. Control actions will be taken if infestations are increasing in size and density or spreading to higher quality areas. High quality sites will be monitored for this and other species. All treated sites will be monitored annually beginning the following growing season and continuing until no re-growth is observed for 2 consecutive years.

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APPENDIX 1. Questions used to rank potentially invasive plants using the Alien Plant Ranking System Version 5.1 (APRS Implementation Team, 2000).

I. Significance of Threat or Impact (Site Characteristics)

1. Distribution relative to disturbance regime
 - a. Found only within sites disturbed within the last 3 years or sites regularly disturbed
 - b. Found in sites disturbed within the last **10** years.
 - c. Found in midsuccessional sites disturbed **11** to **50** years before present
 - d. Found in late-successional sites disturbed **51** to **100** years BP.
 - e. Found in high quality natural areas with no known major disturbance for **100** years
 - f. Unknown
2. Areal extent of populations
 - a. Not in site, but in adjacent areas
 - b. Found in less than **5%** of site
 - c. Found in between **5%** and **10%** of site
 - d. Found in between **10%** and **25%** of site
 - e. Found in more than **25%** of site
 - f. Unknown
3. Numerical dominance of species within a community
 - a. Not found on site
 - b. Usually observed as a single individual (or fewer than **5** per **5** m²)
 - c. Usually observed in numbers less than the **2** or **3** most common native species in the community (but more than **5** per **5** m²)
 - d. Usually observed in numbers approximately equivalent to the most common native species in the community
 - e. Usually observed in numbers greater than the most common native species in the community
 - f. Unknown
4. Association with native community
 - a. Associated with weedy (early successional) species
 - b. Associated with midsuccessional species
 - c. Associated with dominant (late-successional) species
 - d. Displaces native plant community
 - e. Unknown
5. Hybridization with native species
 - a. Not known to hybridize with native species
 - b. Known to hybridize with native species
 - c. Unknown
6. Degree of threat and impact
 - a. Little or no increase in numbers of individuals and populations and no invasion of native communities
 - b. Present in native communities, but static or decreasing
 - c. Moderate rate of increase in numbers of individuals and populations; little or no invasion of native communities
 - d. Moderate rate of increase in numbers of individuals and populations; invading native plant communities
 - e. High rate of increase of numbers of individuals and populations; invading and replacing or

highly modifying native plant communities
f. Unknown

7. Effects on management goals
- a. No effect
 - b. Little impact on site management goals
 - c. Moderate impact on site management goals
 - d. Large impact on site management goals
 - e. Unknown

II. Innate ability to become a pest

8. Mode of reproduction
- a. Rarely, if ever, reproduces in area
 - b. Reproduces almost entirely by vegetative means
 - c. Reproduces only by seed
 - d. Reproduces vegetatively and by seeds
 - e. Unknown
9. Vegetative reproduction
- a. No vegetative reproduction
 - b. Vegetative reproduction rate maintains population
 - c. Vegetative reproduction rate results in moderate increase in population size
 - d. Vegetative reproduction rate results in rapid increase in population size
 - e. Unknown
10. Frequency of sexual reproduction for mature plant
- a. Almost never reproduces sexually in area
 - b. Once every 5 or more years
 - c. Every other year
 - d. One or more times a year
 - e. Bursts of sexual reproduction in response to environmental stimulus
 - f. Unknown
11. Number of seeds per plant
- a. Rarely, if ever, produces seed in area
 - b. Few (0-10)
 - c. Moderate (11-1000)
 - d. Many (>1000)
 - e. Unknown
12. Dispersal ability
- a. Little potential for long-distance dispersal
 - b. Great potential for long-distance dispersal
 - c. Unknown
13. Germination requirements
- a. Requires open soil and disturbance to germinate
 - b. Can germinate in vegetated areas but in a narrow range or in special conditions
 - c. Can germinate in existing vegetation in a wide range of conditions
 - d. Unknown

14. Seed banks
 - a. Seeds remain viable in the soil for less than 1 year
 - b. Seeds remain viable in the soil for 1 to 5 years
 - c. Seeds remain viable in the soil for more than 5 years
 - d. Unknown
15. Competitive ability
 - a. Poor competitor
 - b. Moderately successful competitor
 - c. Highly successful competitor
 - d. Unknown
16. Ecological effects (select all that apply)
 - a. Produces persistent litter or shade that affects germination or growth of native species
 - b. Produces allelochemicals
 - c. Affects availability of soil nutrients
 - d. Affects water availability to native plants
 - e. Changes natural fire regime
 - f. None of the above
 - g. Unknown
17. Known level of impact in natural areas
 - a. Not known to cause impacts in any other natural area
 - b. Known to cause impacts in natural areas, but with different habitats and climate zones
 - c. Known to cause low impact in natural areas with similar habitats and climate zones
 - d. Known to cause moderate impact in natural areas with similar habitats and climate zones
 - e. Known to cause high impact in natural areas with similar habitats and climate zones and/or on the list of most invasive alien plants for the region
 - f. Unknown

III. Difficulty of control

18. Likelihood of successful control
 - a. This species has been eradicated in a natural area
 - b. Control (populations declining) of this species has been achieved in a natural area
 - c. Limited control (species is no longer spreading, but persists near pre-control levels) of this species has been achieved in a natural area
 - d. Control of this species has never been achieved in a natural area
 - e. Unknown
19. Saturation in surrounding region
 - a. Not present in areas surrounding the site
 - b. Present in few areas surrounding the site
 - c. Present in several areas but not entirely surrounding the site
 - d. Present in most areas surrounding the site
 - e. Unknown
20. Effectiveness of community management
 - a. Protection from disturbance effectively controls target species
 - b. Cultural techniques (burning, flooding) can be used to control target species
 - c. Restoration or preservation practices effectively control target species
 - d. The above options are not effective

e. Unknown

21. Vegetative regeneration

- a. No resprouting following removal of above ground growth
- b. Sprouts from roots or stumps
- c. Any plant part is a viable propagule
- d. Unknown

22. Biological control

- a. Biological control feasible
- b. Potential may exist for biological control
- c. Biological control not feasible (not practical, possible, or probable)
- d. Unknown

23. Side effects of control measures

- a. Control measures have little potential to affect native communities
- b. Control measures are likely to cause moderate impacts on communities
- c. Control measures are likely to cause major impacts on communities
- d. Side effects of control unknown
- e. Unknown

APPENDIX 2. Photos taken during plant census at GUCO (2007-2008; Matt O'Driscoll).



Pitch pine (*Pinus rigida*)



Wild yam (*Dioscorea villosa*)



New Jersey tea (*Ceanothus americanus*)



Moccasin flower (*Cypripedium acule*)



Winterberry (*Ilex verticillata*)



Striped Gentian (*Gentiana villosa*)



Carolina rose (*Rose carolina*)



Sweet shrub (*Calycanthus floridus*)



Milk vine (*Matelea carolinensis*)



Pawpaw (*Asimina triloba*)



Snakeroot (*Aristolochia serpentaria*)



Horsebalm (*Collinsonia canadensis*)



Monkey flower (*Mimulus ringens*)



Bur-reed (*Sparganium americanum*)



Trumpet honeysuckle (*Lonicera sempervirens*)



Foamflower (*Tiarella cordifolia*)



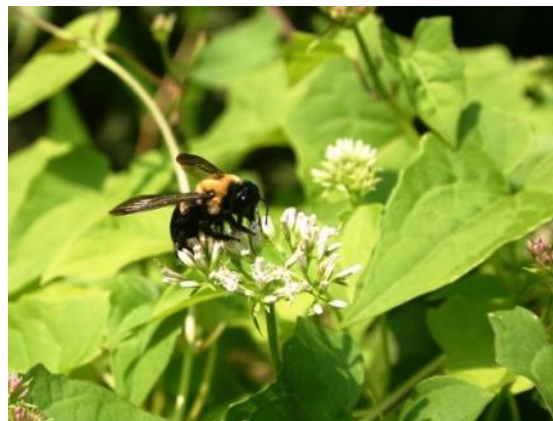
Cardinalflower (*Lobelia cardinalis*)



Passionflower (*Passiflora incarnata*)



Great laurel (*Rhododendron maximum*)



Climbing hempvine (*Mikania scandens*)



Rattlesnake plantain (*Goodyera pubescens*)



Crippled crane fly (*Tipularia discolor*)



Water oak (*Quercus nigra*)



Indian pipe (*Monotropa uniflora*)



Chocolate vine (*Akebia quinata*)



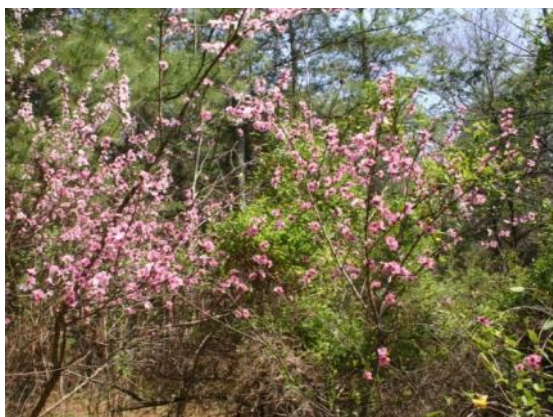
Callery pear (*Pyrus calleryana*)



Burning bush (*Euonymus alatus*)



Common periwinkle (*Vinca minor*)



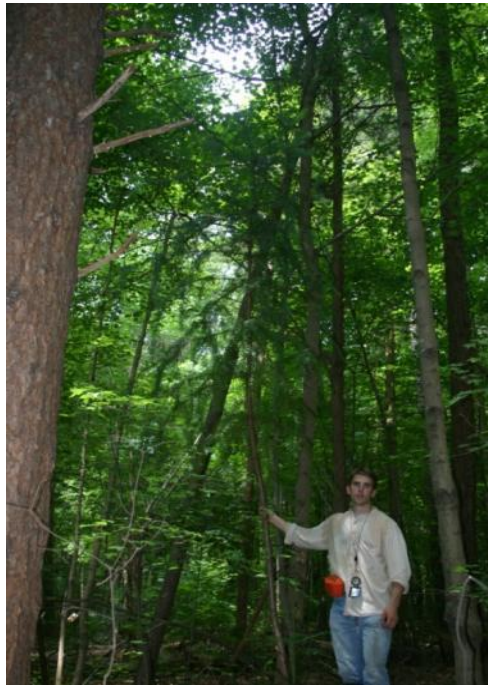
Flowering cherry (*Prunus* sp.)



Chinese yam (*Dioscorea oppositifolia*)



Annual honesty (*Lunaria annua*)



Chinese fir (*Cunninghamia lanceolata*)



Holly osmanthus (*Osmanthus heterophyllus*)



Wine raspberry (*Rubus phoenicolasius*)



Gray poplar (*Populus x canescens*)



Virginsbower (*Clematis terniflora*)



Hardy orange (*Poncirus trifoliata*)



Leatherleaf viburnum (*Viburnum rhytidophyllum*)



Western red cedar (*Thuja plicata*)



Bridalwreath spiraea (*Spiraea prunifolia*)



Winter creeper (*Euonymus fortunei*)



Sawtooth oak (*Quercus acutissima*)



Rose-of-Sharon (*Hibiscus syriacus*)



Nonnative bush honeysuckle (*Lonicera* sp.)



Upland oak-hickory forest south of Visitor Center in winter, thorny olive (*Elaeagnus pungens*) in forefront.



Obelisk at Tour Stop 5



Shortleaf/VA pine successional forest



Japanese holly (*Ilex crenata*)



Peach (*Prunus persica*)



Jasmine (*Jasminum nudiflorum*)



Japanese barberry (*Berberis thunbergii*)



Old Lake Wilfong area



Richland Creek near Schenck's Field



Copperhead (*Agkistrodon contortrix*)



Black rat snake (*Elaphe obsoleta*)



Worm snake (*Carphophis amoenus*)



Green snake (*Opheodrys aestivus*)



Box turtle (*Terrapene carolina*)



Unknown fungus



Park boundary, facing Country Park



Old Lake Caldwell area, stiltgrass mat



Paper mulberry thicket at Tour Stop 6



Tour Stop 6, facing Centennial Oak



Northern property line, English ivy



English ivy (*Hedera helix*)



Specimen collection, Beverly Henson and Paul Fantz



Periwinkle infestation



Plastic flowers from Forest Lawn Cemetery



Beverly Henson holding a black rat snake



White ash (*Fraxinus americana*)



Morel mushroom (*Morchella* sp.)



Downed pine trees



Sugar maple (*Acer barbatum*)