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Invasive Plant Management Plan

Appomattox River Trail System

Counties of Dinwiddie, Chesterfield, and Prince George, and Cities of Petersburg, Colonial Heights, and Hopewell

SUBMITTED TO

Attn:

Heather Barrar
Regional Trails Program Director
1964 Wakefield Street
Petersburg, VA 23805

SUBMITTED BY

Senior Project Scientist:

Douglas A. DeBerry, PhD, PWS, PWD
351 McLaws Circle, Suite 3
Williamsburg, VA 23185

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Note: The text of this report has been prepared for Friends of the Lower Appomattox River (FOLAR) to incorporate into a web-based version of the Invasive Plant Management Plan for the Appomattox River Trail.

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Introduction

The Appomattox River Blueway-Greenway corridor faces threats from numerous species of damaging, invasive plants. Recognizing these threats, Friends of the Lower Appomattox River (FOLAR) have teamed with a group of specialists to develop the Appomattox River Trail Invasive Plant Management Plan ("the Plan"), which is outlined here. The purpose of this Plan is to protect and restore the natural and cultural resources within the Appomattox River Trail & Park system ("ART") by containing, controlling, or substantially minimizing populations of non-native invasive plant species through targeted treatment.

This is no small undertaking: the geographic sweep of the ART parallels nearly 20 river miles from the mouth of the Appomattox River to the dam at Lake Chesdin, a corridor that spans two of Virginia's physiographic provinces and six municipalities, including the Tri-cities of Colonial Heights, Hopewell, and Petersburg, and the three counties of Chesterfield, Dinwiddie, and Prince George. Once fully constructed, the ART will include 26.5 miles of bicycle-pedestrian paths intersecting 16 riverside parks, 11 historical sites, 8 boat access points, and 3 marinas.

While this alignment harbors one of the most historic and scenic river corridors in the Commonwealth, the legacy of human land use – particularly near population centers – has exposed much of the ART to modes of introduction for non-native and potentially problematic plants. In addition, notwithstanding the amazing recreational opportunities afforded, having a major river as the focal point for a park system means that the river itself can serve as a vector of dispersal for invasive species. With these factors in mind, FOLAR has taken the important step of initiating the Plan to heighten awareness, increase vigilance, restore ecological integrity, and enhance visitor experience along the ART corridor.

The Impact of Invasive Plants: The "4 Es"

- **Ecosystems:** Invasive plant species reduce native species richness and diversity, modify habitats and landscapes, cause local extirpation of rare species, and impact wildlife habitat (Lockwood et al. 2013).
- **Economies:** Over the past 50 years, invasive plants have accounted for an estimated $190 billion in associated costs in the U.S. alone (Fantle-Lepczyk et al. 2022).
- **Education:** Invasive plant species cause a loss of natural habitats important for research and education (Ardoin et al. 2020).
- **Experience:** Plant invaders smother native habitats and cause unsightly damage to the aesthetics of parks and natural areas, thereby impacting visitor experience. Dense populations of invaders can make areas nearly impenetrable to pedestrians, bikers, and rivergoers in small watercraft, exposing visitors to potentially unsafe conditions (Talal and Santelmann 2020).

The Plan is a living document: it has been created with the capacity to be updated and modified as needed following the principles of Integrated Vegetation Management (IVM) as defined below. The Plan is available to the public through the information presented here, and interested parties can track progress on ecosystem restoration and invasive species management projects using the interactive story map features highlighted below.

This Plan has been prepared by FOLAR under a grant from the Virginia Department of Forestry Urban & Community Forestry (U&CF) Grant Program. Invasive species inventory and management strategies were prepared by scientists and GIS analysts at Vanasse Hangen Brustlin, Inc. (VHB). Environmental Resources Management (ERM) also participated in early coordination on the project.

Ecological Setting

On its geographic trajectory from west-to-east, the ART straddles the divide between two major Virginia physiographic provinces, the Piedmont and the Coastal Plain. The Piedmont is characterized by gently rolling to somewhat hilly terrain, and the ART is positioned along its eastern edge where the topography reflects the transition down to the Coastal Plain at the "Fall Line," an abrupt drop in elevation that represents the inland extent of the highest Atlantic sea level stand ca. 120,000 years ago (Johnson and Ward 1990). The namesake for this transition zone refers to the prevalent waterfalls and rapids like those found in the Appomattox River along the western half of the ART corridor (Owens et al. 2017). In general, Piedmont vegetation falls under the Eastern Deciduous Forest Floristic Province (Gleason and Cronquist 1964), which is a characterized by a forest type that matures to an oak-hickory assemblage on relatively undisturbed upland sites, with wetlands occupied by water-loving oaks and other species that frequent bottomlands (e.g., ash, maple, sycamore, etc.) (Spira 2011).

The eastern half of the ART sits in the Coastal Plain, which is characterized by nearly level to gently sloping terrain extending from the Fall Line east to the Atlantic shore. Although the Coastal Plain is generally regarded as a flat, terraced landscape, the ART resides on the upper (or inner) portion of the province, which is also referred to as "dissected" due to the prevalent stream erosion that has cut moderately sloping valleys into the local terrain. This type of topography can be seen throughout the eastern ART corridor in the steep stream valleys that abut the river's edge. Vegetation in the inner Coastal Plain falls under the Coastal Plain Floristic Province (Gleason and Cronquist 1964), which is

Ecological Setting for Restoration Design

Throughout the ART corridor there are natural areas that are representative of the native vegetation community types that would be expected in undisturbed conditions. These "reference" habitats are most likely to be found within the management units that have been least impacted by invasive plants. In strategizing habitat restoration practices, FOLAR will use reference sites within the ART corridor to develop the native planting plans that will accompany invasive removal projects.

occupied by more pine-prevalent forest stands, with wetland sites maturing to cypress-gum communities in low-lying areas such as stream bottomlands, broad river floodplains, or deepwater swamps (Ware et al. 1993). In addition to inland freshwater wetlands, the eastern half of the ART occupies a unique position along the estuarine reaches of the Appomattox River that is subject to tidal influence but effectively freshwater (i.e., less than 0.5 parts per thousand salinity). As a result, the fringe of the river along this reach supports a high diversity freshwater tidal marsh species.

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Inventory Methods

FOLAR worked with scientists at VHB to designate park units for the invasive plant species inventory that would represent baseline conditions moving forward. These units are referred to in the Plan as "management compartments," and they were drawn based on the following criteria: 1) level of infestation (i.e., degree, density, and types of invasion), 2) landscape position and habitat type, and 3) accessibility for management applications. Each management compartment was given a unique identification code based on the following formula:

Locality Code – Park Name – Compartment Number

Thus, for example, the first management compartment within City Park in Hopewell would be designated as "H-City Park-1." Locality codes are summarized in Table 1 below.

Table 1. Locality Codes for Compartment Labeling

Code	Locality
CF	Chesterfield County
D	Dinwiddie County
P	City of Petersburg
CH	City of Colonial Heights
PG	Prince George County
H	City of Hopewell

Field Methods

Between August 29 and September 22, 2023, VHB's scientists conducted a comprehensive review of each management compartment and documented the overall level of invasive plant species cover using a modified Braun-Blanquet cover scale, which is a way to rapidly assess the overall cover of plants using cover classes (Mueller-Dombois and Ellenberg 1974). The cover categories are given below, along with the color scheme used to designate cover class in the GIS data:

Table 2. Cover Class Categories for Overall Level of Invasive Cover by Compartment

Class	Percent Cover Range	Color Code
1	0-5% cover of invasive plants within the compartment	Green
2	5-25% cover of invasive plants within the compartment	Yellow
3	25-50% cover of invasive plants within the compartment	Blue
4	50-75% cover of invasive plants within the compartment	Orange
5	75-100% cover of invasive plants within the compartment	Red

By attaching a color to each cover class, users of the GIS inventory data have a quick reference to the level of invasive species infestation within each compartment.

During the inventory, VHB's scientists also compiled a list of all invasive plant species found within each compartment and documented the relative dominance of each invader. Invasive plants were identified to species level and verified by a senior scientist at VHB. Verification followed the dichotomous keys in the *Flora of Virginia* (Weakley et al. 2020). There were four relative dominance categories used (Table 3):

"Invasive Species" Defined

The technical definition for an invasive species is one that enters an area that it did not previously occupy, rapidly expands in space once there, and has negative consequences for the species already present (Alpert et al. 2000). For the purposes of this Plan, an invasive plant species was defined as any plant included on the **Virginia Invasive Plant Species List** (Heffernan et al. 2014), with the addition of a few other aggressive plant species tracked by FOLAR in the ART corridor.

Table 3. Relative Dominance Categories for Invaders within Compartments

Dominance Class	Relative Cover
Occasional	0-1% cover within the compartment
Scattered	1-5% cover within the compartment
Common	5-20% cover within the compartment
Dominant	>20% cover within the compartment

Recording the data in this way will allow future users of the Plan to select management compartments of interest and not only generate a list of invaders, but also determine which invasive plants are most problematic.

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Inventory Results

Forty (40) total management compartments were delineated within 21 park units in the six counties and cities through which the ART corridor passes. The compartments are listed below in alphabetical order by locality code:

Table 4. Summary List of Management Compartments within the ART

Management Compartment ID Codes	
CF-Radcliffe Conservation Area-1	H-City Park-1
CF-Radcliffe Conservation Area-2	H-City Park-2
CF-Radcliffe Conservation Area-3	H-City Park-3
CH-Appamattuck Park-1	H-Marina Overlook-2
CH-Appamattuck Park-2	H-Marina Overlook-3
CH-Appamattuck Park-3	H-Riverside Greenway-1
CH-Cedarwood Recreation Area-1	PG-Appomattox River Regional Park-1
CH-CHARTS-1	PG-Appomattox River Regional Park-2
CH-Fort Clifton Park-1	PG-Appomattox River Regional Park-3
CH-Fort Clifton Park-2	P-Merchants Island-1
CH-Roslyn Landing Park-2	P-Merchants Island-2
CH-Roslyn Landing Park-3	P-No Name Park-1
CH-White Bank Park-1	P-Patton Park-1
CH-White Bank Park-2	P-Peter Jones Trading-2
D-Appomattox Riverside Park East-1	P-Peter Jones Trading-3
D-Appomattox Riverside Park East-2	P-Riverfront Park-1
D-Appomattox Riverside Park West-1	P-Riverfront Park-2
D-Ferndale Park-1	P-Riverfront Park-3
D-Ferndale Park-2	P-Rotary Park-1
D-Ferndale Park-3	P-VSU-1

There were 37 invasive plant species documented within the ART corridor (Table 5). A detailed inventory of the relative dominance of each invader within each management compartment is provided in Appendix B. Based on a review of the data, the most dominant invasive plants are English ivy (*Hedera helix*), Chinese privet (*Ligustrum sinense*), Japanese stiltgrass (*Microstegium vimineum*), kudzu (*Pueraria montana* var. *lobata*), Johnsongrass (*Sorghum halepense*), and Chinese wisteria (*Wisteria sinensis*), with ground-ivy (*Glechoma hederacea*) also dominant in localized areas. Other common invaders include Norway maple (*Acer platanoides*), tree-of-heaven (*Ailanthus altissima*), joint-head grass (*Arthraxon hispidus*), Oriental bittersweet (*Celastrus orbiculatus*), sericea lespedeza (*Lespedeza cuneata*), Japanese honeysuckle (*Lonicera japonica*), white mulberry (*Morus alba*), marsh dewflower (*Murdannia*

keisak), princess tree (*Paulownia tomentosa*), Callery pear (*Pyrus calleryana*), Japanese knotweed (*Reynoutria japonica*), multiflora rose (*Rosa multiflora*), and greater periwinkle (*Vinca major*).

Table 5. List of Invasive Plants Found within the ART

Scientific name	Common name
Acer platanoides	Norway maple
Ailanthus altissima	Tree-of-heaven
Albizia julibrissin	Mimosa
Ampelopsis glandulosa	Porcelain-berry
Arthraxon hispidus	Joint-head grass
Celastrus orbiculatus	Oriental bittersweet
Commelina communis	Asiatic dayflower
Dioscorea polystachya	Chinese yam
Elaeagnus pungens	Thorny olive
Elaeagnus umbellata	Autumn olive
Euonymus alatus	Winged euonymus
Euonymus fortunei	Winter creeper
Glechoma hederacea	Ground-ivy
Hedera helix	English ivy
Humulus japonicus	Japanese hops
Hydrilla verticillata	Hydrilla
Lespedeza cuneata	Chinese clover
Ligustrum sinense	Chinese privet
Lonicera japonica	Japanese honeysuckle
Lonicera maackii	Amur honeysuckle
Melia azedarach	Chinaberry
Microstegium vimineum	Japanese stiltgrass
Morus alba	White mulberry
Murdannia keisak	Marsh dewflower
Nandina domestica	Sacred-bamboo
Paulownia tomentosa	Princess tree
Perilla frutescens	Beefsteak plant
Persicaria longiseta	Japanese knotweed
Phragmites australis	Common reed
Pueraria montana* var. *lobata	Kudzu
Phylostachys aurea	Asiatic bamboo
Pyrus calleryana	Callery pear
Reynoutria japonica	Japanese knotweed
Rosa multiflora	Multiflora rose
Sorghum halepense	Johnson grass
Vinca minor	Greater periwinkle
Wisteria sinensis	Chinese wisteria

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Invasive Plant Management in the ART

Integrated Vegetation Management

The management approach in this Plan is based on the principles Integrated Vegetation Management ("IVM"). IVM is not a specific technique – it is rather a management framework using prescriptive treatments to control pest species, followed by re-vegetation efforts using targeted plantings. One benefit of an IVM approach is that it minimizes its own use over time, which reduces operation and management costs over the life span of an ecological restoration project (Nowak and Ballard 2005). The approach works to control invasive species in combination with techniques that help to establish a diversity of native species, thereby reducing potential for non-native, aggressive plants to colonize after management activities (Kennedy et al. 2002). IVM uses the concept of adaptive management to modify the prescriptive approaches as a re-vegetation project develops, with the assumption that the need for active intervention should wane over time. Adaptive management is a process of managed learning that steers strategic action to achieve desired endpoints in complex ecosystems (Foxcroft 2004). The benefit of this approach is that it recognizes that every project is different, and therefore avoids the pitfalls of setting unrealistic targets and thresholds for project milestones by using direct feedback from project performance to guide management decisions.

Control Methods

Invasive plant control methods can be group into five general categories: 1) Chemical, 2) Biological, 3) Cultural, 4) Mechanical, and 5) Manual (Clout and Williams 2009, Mannin and Miller 2011). Table 6 describes the basic technical points of each method.

Within the ART, the selection of a specific method will depend on the level of infestation and the species being treated. To that end, we have created a matrix of recommended management prescriptions by species, which includes treatments that are prioritized based on the best scientific and technical literature available. This matrix is included in Appendix C.

For most projects involving removal of excessive infestations (e.g., a "red" or "Category 5" compartment with over 75% cover of invasive plants), the work will be performed by a qualified professional with appropriate licenses and certifications to conduct management activities in accordance with applicable federal, state, and local laws. When outside contractors are involved, FOLAR will draw from their expertise to develop the most appropriate management strategy in concert with the prescriptions included in Appendix C.

Table 6. General Categories of Invasive Plant Control Methods

Method	Description
Chemical	Use of herbicides to kill invasive plants. Herbicides can be either non-selective, in which all plant species exposed to the chemical are treated, or selective, in which only a certain type of plant is targeted by the chemical compound(s). Non-selective herbicides will typically result in collateral damage of desirable native species, so application techniques should be carefully considered before use. Techniques include foliar spray, wick application, cut stump (or cut stem), direct stem injection, axe cut injection (aka "hack and squirt"), drill and fill, and basal spray. In Virginia, use of chemical methods should be performed by an expert with a state Certified Pesticide Applicator license. In addition, because the majority of the ART corridor is in close proximity to the Appomattox River and its tributaries, chemical methods should be restricted to herbicides that are approved by the Environmental Protection Agency for use near aquatic resources.
Biological	Use of natural enemies to control invasive plants. In the most common form of this approach, non-native insects known to control the growth of an invasive species in its home range are deliberately introduced into the environment in its invasive range. Because of the potential risks involved in non-native species introductions, biological control is not considered a viable alternative for ART at this time. As scientific research progresses on this topic, new approaches may warrant reconsideration in the future.
Cultural	Use of various land management techniques from agriculture, horticulture, and related fields to control invasive plants. Examples include mulching, solarization, thermal control, prescribed burning, water level manipulation, and livestock grazing. Cultural methods can be relatively inexpensive to implement at smaller scales; however, for larger projects, certain approaches (e.g., solarization) will be impractical. Where possible, FOLAR will prioritize cultural methods in lieu of chemical methods.
Mechanical	Use of mechanized equipment to physically remove or reduce the cover of invasive plant species. Techniques include mowing, cutting, disking, root raking, bushhogging, grubbing, and bulldozing. Mechanical methods are very effective at instantaneous removal of invasive plant biomass. However, most methods result in collateral damage of desirable plant species, and they often leave the belowground organs (roots, rhizomes, etc.) of the invaders intact. This allows for rapid re-growth of the invasive plants into a newly disturbed, open habitat, which can often result in a secondary infestation that is even worse than the original condition being treated. For this reason, mechanical techniques are often paired with targeted herbicide treatment (for example, cutting invasive trees and directly treating the stumps to prevent coppice sprouts from forming).
Manual	Removal of unwanted vegetation by hand. Techniques include hand-pulling, cutting with hand tools, hoeing, digging, weed wrenching, and girdling. Like mechanical approaches, manual techniques are immediately effective, but they are labor-intensive, and progress can be slow unless executed by a large workforce. However, they are generally safe for participants, and therefore good for public outreach events. Manual techniques work well to control the incipient stages of an infestation; for well-established invaders, use of manual approaches will require repeat treatments and long-term persistence to be most effective.

Disposal of Invasive Plants

For future invasive plant management projects within the ART, FOLAR will work with the implementation team and the locality to determine the most appropriate means for disposal of invasive plant biomass. The focus for disposal will be on safely isolating or destroying the biomass to the extent that re-colonization of the invader from reproductive or regenerative plant parts is prevented (e.g., re-establishment from seeds, rhizomes, etc.). Table 7 reviews some general approaches.

Table 7. Invasive Plant Disposal Methods

Method	Description
Stockpiling	Areas within the ART that are easily accessed by motorized vehicles (e.g., ATVs, pickup trucks, and dump trucks) should be prioritized for stockpiling invasive plant material. Stockpiling allows quick access for loading and removing large quantities of biomass, and also provides ancillary benefits such as public outreach (e.g., photos for press releases) and motivates project team members to track and quantify biomass (e.g., number of dump truck loads equated to units of volume).
Bag-and-remove	This approach is best used in remote areas of the park where stockpiling is impractical. Bag-and-remove operations should be carefully planned to ensure that team members follow safety protocols and do not risk overexertion or injury. FOLAR will work with implementation teams to ensure bag transport only occurs by hand over short distances, and that assist mechanisms are in place for challenging terrain (e.g., rope and pulley systems for hauling on steep slopes).
Controlled Burning	Burning is an effective method of destroying invasive plant biomass, but use of managed fire carries a potential risk to natural communities, human health, and property. On invasive management projects where controlled burning is allowed by local ordinance, FOLAR will work with the localities and the implementation team to ensure that disposal activities avoid the potential for wildfires, burning of potential contaminants (e.g., plastics), use of fire during poor air quality conditions (e.g., summer months with high ground level ozone conditions), and burning of plant parts with toxic inhalants (e.g., poison ivy).
Leave in Place	Leave in place disposal methods are most commonly used for woody plants that have been cut down via mechanical or manual techniques. However, as noted in the Control Methods section above, cut stems should be treated with a targeted herbicide application to prevent resprouting (usually injection or surface application on the stump). When leaving aboveground woody biomass in place, it is recommended that the material be stockpiled or arranged in brush piles to create habitat and refugia for small mammals, reptiles, amphibians, insects, and birds. However, if the aboveground biomass contains viable reproductive structures (seeds or fruits), stockpile and removal is recommended to prevent re-establishment from seed.

Re-vegetation Strategies

One of the most important tenets of IVM is that effective invasive plant management cannot occur without an aggressive re-vegetation strategy. Once invasive plants have been removed, native species that can successfully compete with the invader should be introduced into the environment to culminate the re-vegetation efforts. However, a successful re-vegetation program must also consider environmental conditions within the project area, notably soil nutrient status, substrate disturbance, light availability, and soil moisture (Hunter and DeBerry 2023).

"Re-vegetation" Defined

Re-vegetation refers to process of establishing a new or enhanced vegetation community on a landscape area from which vegetation has been removed or altered, or in an area where an undesirable plant community exists. To the extent that re-vegetation approaches approximate natural communities, they can be broadly classified as "ecological restoration." However, in invasive species management, the specific goals of removal and replacement warrant use of the more precise "re-vegetation" moniker.

Invasion Ecology and Re-vegetation

To put it another way, a re-vegetation initiative should consider all of the above factors in the context of general principles in invasion ecology, which suggest that:

1) Sites that are recently disturbed are most likely to be invaded (Zedler and Kercher 2004).

2) Sites that are minimally stressful to plants are more likely to be invaded (Alpert et al. 2000).

3) Conversely, sites exposed to a diverse population of native species are less likely to be invaded than those with lower native species diversity (Alpert et al. 2000, Yanelli et al. 2018).

Stress vs. Disturbance

To understand the above criteria, it is important to differentiate between "disturbance" and "stress" in plant ecology. From a plant-centric perspective, disturbance means any change that is outside the normal range of conditions for a species and results in the destruction or removal of biomass (Hobbs and Huenneke 1992). By contrast, stress is defined as any change in physiological processes due to one or more environmental or biological factors that results in a reduction in fitness or growth (Craine 2009). Included within the disturbance category are human-induced modifications of the landscape such as clearing, mowing, or herbicide treatment (Clewell and Aronson 2013). In contrast with disturbance, stress does not directly result in destruction or removal of biomass, but rather involves a condition in the environment that affects an organism systemically such as nutrient limitation, drought, or shading (Craine 2009).

Unfortunately, almost all of the management techniques used to control invasive plants satisfy the first criteria – they result in the types of disturbance that make sites easier to invade. However, on the second criteria, the degree to which a site is *stressful* depends on whether or not the soils, light, or moisture are limiting factors. If not, then the site is likely to be re-invaded. However, although it seems counterintuitive, if environmental conditions can be managed to keep some factors limiting to plant growth, in most cases a somewhat stressful condition will promote higher native species richness. This is because native plants are already acclimated to deal with limiting conditions – invaders are not.

Re-vegetation Feasibility Analysis

The best way to achieve appropriate site conditions is to understand the environmental factors on the ground *before* the re-vegetation project is initiated. This is referred to as a re-vegetation feasibility analysis (DeBerry et al. 2019), and it involves simple, low-cost sampling of environmental conditions by: 1) taking representative soil samples and having them analyzed in a soil lab for basic nutrient status, pH, organic matter, soluble salts, and particle size distribution, 2) evaluating light availability by taking simple canopy cover estimates, 3) qualifying availability of soil moisture by evaluating site hydrology using topographic maps or other resources (e.g., web-available wetland and soil mapping, site specific inventory data (e.g., wetland delineation), county or city GIS layers, etc.), and 4) documenting existing vegetation to determine composition and relative dominance of the plants that co-occur with the targeted invader.

Although interpretation of site feasibility data should be completed by a professional qualified in re-vegetation services, some simple site management guidelines can be implemented: 1) if soils are not overly restrictive or toxic to plant growth, avoid soil amendments that will increase nutrient availability such as fertilizer or organic amendments, which will favor aggressive or weedy plants and increase the risk of invasion, 2) if the site is already reasonably shady, avoid unnecessary cutting of trees that will reduce canopy cover and increase ground-level sunlight, which will encourage expansion of aggressive weeds and invaders, 3) if the site has been artificially drained or, alternatively, recently flooded by beavers or some other atypical scenario (e.g., log jam, debris dam, or man-made structure), consider restoration of a natural hydrology regime as part of the re-vegetation initiative, and 4) if a large number of desirable native species is already present in the community, consider targeted management techniques that will keep as many native species alive at the end of the invasive removal process.

Diverse Native Plantings

On the third invasion ecology point above, it is clear from the literature that a high diversity of native plantings is one of the best approaches to combating invasive species in the long term (Reinartz and Warne 1993, Yanelli et al. 2018). The reason for this is that a high-diversity native seed mix, a species-rich woody planting project, or a soil seedbank transplant taken from an area with lots of native species will introduce *contingency* into the re-vegetation program. In other words, the more native species available to participate in the community, the more likely it is that environmental conditions will select for native plants

that can successfully compete with the invaders. Further, when developing planting plans for a re-vegetation project, one can potentially increase the chances for success by choosing species that have functional traits similar to those of the targeted invaders. This is referred to as "limiting similarity," and it takes advantage of the fact that plants with similar needs and resource strategies (i.e., similar functional traits) will compete more aggressively with each other than those with dissimilar needs and strategies (Laughlin 2014). Limiting similarity is a relatively new idea in plant ecology, but the concept is gaining traction in plant management, and species lists with successful native competitors are beginning to emerge.

Native Species Selection

From the above discussion, it should be clear that developing a native planting plan for an invasive management project is a site-specific endeavor. For re-vegetation initiatives in the ART corridor, FOLAR will work with the management team to develop planting plans that maximize the strategies outlined above. Suffice it to mention that one of the best approaches for selecting native species is to evaluate nearby natural areas that are uninvaded or have low cover of invasive species. Such areas are often referred to as "reference sites" in restoration ecology because they provide a reference for the proposed restoration target. Reference sites can be easily extracted from the inventory data provided in this Plan, and FOLAR will be working with local botanical experts to develop species lists for those areas as we inventory natural resources within the ART corridor.

For re-vegetation projects that will use native seeds and/or plantings from a seed supplier or nursery, it is highly recommended that the planting materials be acquired as early in the planning process as possible to ensure that enough material is available when needed. Most suppliers will be able to secure and store the materials for a period of time prior to delivery.

Timing of Planting

For native planting projects, time of year is important. For most re-vegetation projects involving native seeds, spring seeding with a temporary cover crop is recommended. Fall seeding in our region is also a viable option; however, an over-wintering cover crop is recommended for soil stabilization and to encourage herbaceous density for increased competition with the invaders when warmer temperatures return in the spring. For woody stems, fall planting is recommended so that the plants have time to acclimate to colder temperatures (hardening) during dormancy.

Monitoring

Finally, one of the most important aspects of a successful IVM program is monitoring. The purpose of monitoring is twofold: 1) to evaluate the success of the re-vegetation program, and 2) to learn from outcomes and use adaptive management principles to adjust future maintenance practices accordingly. In planning a monitoring program, there is no substitute for plot-based data collection that may be tested for sample adequacy in accordance with ecological sampling theory (DeBerry 2020). This type of analysis is very robust for statistical

evaluation of data from season-to-season or year-to-year, and as long as the plot locations have been randomized, it provides a non-biased view of project performance.

However, plot sampling can also be labor-intensive and expensive for projects with limited manpower or budget available. Another reasonable and informative approach would be to maintain permanent photograph stations and conduct routine site inspections seasonally at the re-vegetation project site. Generally, a good annual schedule for site inspections is mid-spring, mid-summer, and late-summer/early fall. Georeferenced ground-level photographs can be rapidly collected during site visits using GPS-enabled devices and uploaded directly to the geodatabase for the Plan, allowing time series photo-documentation of the re-vegetation project.

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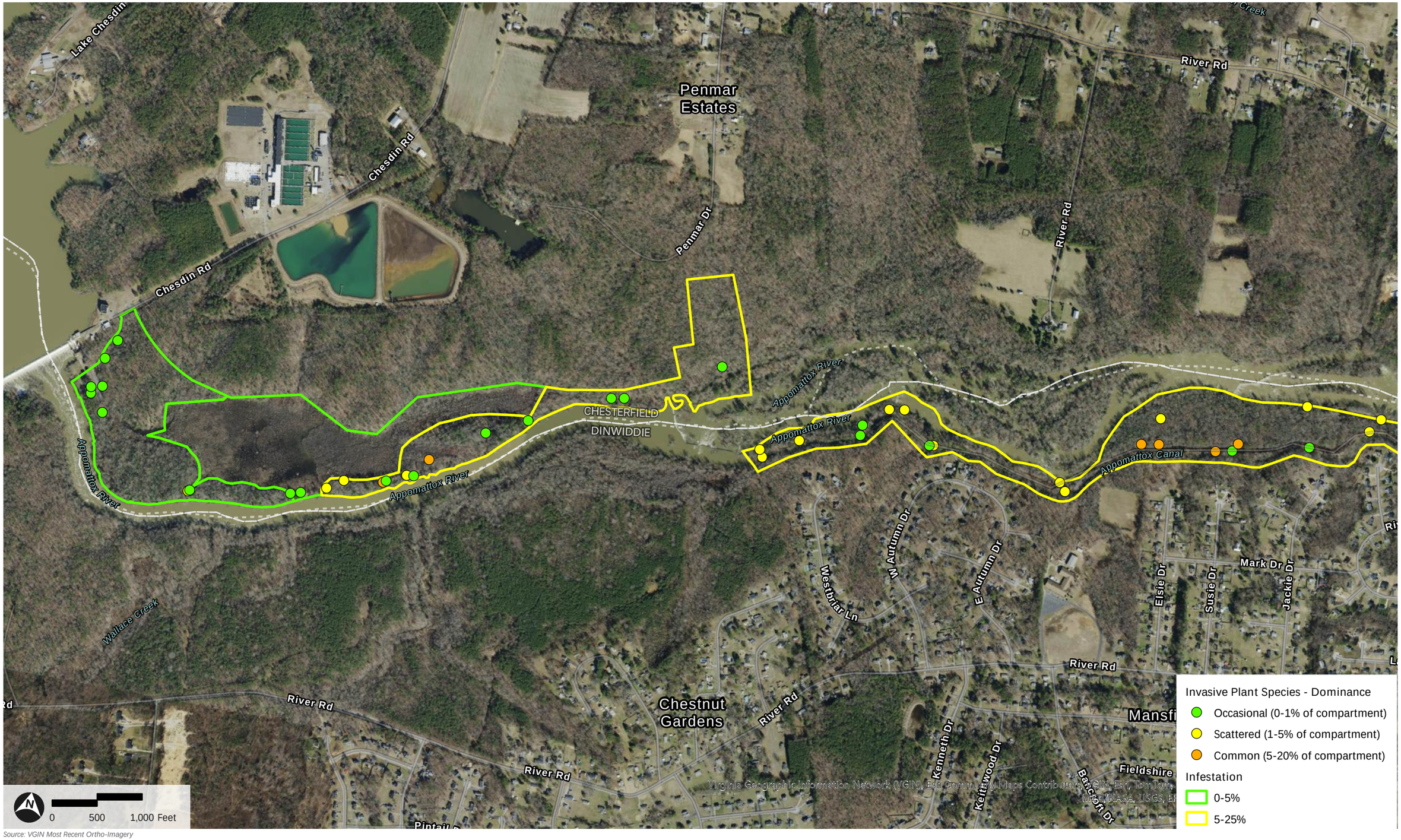
APPENDIX A:
FIGURES

Figure 1: Invasive Species Map

FOLAR/Invasive Species Management Plan

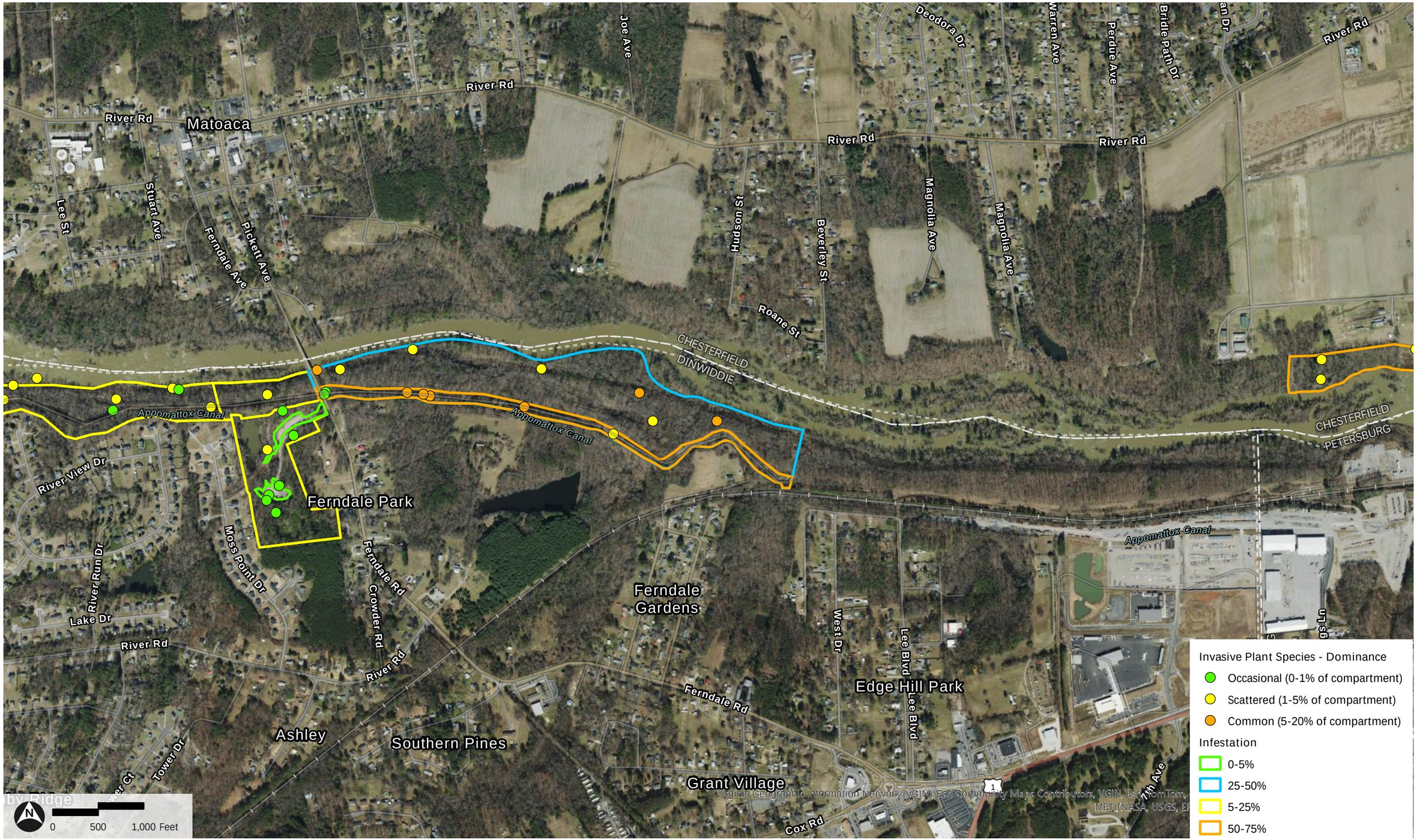


Source: VGIN Most Recent Ortho-Imagery

Path: \\vhb.com\gis\proj\Williamsburg\35058.00 FOLAR_Invasive_Species_Management_Plan\Invasive_Species\Transfer\Outgoing\to_Folar_01-29-24\FOLAR_ART_Invasive_Species_Management_Plan.aprx

Figure 2: Invasive Species Map

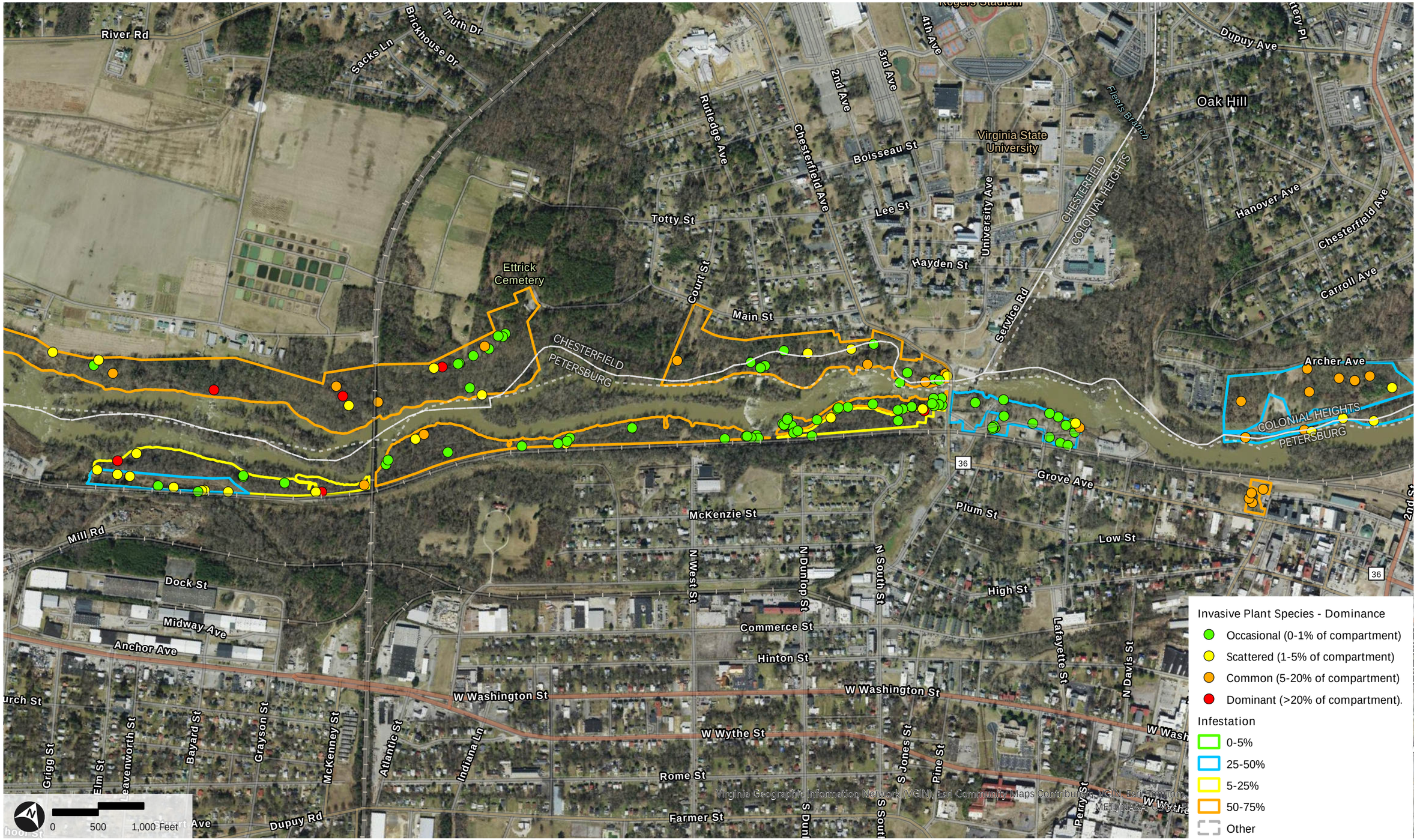
FOLAR/Invasive Species Management Plan



Source: VGIN Most Recent Ortho-Imagery

Figure 3: Invasive Species Map

FOLAR/Invasive Species Management Plan



Source: VGIN Most Recent Ortho-Imagery

Figure 4: Invasive Species Map

FOLAR/Invasive Species Management Plan

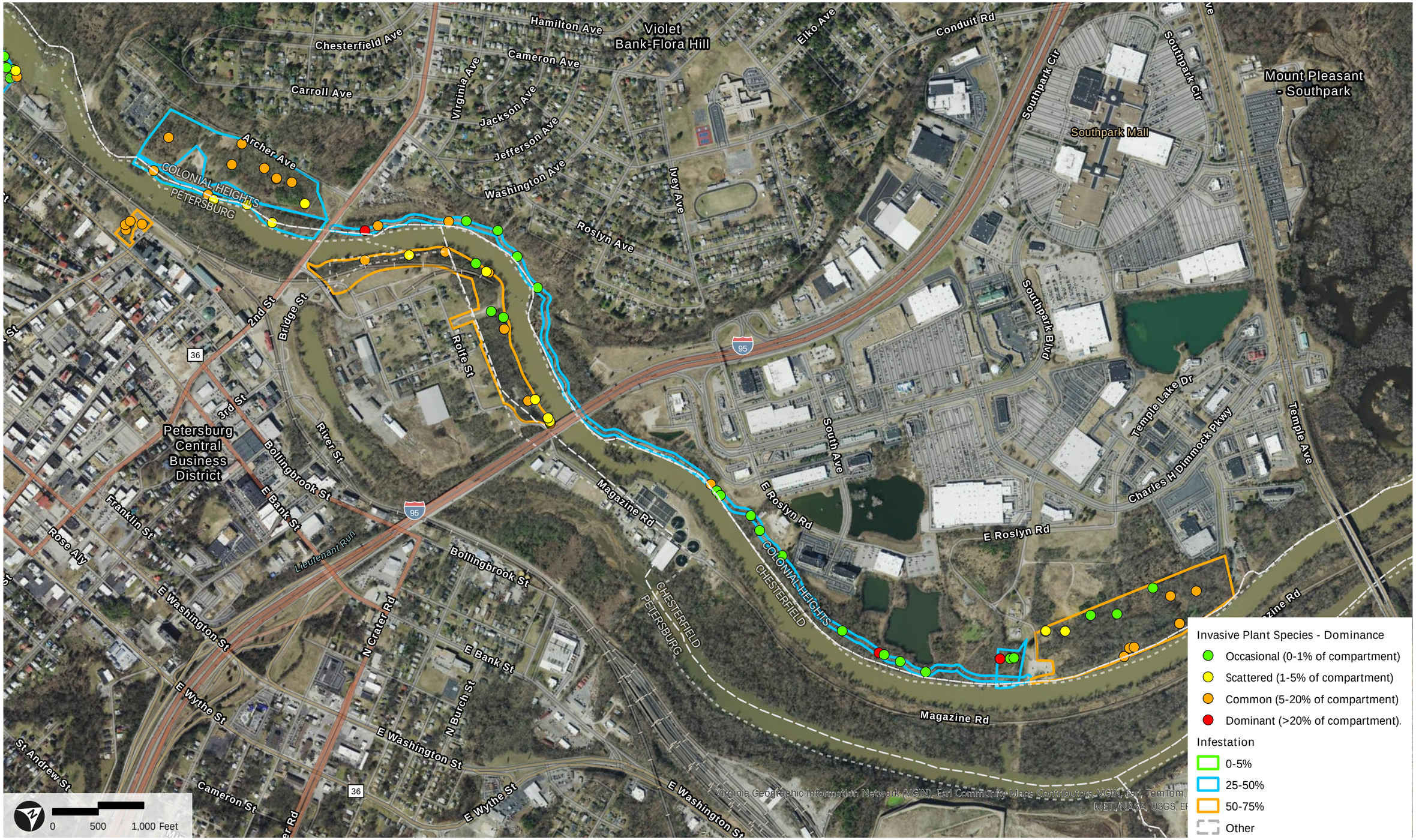


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Figure 5: Invasive Species Map

FOLAR/Invasive Species Management Plan

Source: VGIN Most Recent Ortho-Imagery

Path: \\vhb.com\gis\proj\Williamsburg\35058.00 FOLAR_ART_Invasive_Species_Management_Plan.aprx

Figure 6: Invasive Species Map

FOLAR/Invasive Species Management Plan

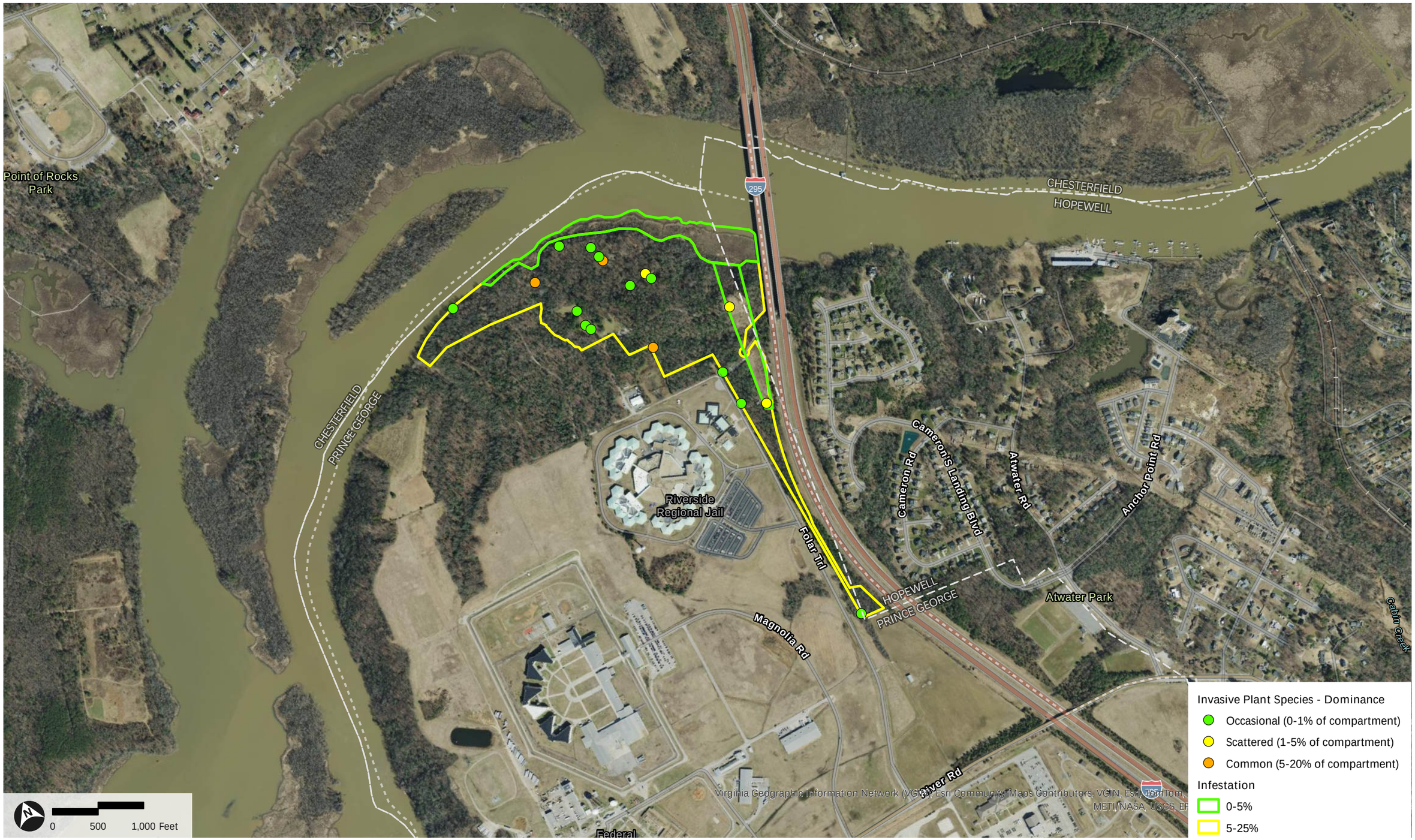

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Figure 7: Invasive Species Map

FOLAR/Invasive Species Management Plan

Source: VGIN Most Recent Ortho-Imagery

APPENDIX B:
COMPARTMENT SUMMARY

Appomattox River Trail Invasive Species Inventory: Compartment Summary

Compartment ID	Overall Invasive Cover	Invasive Species in Compartment	Relative Dominance of Invaders
CF-Radcliffe Conservation Area-1	0-5%	*Lonicera japonica*	Scattered (1-5% of compartment)
		Microstegium vimineum	Scattered (1-5% of compartment)
		Murdannia keisak	Scattered (1-5% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Clematis terniflora	Occasional (0-1% of compartment)
		Persicaria longiseta	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Ligustrum japonicum	Occasional (0-1% of compartment)
		Euonymus alatus	Occasional (0-1% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
		Nandina domestica	Occasional (0-1% of compartment)
		Hedera helix	Occasional (0-1% of compartment)
CF-Radcliffe Conservation Area-2	0-5%	*Murdannia keisak*	Scattered (1-5% of compartment)
		Pyrus calleryana	Occasional (0-1% of compartment)
		Lonicera japonica	Occasional (0-1% of compartment)
		Microstegium vimineum	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Persicaria longiseta	Occasional (0-1% of compartment)
CF-Radcliffe Conservation Area-3	5-25%	*Lonicera japonica*	Common (5-20% of compartment)
		Microstegium vimineum	Common (5-20% of compartment)
		Murdannia keisak	Occasional (0-1% of compartment)
		Persicaria longiseta	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Pyrus calleryana	Occasional (0-1% of compartment)
		Celastrus orbiculatus	Occasional (0-1% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
CH-Appamattuck Park-1	0-5%	*Morus alba*	Scattered (1-5% of compartment)
CH-Appamattuck Park-2	25-50%	*Vinca major*	Common (5-20% of compartment)
		Morus alba	Scattered (1-5% of compartment)
		Microstegium vimineum	Scattered (1-5% of compartment)
		Phyllostachys aurea	Scattered (1-5% of compartment)
		Ligustrum sinense	Scattered (1-5% of compartment)
		Glechoma hederacea	Occasional (0-1% of compartment)
		Wisteria sinensis	Occasional (0-1% of compartment)
		Ampelopsis brevipedunculata	Occasional (0-1% of compartment)

Appomattox River Trail Invasive Species Inventory: Compartment Summary

Compartment ID	Overall Invasive Cover	Invasive Species in Compartment	Relative Dominance of Invaders
CH-Appamattuck Park-3	25-50%	*Hedera helix*	Common (5-20% of compartment)
		Microstegium vimineum	Common (5-20% of compartment)
		Morus alba	Common (5-20% of compartment)
		Sorghum halepense	Scattered (1-5% of compartment)
		Glechoma hederacea	Scattered (1-5% of compartment)
		Lonicera japonica	Scattered (1-5% of compartment)
		Microstegium vimineum	Scattered (1-5% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
CH-Cedarwood Recreation Area-1	50-75%	*Microstegium vimineum*	Dominant (>20% of compartment)
		Ailanthus altissima	Common (5-20% of compartment)
		Ligustrum sinense	Common (5-20% of compartment)
		Wisteria sinensis	Common (5-20% of compartment)
		Hedera helix	Scattered (1-5% of compartment)
		Vinca minor	Occasional (0-1% of compartment)
		Lonicera japonica	Occasional (0-1% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Elaeagnus umbellata	Occasional (0-1% of compartment)
CH-CHARTS-1	25-50%	*Microstegium vimineum*	Dominant (>20% of compartment)
		Ailanthus altissima	Common (5-20% of compartment)
		Wisteria sinensis	Common (5-20% of compartment)
		Ligustrum sinense	Common (5-20% of compartment)
		Humulus japonicus	Scattered (1-5% of compartment)
		Morus alba	Scattered (1-5% of compartment)
		Lonicera japonica	Scattered (1-5% of compartment)
		Ampelopsis brevipedunculata	Scattered (1-5% of compartment)
		Sorghum halepense	Scattered (1-5% of compartment)
		Albizia julibrissin	Scattered (1-5% of compartment)
		Hedera helix	Scattered (1-5% of compartment)
		Euonymus sp.	Scattered (1-5% of compartment)
		Persicaria longiseta	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Elaeagnus umbellata	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Paulownia tomentosa	Occasional (0-1% of compartment)
		Murdannia keisak	Occasional (0-1% of compartment)
		Robinia pseudoacacinia	Occasional (0-1% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)
		Arthraxon hispidus	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Elaeagnus pungens	Occasional (0-1% of compartment)
		Clematis terniflora	Occasional (0-1% of compartment)
		Pyrus calleryana	Occasional (0-1% of compartment)
CH-Fort Clifton Park-1	25-50%	*Microstegium vimineum*	Dominant (>20% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
CH-Fort Clifton Park-2	0-5%	*Lespedeza cuneata*	Occasional (0-1% of compartment)

Appomattox River Trail Invasive Species Inventory: Compartment Summary

Compartment ID	Overall Invasive Cover	Invasive Species in Compartment	Relative Dominance of Invaders
CH-Roslyn Landing Park-2	25-50%	*Microstegium vimineum*	Dominant (>20% of compartment)
		Glechoma hederacea	Dominant (>20% of compartment)
		Lonicera japonica	Common (5-20% of compartment)
		Ligustrum sinense	Common (5-20% of compartment)
		Celastrus orbiculatus	Common (5-20% of compartment)
		Pyrus calleryana	Scattered (1-5% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Reynoutria japonica	Occasional (0-1% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)
		Morus alba	Occasional (0-1% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
		Ampelopsis brevipedunculata	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
CH-Roslyn Landing Park-3	50-75%	*Microstegium vimineum*	Dominant (>20% of compartment)
		Glechoma hederacea	Dominant (>20% of compartment)
		Wisteria sinensis	Dominant (>20% of compartment)
		Murdannia keisak	Common (5-20% of compartment)
		Ligustrum sinense	Common (5-20% of compartment)
		Arthraxon hispidus	Common (5-20% of compartment)
		Ligustrum sinense	Common (5-20% of compartment)
		Celastrus orbiculatus	Scattered (1-5% of compartment)
		Lespedeza cuneata	Scattered (1-5% of compartment)
		Pyrus calleryana	Scattered (1-5% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)
		Sorghum halepense	Occasional (0-1% of compartment)
CH-White Bank Park-1	5-25%	*Microstegium vimineum*	Scattered (1-5% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Lonicera japonica	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Clematis terniflora	Occasional (0-1% of compartment)
		Robinia pseudoacacia	Occasional (0-1% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
CH-White Bank Park-2	0-5%	*Ailanthus altissima*	Occasional (0-1% of compartment)
		Microstegium vimineum	Occasional (0-1% of compartment)
D-Appomattox Riverside Park East-1	25-50%	*Microstegium vimineum*	Common (5-20% of compartment)
		Lonicera japonica	Scattered (1-5% of compartment)
		Ligustrum sinense	Scattered (1-5% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Murdannia keisak	Scattered (1-5% of compartment)
		Arthraxon hispidus	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Sorghum halepense	Occasional (0-1% of compartment)

Appomattox River Trail Invasive Species Inventory: Compartment Summary

Compartment ID	Overall Invasive Cover	Invasive Species in Compartment	Relative Dominance of Invaders
D-Appomattox Riverside Park East-2	50-75%	*Microstegium vimineum*	Dominant (>20% of compartment)
		Ailanthus altissima	Common (5-20% of compartment)
		Wisteria sinensis	Common (5-20% of compartment)
		Lespedeza cuneata	Common (5-20% of compartment)
		Lonicera japonica	Common (5-20% of compartment)
		Murdannia keisak	Common (5-20% of compartment)
		Sorghum halepense	Scattered (1-5% of compartment)
		Hedera helix	Scattered (1-5% of compartment)
		Ligustrum sinense	Scattered (1-5% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
D-Appomattox Riverside Park West-1	5-25%	*Lonicera japonica*	Scattered (1-5% of compartment)
		Lespedeza cuneata	Scattered (1-5% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Microstegium vimineum	Scattered (1-5% of compartment)
		Ligustrum sinense	Scattered (1-5% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Elaeagnus umbellata	Occasional (0-1% of compartment)
		Arthraxon hispidus	Occasional (0-1% of compartment)
		Paulownia tomentosa	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Persicaria longiseta	Occasional (0-1% of compartment)
		Hydrilla verticillata	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
D-Ferndale Park-1	5-25%	*Microstegium vimineum*	Scattered (1-5% of compartment)
		Arthraxon hispidus	Scattered (1-5% of compartment)
		Ligustrum sinense	Scattered (1-5% of compartment)
		Lonicera japonica	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Elaeagnus umbellata	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
D-Ferndale Park-2	0-5%	N/A	N/A
D-Ferndale Park-3	0-5%	N/A	N/A
H-City Park-1	75-100%	*Pueraria montana var. lobata*	Dominant (>20% of compartment)
		Clematis terniflora	Scattered (1-5% of compartment)
		Hedera helix	Scattered (1-5% of compartment)
		Ligustrum sinense	Scattered (1-5% of compartment)
		Sorghum halepense	Scattered (1-5% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Microstegium vimineum	Occasional (0-1% of compartment)
		Morus alba	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)

Appomattox River Trail Invasive Species Inventory: Compartment Summary

Compartment ID	Overall Invasive Cover	Invasive Species in Compartment	Relative Dominance of Invaders
H-City Park-2	75-100%	*Ligustrum sinense*	Dominant (>20% of compartment)
		Ailanthus altissima	Common (5-20% of compartment)
		Hedera helix	Common (5-20% of compartment)
		Pueraria montana var. lobata	Common (5-20% of compartment)
		Clematis terniflora	Scattered (1-5% of compartment)
		Morus alba	Scattered (1-5% of compartment)
		Microstegium vimineum	Scattered (1-5% of compartment)
		Lonicera japonica	Occasional (0-1% of compartment)
		Elaeagnus umbellata	Occasional (0-1% of compartment)
		Pyrus calleryana	Occasional (0-1% of compartment)
		Phragmites australis	Occasional (0-1% of compartment)
H-City Park-3	75-100%	*Ailanthus altissima*	Occasional (0-1% of compartment)
		Clematis terniflora	Occasional (0-1% of compartment)
H-Marina Overlook-2	75-100%	*Hedera helix*	Dominant (>20% of compartment)
		Ligustrum sinense	Common (5-20% of compartment)
		Lonicera japonica	Scattered (1-5% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)
		Robinia pseudoacacia	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Ampelopsis brevipedunculata	Occasional (0-1% of compartment)
H-Marina Overlook-3	25-50%	*Hedera helix*	Common (5-20% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Clematis terniflora	Scattered (1-5% of compartment)
		Robinia pseudoacacia	Scattered (1-5% of compartment)
		Ligustrum sinense	Scattered (1-5% of compartment)
		Ampelopsis brevipedunculata	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
H-Riverside Greenway-1	50-75%	*Microstegium vimineum*	Dominant (>20% of compartment)
		Lonicera japonica	Common (5-20% of compartment)
		Hedera helix	Common (5-20% of compartment)
		Ligustrum sinense	Common (5-20% of compartment)
		Murdannia keisak	Common (5-20% of compartment)
		Robinia pseudoacacia	Scattered (1-5% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Commelina communis	Scattered (1-5% of compartment)
		Persicaria longiseta	Scattered (1-5% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Sorghum halepense	Occasional (0-1% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Glechoma hederacea	Occasional (0-1% of compartment)
		Vinca minor	Occasional (0-1% of compartment)

Appomattox River Trail Invasive Species Inventory: Compartment Summary

Compartment ID	Overall Invasive Cover	Invasive Species in Compartment	Relative Dominance of Invaders
P-Merchants Island-1	50-75%	*Wisteria sinensis*	Dominant (>20% of compartment)
		Ligustrum sinense	Common (5-20% of compartment)
		Lonicera japonica	Common (5-20% of compartment)
		Commelina communis	Scattered (1-5% of compartment)
		Rosa multiflora	Scattered (1-5% of compartment)
		Microstegium vimineum	Scattered (1-5% of compartment)
		Elaeagnus umbellata	Occasional (0-1% of compartment)
		Humulus japonicus	Occasional (0-1% of compartment)
		Sorghum halepense	Occasional (0-1% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Clematis terniflora	Occasional (0-1% of compartment)
		Morus alba	Occasional (0-1% of compartment)
		Robinia pseudoscacia	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Phyllostachys aurea	Occasional (0-1% of compartment)
		Elaeagnus umbellata	Occasional (0-1% of compartment)
		Hedera helix	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Euonymus fortunei	Occasional (0-1% of compartment)
		Vinca minor	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Reynoutria japonica	Occasional (0-1% of compartment)
		Elaeagnus pungens	Occasional (0-1% of compartment)
P-Merchants Island-2	5-25%	*Wisteria sinensis*	Dominant (>20% of compartment)
		Lonicera japonica	Occasional (0-1% of compartment)
		Hedera helix	Occasional (0-1% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Paulownia tomentosa	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Microstegium vimineum	Occasional (0-1% of compartment)
		Euonymus fortunei	Occasional (0-1% of compartment)

Appomattox River Trail Invasive Species Inventory: Compartment Summary

Compartment ID	Overall Invasive Cover	Invasive Species in Compartment	Relative Dominance of Invaders
P-Patton Park-1	25-50%	*Reynoutria japonica*	Common (5-20% of compartment)
		Paulownia tomentosa	Scattered (1-5% of compartment)
		Humulus japonicus	Scattered (1-5% of compartment)
		Hedera helix	Scattered (1-5% of compartment)
		Glechoma hederacea	Scattered (1-5% of compartment)
		Sorghum halepense	Occasional (0-1% of compartment)
		Setaria faberi	Occasional (0-1% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
		Microstegium vimineum	Occasional (0-1% of compartment)
		Lonicera japonica	Occasional (0-1% of compartment)
		Morus alba	Occasional (0-1% of compartment)
		Celastrus orbiculatus	Occasional (0-1% of compartment)
		Dioscorea polystachya	Occasional (0-1% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Euonymus fortunei	Occasional (0-1% of compartment)
		Clematis terniflora	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Wisteria sinensis	Occasional (0-1% of compartment)
		Pueraria montana var. lobata	Occasional (0-1% of compartment)
P-Peter Jones Trading-2	50-75%	*Sorghum halepense*	Dominant (>20% of compartment)
		Pyrus calleryana	Common (5-20% of compartment)
P-Peter Jones Trading-3	50-75%	*Ailanthus altissima*	Common (5-20% of compartment)
		Paulownia tomentosa	Common (5-20% of compartment)
		Morus alba	Common (5-20% of compartment)
		Acer platanoides	Common (5-20% of compartment)
		Hedera helix	Scattered (1-5% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Sorghum halepense	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
P-Riverfront Park-1	5-25%	*Microstegium vimineum*	Common (5-20% of compartment)
		Lonicera japonica	Common (5-20% of compartment)
		Lespedeza cuneata	Scattered (1-5% of compartment)
		Persicaria longiseta	Scattered (1-5% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Rosa multiflora	Scattered (1-5% of compartment)
		Euonymus fortunei	Scattered (1-5% of compartment)
		Arthraxon hispidus	Scattered (1-5% of compartment)
		Ligustrum sinense	Scattered (1-5% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Glechoma hederacea	Occasional (0-1% of compartment)
		Hedera helix	Occasional (0-1% of compartment)
		Murdannia keisak	Occasional (0-1% of compartment)
		Lonicera maackii	Occasional (0-1% of compartment)

Appomattox River Trail Invasive Species Inventory: Compartment Summary

Compartment ID	Overall Invasive Cover	Invasive Species in Compartment	Relative Dominance of Invaders
P-Riverfront Park-2	50-75%	*Hedera helix*	Common (5-20% of compartment)
		Lonicera japonica	Common (5-20% of compartment)
		Wisteria sinensis	Common (5-20% of compartment)
		Microstegium vimineum	Common (5-20% of compartment)
		Rosa multiflora	Common (5-20% of compartment)
		Ligustrum sinense	Common (5-20% of compartment)
		Euonymus fortunei	Scattered (1-5% of compartment)
		Vinca minor	Scattered (1-5% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Persicaria longiseta	Scattered (1-5% of compartment)
		Morus alba	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Sorghum halepense	Occasional (0-1% of compartment)
		Robinia pseudoacacia	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Pyrus calleryana	Occasional (0-1% of compartment)
		Glechoma hederacea	Occasional (0-1% of compartment)
		Celastrus orbiculatus	Occasional (0-1% of compartment)
		Clematis terniflora	Occasional (0-1% of compartment)
		Reynoutria japonica	Occasional (0-1% of compartment)
		Ampelopsis brevipedunculata	Occasional (0-1% of compartment)
		Reynoutria japonica	Occasional (0-1% of compartment)
P-Riverfront Park-3	25-50%	*Microstegium vimineum*	Common (5-20% of compartment)
		Rosa multiflora	Common (5-20% of compartment)
		Lespedeza cuneata	Scattered (1-5% of compartment)
		Arthraxon hispidus	Scattered (1-5% of compartment)
		Sorghum halepense	Scattered (1-5% of compartment)
		Commelina communis	Scattered (1-5% of compartment)
		Lonicera japonica	Scattered (1-5% of compartment)
		Elaeagnus umbellata	Occasional (0-1% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
		Glechoma hederacea	Occasional (0-1% of compartment)
		Celastrus orbiculatus	Occasional (0-1% of compartment)
P-Rotary Park-1	50-75%	*Hedera helix*	Dominant (>20% of compartment)
		Ligustrum sinense	Dominant (>20% of compartment)
		Microstegium vimineum	Common (5-20% of compartment)
		Rosa multiflora	Common (5-20% of compartment)
		Ailanthus altissima	Common (5-20% of compartment)
		Acer platanoides	Scattered (1-5% of compartment)
		Lonicera japonica	Scattered (1-5% of compartment)
		Wisteria sinensis	Scattered (1-5% of compartment)
		Ampelopsis brevipedunculata	Scattered (1-5% of compartment)
		Pyrus calleryana	Occasional (0-1% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)
		Morus alba	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Paulownia tomentosa	Occasional (0-1% of compartment)

Appomattox River Trail Invasive Species Inventory: Compartment Summary

Compartment ID	Overall Invasive Cover	Invasive Species in Compartment	Relative Dominance of Invaders
P-VSU-1	50-75%	*Ligustrum sinense*	Dominant (>20% of compartment)
		Microstegium vimineum	Common (5-20% of compartment)
		Lonicera japonica	Common (5-20% of compartment)
		Rosa multiflora	Scattered (1-5% of compartment)
		Hedera helix	Scattered (1-5% of compartment)
		Euonymus fortunei	Occasional (0-1% of compartment)
		Persicaria longiseta	Occasional (0-1% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Morus alba	Occasional (0-1% of compartment)
		Murdannia keisak	Occasional (0-1% of compartment)
		Celastrus orbiculatus	Occasional (0-1% of compartment)
		Melia azedarach	Occasional (0-1% of compartment)
		Paulownia tomentosa	Occasional (0-1% of compartment)
		Glechoma hederacea	Occasional (0-1% of compartment)
P-No Name Park-1	50-75%	*Microstegium vimineum*	Common (5-20% of compartment)
		Wisteria sinensis	Common (5-20% of compartment)
		Pueraria montana var. lobata	Scattered (1-5% of compartment)
		Humulus japonicus	Scattered (1-5% of compartment)
		Ligustrum sinense	Scattered (1-5% of compartment)
		Lespedeza cuneata	Scattered (1-5% of compartment)
		Elaeagnus pungens	Scattered (1-5% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Commelina communis	Occasional (0-1% of compartment)
		Hedera helix	Occasional (0-1% of compartment)
		Ailanthus altissima	Occasional (0-1% of compartment)
		Lonicera japonica	Occasional (0-1% of compartment)
		Euonymus fortunei	Occasional (0-1% of compartment)
		Murdannia keisak	Occasional (0-1% of compartment)
		Morus alba	Occasional (0-1% of compartment)
		Robinia pseudoacacia	Occasional (0-1% of compartment)
		Sorghum halepense	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
		Glechoma hederacea	Occasional (0-1% of compartment)
PG-Appomattox River Regional Park-1	5-25%	*Microstegium vimineum*	Scattered (1-5% of compartment)
		Ailanthus altissima	Scattered (1-5% of compartment)
		Lonicera japonica	Scattered (1-5% of compartment)
		Hedera helix	Occasional (0-1% of compartment)
		Ligustrum sinense	Occasional (0-1% of compartment)
		Lespedeza cuneata	Occasional (0-1% of compartment)
		Ampelopsis brevipedunculata	Occasional (0-1% of compartment)
		Robinia pseudoacacia	Occasional (0-1% of compartment)
		Sorghum halepense	Occasional (0-1% of compartment)
		Albizia julibrissin	Occasional (0-1% of compartment)
		Rosa multiflora	Occasional (0-1% of compartment)
PG-Appomattox River Regional Park-2	0-5%	*Lespedeza cuneata*	Scattered (1-5% of compartment)
		Clematis terniflora	Occasional (0-1% of compartment)

APPENDIX C:
RECOMMENDED MANAGEMENT PRESCRIPTIONS BY SPECIES

Appomattox River Trail Invasive Species Management Plan: Recommended Management Prescriptions By Species

Scientific name	Common name	Priority 1	Priority 2	Priority 3	References
Acer platanoides	Norway maple	**Cut Stem Method:** This method is useful in areas where the trees need to be removed from the site and will be cut as part of the process. This method is likely to be most successful during the growing season, with diminishing success through the early fall. Dormant season applications may prevent resprouting from the stump itself, but will do little to inhibit root suckering. However, at any time of year, if the tree must be cut it is better to treat the stump than not. Cut trees near ground level and immediately apply a 25% solution of glyphosate mixed with water or 20% Garlon® 4 plus 80% oil dilutant, to the whole cut stump surface and the sides to the ground line. As with basal bark, a dye added to the mix will help keep track of treated plants. The mixture may be painted on with a paint brush or sprayed on using a spray bottle or backpack sprayer. Application of herbicide to the cut stumps must be conducted immediately after cutting, within 5-15 minutes of the cut with water soluble formulations, longer with oil mixtures, to ensure uptake of the chemical before the plant seals the cut area off.	**Foliar:** Because this method involves applying herbicide mix to foliage (leaves), it should be considered for small dense infestations or for large infestations where the risk to non-target species is minimal. Limitations of the method are the seasonal time frame. It is typically more effective in summer and late season when plants are shifting resources downward to roots. For most plants, use a 2% rate of glyphosate mixed with water and a small amount (0.5%, or as per label) of a non-ionic surfactant (except for Roundup®, which contains a surfactant) to help the spray spread over and penetrate the leaves. A 1.5% rate (4 lb./gal.) triclopyr (Garlon® 4) can also be used in this way. The mixture should be applied to leaves and green stems, including sprouts and suckers, until thoroughly wet but not to the point of runoff. Use a low pressure and coarse spray pattern to reduce spray-drift damage to non-target species. To avoid drift, applications should be made when winds are below about 8 mph. If desirable trees are nearby, a no-spray buffer area should be established to protect non-target plants. Foliar application can be done almost anytime as long as air temperature is above about 65°F (and no higher than 85°F for triclopyr) to ensure absorption of the herbicide. To allow ample drying, applications should be made when rain is unlikely for about 12 hours after application and leaves should be dry prior to treatment. Wind speed should be below 8-10 mph to avoid off-site drift.	**Hack-and-squirt or injection:** This method can be very effective and is useful when target trees are mixed in with desirable trees. it requires using a hand axe to make downward-angled cuts into the sapwood around the tree trunk and squirting about a teaspoon of concentrated herbicide into the cut.	UGA Center for Invasive Species and Ecosystem Health. (2018).
Ailanthus altissima	Tree-of-heaven	**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). **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.	**Resprouts and seedlings:** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC* 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).	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Albizia julibrissin	Mimosa	**Large trees:** Make stem injections using Arsenal AC* or Garlon 3A in dilutions as specified on the herbicide label (anytime except March and April). **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.	**Resprouts and seedlings:** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant: July to October—Garlon 3A, Garlon 4, or glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix). July to September—Transline† as a 0.2- to 0.4-percent solution (1 to 2 ounces per 3-gallon mix)	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Ampelopsis glandulosa	Porcelain-berry	**Foliar applications:** The most effective control has been achieved using triclopyr formulations. From summer to fall, apply a water-based solution of 2.5% Garlon® 3A (triclopyr amine) to foliage or cut plants first, allow time for regrowth and then apply the mixture. Smaller infestations can be controlled to some extent with spot applications of glyphosate to leaves, used sparingly to avoid contact of desirable plants with spray. Cut the vines back during the summer and allow to resprout before applying herbicide, or apply glyphosate to leaves in early autumn, just prior to senescence.	**Basal bark applications:** Apply a mixture of 20-30% Garlon® 4 (triclopyr ester) mixed with commercially available basal oil, horticultural oil, diesel fuel, No. 1 or No. 2 fuel oil, or kerosene, to 2 - 3 ft. long sections of stem near the base of the vines.	**Manual:** Hand pulling of vines in the fall or spring will prevent flower buds from forming the following season. Where feasible, plants should be pulled up by hand before fruiting to prevent the production and dispersal of seeds. If the plants are pulled while in fruit, the fruits should be bagged and disposed of in a landfill. For vines too large to pull out, cut them near the ground and either treat cut stems with systemic herbicide or repeat cutting of regrowth as needed.	Young, J. (2005). Fact Sheet: Porcelain-berry. Plant Conservation Alliances Alien Plant Working Group.
Arthraxon hispidus	Joint-head grass	**Foliar Spray Method (1):** Glyphosate -- Apply a 2% solution of glyphosate and water plus a non-ionic surfactant to thoroughly wet all foliage. Do not spray to the point of runoff. Ambient air temperature should be above 65°F to ensure translocation of the herbicide to the roots. Do not apply if windy or if rainfall is expected within two hours following application. NOTE: Glyphosate is a non-selective herbicide (i.e. it kills any green plant). Use extra caution to avoid getting chemical spray on any non-target species. Refer to manufacturer's label for specific information and restrictions regarding use.	**Foliar Spray Method (2):** Sethoxydin -- Apply a 1.5% solution of sethoxydin and water plus a non-phytotoxic, vegetable-based oil to thoroughly wet all foliage. Do not spray to the point of runoff. Ambient air temperature should be above 65°F to ensure translocation of the herbicide to the roots. Do not apply if rainfall is expected within one hour following application.	**Manual:** Hand pulling or mowing before seed production in mid-late summer.	Tennessee Invasive Plant Council. (2023).
Celastrus orbiculatus	Oriental bittersweet	Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Garlon 4, Garlon 3A, or a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix).	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 the lower 16 inches of stems.	Cut large stems and immediately treat the cut surfaces with one of the following herbicides in water with a surfactant: Garlon 4 or a glyphosate herbicide as a 25-percent solution (32 ounces per 1-gallon mix).	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Commelina communis	Asiatic dayflower	Noteably difficult to control; few efficacious mamangement strategies exist: Post Emergence: 2,4-D; Dicamba, Mecoprop-p, Triclopyr			Penn State College of Agricultural Science: Department of Plant Science (2023).
Dioscorea polystachya	Chinese yam	Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Garlon 3A or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix). Sometimes the air yams take up the herbicide; otherwise, they must be collected and destroyed (not composted).	Cut climbing plants just above the soil surface and immediately treat the freshly cut stem with undiluted Garlon 3A (safe to surrounding plants).		Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Elaeagnus pungens	Thorny olive	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).	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).	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Elaeagnus umbellata	Autumn olive	□ 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* 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).	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.

Appomattox River Trail Invasive Species Management Plan: Recommended Management Prescriptions By Species

Scientific name	Common name	Priority 1	Priority 2	Priority 3	References
Euonymus alatus	Winged euonymus	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* 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).	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Euonymus fortunei	Winter creeper	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* ǂ as a 3-percent solution (12 ounces per 3-gallon mix) or Tordon K* ǂ as a 2-percent solution (8 ounces per 3-gallon mix).	Repeatedly apply Garlon 4 or a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix) in water with a surfactant, a less effective treatment that has no soil activity to damage surrounding plants.	Cut all vertical climbing stems to prevent fruiting and spread by birds.	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Glechoma hederacea	Ground-ivy	**Foliar:** This method is effective on infestations where mechanical control is not practical or desired. Glyphosate (e.g., Accord®, Rodeo® and other products) is a non-selective systemic herbicide that is absorbed by the plant and carried to the roots, killing the entire plant. It is important to avoid contact of spray with desirable plants. Treatments should be done either in early spring when most other non-target vegetation is dormant or mid to late summer and fall when plant growth slows and resources are being sent to the roots. Refer to manufacturer's label for specific information and restrictions regarding use. In general, a 1-2% solution of glyphosate mixed with water and a non-ionic surfactant (seek manufacturer's recommendations) is used. Spray should be applied such that it thoroughly covers most of the leaves but not to the point that it is dripping off the leaves.	**Manual:** Generally speaking, most herbaceous plants can be pulled by hand as long as the entire plant including the roots is removed to prevent regrowth. This is almost always recommended for individual plants	**Mechanical:** While repeated mowing can be effective for control of some herbaceous forbs, it may not be practical for others. Mowing often needs to be conducted repeatedly and for many years to eradicate plants with significant root systems. It may be more practical and effective to use chemical methods or a combination of mowing and herbicides for difficult species.	Plant Conservation Alliance (PCA). U.S. Department of the Interior Bureau of Land Management. Herbaceous Forbs.
Hedera helix	English ivy	Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant (July to October for successive years): Garlon 3A or Garlon 4 as a 3- to 5-percent solution (12 to 20 ounces per 3-gallon mix) or a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix). Use a string trimmer to reduce growth layers and injure leaves for improved herbicide uptake. Cut large vines and apply these herbicides to cut surfaces.	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 large vines being careful to avoid the bark of the host tree.		Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Humulus japonicus	Japanese hops	**Chemical:** In areas with heavier infestations or in newly established tree plantings, a pre-emergent herbicide containing sulfometuron methyl (Oust® XP) applied in mid-March generally causes minimal or no damage to other perennial vegetation eliminating the need to rescue desirable vegetation from an established hop infestation. Application of a pre-emergent herbicide followed by a foliar application of glyphosate or metsulfuron applied prior to seed production (mid-April to August) may provide the most effective control. Subsequent applications will be necessary to control germinating plants throughout the season to prevent seed production.	**Manual:** In areas with light infestation, manual removal can work well within moist soil in early spring when the root system is small. The entire root and plant must be removed and taken of-site to prevent regrowth. Repeated pulling/ digging should continue until dieback in fall when new plants cease to emerge.	**Mechanical:** Mowing/cutting is also effective when started in early spring and continued until dieback in fall. The location of plants within wet soils and amongst trees may hinder mowing control efforts. Reports indicate that after three consecutive years of control efforts that prevent seed production, the seed bank is normally exhausted. In areas with the potential for recolonization, such as stream banks, continued monitoring will be needed until the upstream seed source is eliminated.	Japanese Hops Control. n.d. Missouri Department of Conservation.
Hydrilla verticillata	Hydrilla	**Chemical:** Bispyribac-sodium comes in water soluble powder form in packets. Each packet should be mixed with water first and then sprayed or injected. It is a selective, systemic herbicide. Systemic Herbicides are absorbed and move within the plant to the site of action. Systemic herbicides tend to act more slowly than contact herbicides. A surfactant (substance that can reduce the surface tension) will be needed if herbicide is applied to foliage of floating or emergent plants. Common trade and product names include but are not limited to:	**Mechanical:** Many types of mechanical removal devices are available that cut or chop up aquatic weeds. It is important to remember that many submerged plants regrow from fragments, so removal of cut fragments may be necessary to keep from spreading the unwanted plant.	**Physical:** Physical barriers are also used to eliminate plants by shading the bottom. These work well for swimming areas, docks, etc. but must be kept clean of any buildup of sediment and debris.	AquaPlant. n.d. Texas A&M AgriLife Extension.
Lespedeza cuneata	Chinese clover	Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to September): Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix), Escort* at three-fourths of an ounce per acre (0.2 dry ounces per 3-gallon mix), Transline† as a 0.2-percent solution (1 ounce per 3-gallon mix), a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix), or Velpar L* as a 2-percent solution (8 ounces per 3-gallon mix).	Mowing 1 to 3 months before herbicide applications can assist control.		Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Ligustrum sinense	Chinese privet	Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (August to December): a glyphosate herbicide as a 3-percent solution (12 ounces per 3-gallon mix) or Arsenal AC* as a 1-percent solution (4 ounces per 3-gallon mix).	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.	Or, cut large stems and immediately treat the stumps with Arsenal AC* or Velpar L* as a 10-percent solution in water (1 quart per 3-gallon mix) with a surfactant. When safety to surrounding vegetation is desired, immediately treat stumps and cut stems with Garlon 3A or a glyphosate herbicide as a 20-percent solution in water (2.5 quarts per 3-gallon mix) with a surfactant.	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Lonicera japonica	Japanese honeysuckle	Apply Escort* with a surfactant to foliage June to August either by broadcast spraying 2 ounces per acre in water (0.6 dry ounces per 3-gallon mix) or by spot spraying 2 to 4 ounces per acre in water (0.6 to 1.2 dry ounces per 3-gallon mix).	Treat foliage with one of the following herbicides in water with a surfactant (July to October or during warm days in early winter) keeping spray away from desirable plants: a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix) or Garlon 3A or Garlon 4 as a 3- to 5-percent solution (12 to 20 ounces per 3-gallon mix).	Cut large vines just above the soil surface and immediately treat the freshly cut stem with a glyphosate herbicide or Garlon 3A as a 20-percent solution (2.5 quarts per 3-gallon sprayer) in water with a surfactant July to October (safe to surrounding plants).	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Lonicera maackii	Amur honeysuckle	Thoroughly wet all leaves with glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant (August to October).	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).	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Melia azedarach	Chinaberry	**Trees:** Make stem injections using Arsenal AC*, Pathway*, Pathfinder II, or Garlon 3A in dilutions and cut spacings specified on the herbicide label (anytime except March and April). **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.	**Sprouts and seedlings:** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Garlon 3A or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix); Arsenal AC* as a 1-percent solution (4 ounces per 3-gallon mix).	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.

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Scientific name	Common name	Priority 1	Priority 2	Priority 3	References
Microstegium vimineum	Japanese stiltgrass	Apply a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant in late summer. Or, apply Vantage (see label) for situations that require more selective control and less impact on associated plants.	Repeat treatments for several years to control abundant germinating seeds. Mowing or pulling just before seed set in September will prevent seed buildup.		Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Morus alba	White mulberry	**Cut Stem Method:** This method is useful in areas where the trees need to be removed from the site and will be cut as part of the process. This method is likely to be most successful during the growing season, with diminishing success through the early fall. Dormant season applications may prevent resprouting from the stump itself, but will do little to inhibit root suckering. However, at any time of year, if the tree must be cut it is better to treat the stump than not. Cut trees near ground level and immediately apply a 25% solution of glyphosate mixed with water or 20% Garlon® 4 plus 80% oil dilutant, to the whole cut stump surface and the sides to the ground line. As with basal bark, a dye added to the mix will help keep track of treated plants. The mixture may be painted on with a paint brush or sprayed on using a spray bottle or backpack sprayer. Application of herbicide to the cut stumps must be conducted immediately after cutting, within 5-15 minutes of the cut with water soluble formulations, longer with oil mixtures, to ensure uptake of the chemical before the plant seals the cut area off.	**Foliar:** Because this method involves applying herbicide mix to foliage (leaves), it should be considered for small dense infestations or for large infestations where the risk to non-target species is minimal. Limitations of the method are the seasonal time frame. It is typically more effective in summer and late season when plants are shifting resources downward to roots. For most plants, use a 2% rate of glyphosate mixed with water and a small amount (0.5%, or as per label) of a non-ionic surfactant (except for Roundup®, which contains a surfactant) to help the spray spread over and penetrate the leaves. A 1.5% rate (4 lb./gal.) triclopyr (Garlon® 4) can also be used in this way. The mixture should be applied to leaves and green stems, including sprouts and suckers, until thoroughly wet but not to the point of runoff. Use a low pressure and coarse spray pattern to reduce spray-drift damage to non-target species. To avoid drift, applications should be made when winds are below about 8 mph. If desirable trees are nearby, a no-spray buffer area should be established to protect non-target plants. Foliar application can be done almost anytime as long as air temperature is above about 65°F (and no higher than 85°F for triclopyr) to ensure absorption of the herbicide. To allow ample drying, applications should be made when rain is unlikely for about 12 hours after application and leaves should be dry prior to treatment. Wind speed should be below 8-10 mph to avoid off-site drift.	**Hack-and-squirt or injection:** This method can be very effective and is useful when target trees are mixed in with desirable trees. it requires using a hand axe to make downward-angled cuts into the sapwood around the tree trunk and squirting about a teaspoon of concentrated herbicide into the cut.	UGA Center for Invasive Species and Ecosystem Health. (2018).
Murdannia keisiak	Marsh dewflower	Chemical treatment with glyphosate (e.g. Rodeo®) labeled for wetland use may be effective if applied before seed set but it can be a challenge to control once established.	Hand pulling may be effective if done before the plant sets seed.		Plant Invaders of Mid-Atlantic Natural Areas. n.d. National Park Service and U.S. Fish and Wildlife Service
Nandina domestica	Sacred-bamboo	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.	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Paulownia tomentosa	Princess tree	**Large trees:** Make stem injections using Arsenal AC* or a glyphosate herbicide in dilutions and cut spacings specified on the herbicide label (anytime except March and April). **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.	**Resprouts and seedlings:** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC* as a 1-percent solution (4 ounces per 3-galllon mix); a glyphosate herbicide, Garlon 3A, or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix).	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Perilla frutescens	Beefsteak plant	**Foliar:** This method is effective on infestations where mechanical control is not practical or desired. Glyphosate (e.g., Accord®, Rodeo® and other products) is a non-selective systemic herbicide that is absorbed by the plant and carried to the roots, killing the entire plant. It is important to avoid contact of spray with desirable plants. Treatments should be done either in early spring when most other non-target vegetation is dormant or mid to late summer and fall when plant growth slows and resources are being sent to the roots. Refer to manufacturer's label for specific information and restrictions regarding use. In general, a 1-2% solution of glyphosate mixed with water and a non-ionic surfactant (seek manufacturer's recommendations) is used. Spray should be applied such that it thoroughly covers most of the leaves but not to the point that it is dripping off the leaves.	**Manual:** Generally speaking, most herbaceous plants can be pulled by hand as long as the entire plant including the roots is removed to prevent regrowth. This is almost always recommended for individual plants	**Mechanical:** While repeated mowing can be effective for control of some herbaceous forbs, it may not be practical for others. Mowing often needs to be conducted repeatedly and for many years to eradicate plants with significant root systems. It may be more practical and effective to use chemical methods or a combination of mowing and herbicides for difficult species.	Plant Conservation Alliance (PCA). U.S. Department of the Interior Bureau of Land Management. Herbaceous Forbs.
Persicaria longiseta	Japanese knotweed	**Foliar:** This method is effective on infestations where mechanical control is not practical or desired. Glyphosate (e.g., Accord®, Rodeo® and other products) is a non-selective systemic herbicide that is absorbed by the plant and carried to the roots, killing the entire plant. It is important to avoid contact of spray with desirable plants. Treatments should be done either in early spring when most other non-target vegetation is dormant or mid to late summer and fall when plant growth slows and resources are being sent to the roots. Refer to manufacturer's label for specific information and restrictions regarding use. In general, a 1-2% solution of glyphosate mixed with water and a non-ionic surfactant (seek manufacturer's recommendations) is used. Spray should be applied such that it thoroughly covers most of the leaves but not to the point that it is dripping off the leaves.	**Manual:** Generally speaking, most herbaceous plants can be pulled by hand as long as the entire plant including the roots is removed to prevent regrowth. This is almost always recommended for individual plants	**Mechanical:** While repeated mowing can be effective for control of some herbaceous forbs, it may not be practical for others. Mowing often needs to be conducted repeatedly and for many years to eradicate plants with significant root systems. It may be more practical and effective to use chemical methods or a combination of mowing and herbicides for difficult species.	Plant Conservation Alliance (PCA). U.S. Department of the Interior Bureau of Land Management. Herbaceous Forbs.

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Scientific name	Common name	Priority 1	Priority 2	Priority 3	References
Phragmites australis	Common reed	**Imazapyr and Glyphosate:** Apply after plants are in full bloom in late summer up to the first killing frost (i.e., late August up to first killing frost). Three pints glyphosate and three pints imazapyr per acre. High effectiness, recommended for most sites. **Imazapyr:** Apply to actively growing green foliage after full leaf elongation and up to first killing frost (i.e., June up to first killing frost). High volume: six pints per acre. Low volume: 1 - 1.5% solution. High effectiveness, allows treatment earlier in the growing season. **Glyphosate:** Apply after plants are in full bloom in late summer up to the first killing frost (i.e., late August up to first killing frost). High volume: six pints per acre. Low volume: 1 - 1.5% solution. Medium effectiveness, good results where hydrologic management is available.	**Prescribed fire:** In situations where prescribed fire can be implemented it is easier to locate phragmites regrowth and spot-treat those plants with herbicides once a site has been cleared of the thick, dead stems. In situations where it can be implemented safely and effectively, prescribed fire is a cost-effective and ecologically sound tool to help control phragmites. Prescribed fire is recommended where phragmites exists in large dense stands. Use of prescribed fire without first treating with herbicides does not control *Phragmites* , and instead may encourage rhizome growth and cause phragmites populations to become more vigorous. Prescribed fire should be conducted the year following herbicide treatment, either in late summer (mid-July through August) or winter (January until prior to spring green-up). Both options are very effective in controlling *Phragmites* and encouraging native plant growth. Prescribed fire conducted in late summer as a second-year treatment following an herbicide treatment is preferred.	**Mechanical:** Mechanical treatment should be limited to only those areas where phragmites is present, and should not include broadscale mowing of other wetland vegetation. Mechanical control of phragmites includes the use of weedwackers, small mowers, brush hogs, and flail mowers or hand-cutting of stems and seed heads. The use of mechanical equipment is highly dependent on the size and wetness of the site and the density of phragmites. Handheld cutting tools are ideal for use on wet or dry sites with low plant densities. Small mowers can be used effectively on low density sites. Larger mowers can be used on sites with a higher density of plants, but the site must be dry enough to support the weight of the mower in order to avoid soil disturbance. Mechanical treatments should not occur until at least 2 weeks after herbicide treatment to allow plant absorption of the herbicide. To remove dead stems on dry sites after an herbicide treatment,mechanically cut the treated plants once within a period from late summer or fall until prior to spring green-up. On wet sites, mechanically cut the treated plants once when the ground is frozen to minimize soil disruption. Mowing/cutting should occur only during time frames that will avoid soil disturbance. Once an area has been mowed or cut, thatch should be raked, bagged and disposed of in an appropriate location to prevent seed spread and to allow sunlight to reach the soil surface. This ensures that the native seed bank will have an advantage during the subsequent growing season. Use of a flail-type mower can eliminate the need for thatch removal, since it will destroy most plant parts adequately.	Avers et al., n.d. A Guide to the Control and Management of invasive *Phragmites* . Michigan Department of Environmental Quality, Water Bureau, Aquatic Nuisance Control.
Pueraria montana var. *lobata*	Kudzu	Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant: July to October for successive years when regrowth appears—Tordon 101* ǂ as a 3-percent solution (12 ounces per 3-gallon mix) or Tordon K* ǂ as a 2-percent solution (8 ounces per 3-gallon mix), either by broadcast or spot spray—spraying climbing vines as high as possible. July to September for successive years—Escort* at 3 to 4 ounces per acre in water (0.8 to 1.2 dry ounces per 3-gallon mix)—or when safety to surrounding vegetation is desired, Transline† as a 0.5-percent solution in water (2 ounces per 3-gallon mix); spray climbing vines as high as possible or cut vines that are not controlled after herbicide treatment.	For partial control, repeatedly apply Garlon 4 or a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant during the growing season. Cut large vines and immediately apply these herbicides to the cut surfaces. 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 large vines as a basal spray (January to April), which controls vines less than 2 inches in diameter.		Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Phylostachys aurea	Asiatic bamboo	Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (September or October with multiple applications to regrowth): Arsenal AC* as a 1-percent solution (4 ounces per 3-gallon mix), a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix), or combination of the two herbicides.	Cut just above ground level and treat stems immediately with a doublestrength batch of the same herbicides or herbicide mixture.		Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Pyrus calleryana	Callery pear	**Cut Stem Method:** This method is useful in areas where the trees need to be removed from the site and will be cut as part of the process. This method is likely to be most successful during the growing season, with diminishing success through the early fall. Dormant season applications may prevent resprouting from the stump itself, but will do little to inhibit root suckering. However, at any time of year, if the tree must be cut it is better to treat the stump than not. Cut trees near ground level and immediately apply a 25% solution of glyphosate mixed with water or 20% Garlon® 4 plus 80% oil dilutant, to the whole cut stump surface and the sides to the ground line. As with basal bark, a dye added to the mix will help keep track of treated plants. The mixture may be painted on with a paint brush or sprayed on using a spray bottle or backpack sprayer. Application of herbicide to the cut stumps must be conducted immediately after cutting, within 5-15 minutes of the cut with water soluble formulations, longer with oil mixtures, to ensure uptake of the chemical before the plant seals the cut area off.	**Foliar:** Because this method involves applying herbicide mix to foliage (leaves), it should be considered for small dense infestations or for large infestations where the risk to non-target species is minimal. Limitations of the method are the seasonal time frame. It is typically more effective in summer and late season when plants are shifting resources downward to roots. For most plants, use a 2% rate of glyphosate mixed with water and a small amount (0.5%, or as per label) of a non-ionic surfactant (except for Roundup®, which contains a surfactant) to help the spray spread over and penetrate the leaves. A 1.5% rate (4 lb./gal.) triclopyr (Garlon® 4) can also be used in this way. The mixture should be applied to leaves and green stems, including sprouts and suckers, until thoroughly wet but not to the point of runoff. Use a low pressure and coarse spray pattern to reduce spray-drift damage to non-target species. To avoid drift, applications should be made when winds are below about 8 mph. If desirable trees are nearby, a no-spray buffer area should be established to protect non-target plants. Foliar application can be done almost anytime as long as air temperature is above about 65°F (and no higher than 85°F for triclopyr) to ensure absorption of the herbicide. To allow ample drying, applications should be made when rain is unlikely for about 12 hours after application and leaves should be dry prior to treatment. Wind speed should be below 8-10 mph to avoid off-site drift.	**Hack-and-squirt or injection:** This method can be very effective and is useful when target trees are mixed in with desirable trees. it requires using a hand axe to make downward-angled cuts into the sapwood around the tree trunk and squirting about a teaspoon of concentrated herbicide into the cut.	UGA Center for Invasive Species and Ecosystem Health. (2018).
Reynoutria japonica	Japanese knotweed	**Cut stem application**: Use this method in areas where plants are established within or around non-target plants or where vines have grown into the canopy. This treatment remains effective at low temperatures as long as the ground is not frozen. Cut the stem about 2 inches above ground level. Immediately apply a 25% solution of glyphosate (e.g., Roundup®, or use Rodeo® if applying in or near wetland areas) or triclopyr (e.g., Garlon®) and water to the cross-section of the stem. A subsequent foliar application of glyphosate may be require to control new seedlings and resprouts.	**Foliar application:** Use this method to control large populations. It may be necessary to precede foliar applications with stump treatments to reduce the risk of damaging non-target species. Apply a 2% solution of glyphosate or triclopyr and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. A 0.5% non-ionic surfactant is recommended in order to penetrate the leaf cuticle, and ambient air temperature should be above 65 °F.	Grubbing is effective for small initial populations or environmentally sensitive areas where herbicides cannot be used. Using a pulaski or similar digging tool, remove the entire plant including all roots and runners. Juvenile plants can be hand pulled depending on soil conditions and root development. Any portions of the root system not removed will potentially resprout. All plant parts (including mature fruit) should be bagged and disposed of in a trash dumpster to prevent reestablishment.	Remaley, T. (2005). Fact Sheet: Japanese Knotweed. Plant Conservation Alliances Alien Plant Working Group.

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Rosa multiflora	Multiflora rose	Thoroughly wet all leaves with one of the following herbicides in water with a surfactant: April to June (at or near the time of flowering)—Escort* at 1 ounce per acre in water (0.2 dry ounces per 3-gallon mix); August to October—Arsenal AC* as a 1-percent solution (4 ounces per 3-gallon mix) or Escort* at 1 ounce per acre in water (0.2 dry ounces per 3-gallon mix); May to October—repeated applications of a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix), a less effective treatment that has no soil activity to damage surrounding plants.	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* 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).		Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Sorghum halepense	Johnson grass	Glyphosate: 6.5 oz-2.25 lb a.e./acre in a minimum 3-gallon volume; 6 lb a.e. max/season/acre. Do not chemigate. Uniform coverage of weeds is needed for control. Do not till until 3-7 days after application.	Fluazifop: 2-6 oz a.i./acre in a minimum 5-gallon colume; refer to label for maximum rate by crop. Do not overhead irrigate or 1 hour after appplication. Best results if applied within 7 days of irrigation. Most effective on actively growing plant; apply before johnsongrasses reaches boot stage.	Clethodim: 1.5-4 oz a.i./acre in a 5- to 40-gallon volume; 8 oz a.i. max/acre/season. Tillage or sultivation to gragment rhizomes prior to spraying is recommended. Two or more applications will likely be needed for best control. Respray after 14 days.	Ceseski, A., Kassim, A., and Dahlberg, J. A. (2017). Biology and Management of Johnsongrass (Sorghum halepense). University of California Agriculture and Natural Resources.
Vinca minor	Greater periwinkle	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.		Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.
Wisteria sinensis	Chinese wisteria	July to October for successive years when regrowth appears - 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)	July to September for successive years when regrowth appears— Transline* † as a 0.5-percent solution in water (2 ounces per 3-gallon mix) when safety to surrounding vegetation is desired	September to October with repeated applications—a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix)	Miller, J. H. (2003). Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. United States Department of Agriculture.

*Nontarget plants may be killed or injured by root uptake.
†Transline controls a narrow spectrum of plant species.
‡When using Tordon herbicides, rainfall must occur within 6 days after application for needed soil activation. Tordon herbicides are Restricted Use Pesticides.