

EXOTIC PLANT MANAGEMENT PLAN

**BLUE RIDGE PARKWAY
NATIONAL PARK SERVICE**

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I. INTRODUCTION

The legislated purpose of the Blue Ridge Parkway under the Act of June 30, 1936, is to link Shenandoah National Park in Virginia with Great Smoky Mountains National Park in North Carolina and Tennessee by way of a recreationally oriented motor road. Inherent with this legislation and in the subsequent planning of the Parkway is a fundamental objective of providing opportunities to enjoy the scenic beauty of the Southern Appalachian Mountains. Parkway management further promotes public understanding, appreciation and knowledge of Appalachian region by preserving and managing the natural, historic and cultural resources contained within Park lands. The National Park Service is mandated to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations. Furthermore, the natural resources policies of the park service are "...to maintain, rehabilitate, and perpetuate their inherent integrity" (USDI, 1991).

The presence and spread of exotic plant species is a significant concern to park management. (The term "exotic" is defined as "a species occurring in a given place as a result of direct or indirect, deliberate, or accidental actions by humans" (USDI 1991) and is used synonymously with "alien", "non-native" and "introduced"; see definitions below). Many exotic plants are ecologically harmful. They can alter the natural and/or historic scene and impair the natural function of many native plant communities.

Background

Non-native or exotic plants pose a significant hazard to the native flora of the Blue Ridge Parkway. The flora of the Blue Ridge Parkway includes at least 60 exotic species, most of which entered the park and became established within the past 100 years. In particular, shade tolerant and highly invasive species present the greatest risks; these aggressive exotic plants are the target of management. Fortunately, only a small proportion of the lengthy list of non-native plants fall into this category, the majority being "lawn weeds" that are restricted to the road banks and mowed margins of the Parkway. There is potential for many more exotic plant species to enter the park in the future, and for present populations to increase in number, area covered and density. As new species are discovered this management plan will be amended.

During the past 20 years, only incidental attention has been given to control and eradication of exotic (non-native) plant species within the Blue Ridge Parkway and in the Southern Appalachian region. Several species have spread vigorously due to this lack of attention. Dense jungles of kudzu (*Pueraria lobata*), Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), Oriental bittersweet (*Celastrus orbiculatus*), Japanese spiraea (*Spiraea japonica*) and plume grass (*Miscanthus sp.*) to name a few, now exist in many locations in the park. Princess tree (*Paulownia tomentosa*) and tree of heaven (*Ailanthus altissima*) have invaded many disturbed sites, including cut and fill slopes formed during Parkway construction and perpetrated through vista clearing and maintenance activities.

Importance

Exotic plant management is a necessary part of NPS responsibility to protect our natural heritage. An exotic plant management program requires both a guiding plan and long-term, steadfast commitment. Short-term lapses can allow populations of invasive species to expand quickly and to negate previous control efforts. The threat of exotic species will not disappear. The keys to successful control are a systematic approach and consistent follow-up. Anything less will only provide the park with knowledge of an increasing problem.

Managing and preserving natural resources along a 469-mile ribbon of land with some 1,000 miles of boundary is extremely difficult. Because of its linear character, Parkway lands are susceptible to invasion by exotic plants from adjacent lands. With thousands of “cut and fill” slopes, approximately 960 vista openings and more than 1,000 utility and roadway crossings, the Parkway contains an unusually large number of “disturbance” habitats for exotic plant species. In addition, winter storms and occasional tropical storms can cause significant damage to the forest canopy; these disturbances provide opportunities for exotic plants to become established. The dispersal methods of exotics include wind, birds, mowing equipment, domesticated livestock, small mammals, and hiker’s boots. The full extent of many exotic species is unknown as is their impact on native flora and fauna.

The more than 5,000 adjacent landowners hold many different beliefs about the importance of protecting native vegetation as well as their role in helping the National Park Service manage exotic plant species. Many simply do not know the difference between exotic and native plants; others do not have the time, money or interest to devote to management of plant species in wooded areas or open fields. Through education and working cooperatively with adjacent landowners will effective management of exotic plants be achieved?

This management plan provides guidance to park personnel on the treatment of exotic, invasive plants. This plan does not address non-native pests (gypsy moth, hemlock woolly adelgid) and diseases (sudden oak decline), nor does it address non-native animals (fire ant, starlings, zebra mussel).

CONTROL OF AN EXOTIC PLANT SPECIES IS A LONG-TERM COMMITMENT SINCE NON-NATIVES ARE PROLIFIC SEED PRODUCERS AND OFTEN BECOME WELL ESTABLISHED IN AN AREA WITHIN ONE OR TWO YEARS. MANY OF THESE SPECIES ALSO HAVE LONG SEED VIABILITY, FURTHER ENHANCING

II. BLUE RIDGE PARKWAY POLICY

A. Definitions

Native Species: A species that occurs and evolves naturally without human intervention or manipulation. Species that move into an area without the direct or indirect aid of humans are considered native by NPS definition (NPS Management Policies 2001, p34).

Exotic Species: A species occurring in a given place as a result of direct or indirect, deliberate or accidental actions by humans (NPS Management Policies 2001, p34). Some exotic plants aggressively invade natural areas, thus are called invasive exotics.

Historic cultivars: Varieties of domestic, ornamental or crop plants which may be genetically or morphologically distinct from the common contemporary varieties, were present in historic districts during periods of significance, and have been used historically.

Integrated Pest Management (IPM): The selection, integration, and implementation of pest management methods based on predicted economic, ecological, and sociological consequences. It can also be defined as a decision-making process which helps one decide if a treatment is necessary and appropriate, where the treatment should be administered, when treatment should be applied, and what strategies should be integrated for immediate and long-term results (NPS 2001).

Adaptive Management: A system of management practices based on clearly identified outcomes, monitoring to determine if management actions are meeting outcomes, and, if not, facilitating management changes that will best ensure that outcomes are met or to re-evaluate the outcomes.

A. Introducing new exotic plant species

In accordance with an executive order signed in 1999 (Executive Order 13112) the following guidelines will be used:

In general, new exotic species will not be introduced into the park. In rare situations, an exotic species may be introduced or maintained to meet specific, identified management needs when all feasible and prudent measures to minimize the risk of harm have been taken, and it is:

- A closely related race, subspecies, or hybrid of an extirpated native species; or
- An improved variety of a native species in situations in which the natural variety cannot survive current, human altered environmental conditions; or used to control another, already established exotic species; or
- Needed to meet the desired condition of a historic resource, but only where it is prevented from being invasive by such means as cultivating. In such cases, the exotic species used must be known to be historically significant, to have existed in the park during the park's period of historical significance, or to have been commonly used in the local area at that time; or
- An agricultural crop used to maintain the character of a cultural landscape; or
- Necessary to provide for intensive visitor use in developed areas, and both of the following conditions exist:
 - o Available native species will not meet park management objectives; and
 - o The exotic species is managed so it will not spread or become a pest on park or adjacent lands; or

- A sterile, non- invasive plant that is used temporarily for erosion control; or
- Directed by law or expressed legislative intent.

In road shoulders, access ramps, agricultural leases and other developed areas, old standard, non-native grass species may be used to carry out stabilization programs. Chervings fescue is the standard grass cover for Parkway shoulders and lawns. Kentucky-31 fescue is the standard grass cover for slopes.

Fill used in construction projects and other materials likely to transport exotics should be as free as possible of exotic plant propagules. Any outside sources of such material should be selected with care. **EXOTIC SPECIES SUCH AS LESPEDEZA, CROWN VETCH, RED CLOVER, ETC. SHOULD NOT BE PLANTED IN ANY AREAS OF THE PARKWAY.**

III. MANAGEMENT STRATEGIES

The management of exotic plants can be subdivided in categories or objectives.

- Prevent Invasion
- Increase Public Awareness
- Inventory and Monitor Exotic Plants
- Conduct Research
- Manage Invasive Exotic Plants

A. Prevent Invasion

Preventing the introduction of exotic plants is the first line of defense in protecting ecosystems from degradation. It is also the most economical and efficient means of management. The park prevention program must have both internal and external components. The park must prevent introduction of exotic plants onto park lands and work with partners to develop regional and local prevention strategies.

Preventing exotic plant introduction requires constant vigilance. Seeds of exotic plants arrive in the park on the tires of cars, buses, trucks, bicycles, and even on shoes. Exotic seeds attach to the fur or feathers of wildlife and pets that routinely move in and out of the park. Plant materials such as native grasses or earth fill material brought in to revegetate disturbed ground or for other valid management reasons can contain the seeds of exotic plants. Physical forces such as wind and water also transport seeds and other parts of exotic plants.

The following measures will help prevent or mitigate accidental introductions:

- Before disturbing any native ecosystems, either through construction or management activities such as prescribed burning, identify the exotic species likely to invade the disturbed areas, take measures to prevent such invasion, and assess those measures through the environmental compliance process.

- Fill used in construction projects, feed for pack stock, and other materials likely to transport exotics should be as free as possible of exotic plant propagules.
- Control exotic species established on neighboring lands before they become established in the park. This approach is feasible when the populations are localized and neighbors are cooperative.
- Develop an early warning system to identify and eradicate new infestations of exotics in the park.
- Create a park-based list of plant species that have not yet invaded the park but that are known to occur in the region and are likely to invade.
- Cooperate with other regulatory agencies in expediting listing of invasive exotic plants on state and federal noxious plant lists.
- Use locally-grown native plant materials in all appropriate vegetation projects in order to maintain genetic integrity of local species.

B. Increase Public Awareness

For any prevention or management effort to be successful, the public must understand the threats posed by exotic plant species, change behavior that results in the spread of exotic plants, and provide support for management efforts. In order to increase public awareness of invasive exotic plant threats and build support for the park's efforts the following actions are needed:

- Create and disseminate educational materials that increase awareness of, understanding of, and support for the full range of exotic plant management activities. Such materials could be displayed in park visitor centers and wayside exhibits, and also used in the parks-as-classrooms interpretive program.
- Participate in local area field days and other meetings oriented toward exotic plant management.
- Cooperate with other agencies to develop and distribute educational material to the public.

C. Inventory and Monitor Exotic Plants

Early detection and treatment of new infestations of invasive exotic plants is an effective and ecologically sound management approach. Surveys or inventories provide baseline information on presence, distribution, and size of extant exotic plant populations. Regular monitoring will spot exotic plant encroachments in time to take effective action and can be used as a tool to measure the effectiveness of management efforts. Baseline information important for making decision includes species identification; locations of infestations; acreage infested; density of plants; general plant community makeup and presence of rare native plants; environmental conditions such as soils, slopes, and proximity to surface or groundwater; and level of disturbance and current land use. To achieve this objective the following actions are needed:

- Develop remote sensing and GIS technologies for detecting and monitoring exotic plants.
- Ensure that site-specific monitoring is included in plans for construction, habitat manipulation, and other activities that might increase the risk of exotic plant infestations.

- Inventory or inspect high-risk areas to detect new invasions. These areas include construction sites and other disturbed areas, roads, trails, livestock holding areas, and streams that enter the park.
- Monitor control programs to assess not only the reduction of the targeted plant, but also the maintenance or restoration of native vegetation and fauna.

D. Conduct Research

Ecological understanding is essential for successful adaptive and integrated management of invasive exotic plants. Individual plant species respond to a particular environmental condition based upon life history, special adaptations, and ranges of tolerances. Management priorities need to be based upon ecological criteria and the feasibility of control. To set these priorities, managers need sound scientific information, including information on dispersal, the life history of specific species, and the ecological effects of specific exotic plants. Under the principles of adaptive management, new management techniques should be treated as experimental and evaluated and adjusted accordingly. Working together, scientists and resource managers must gather sound scientific information, use the information to develop management techniques, monitor the results of the management activities, determine if clearly stated objectives are being met, and modify activities as indicated. To achieve this objective the following actions are needed:

- Classify exotic plants based on potential impacts to ecosystem.
- Develop case histories of highly invasive exotic plants that elucidate characteristics of invasiveness.
- Develop models to predict invasive exotic plants.
- Conduct studies of invaded and non-invaded habitats to determine characteristics of vulnerable habitats.
- Work with cooperating agencies to identify key corridors of invasion and transporters of exotic plants.
- Support research and testing of new biological control agents and development of biological control technologies.

E. Control Invasive Exotic Plants

Exotic plant control is complex because each target species requires a different monitoring and control strategy. Long-term or even permanent management commitments and consistent follow-up are essential to successful exotic plant control programs. Persistent seed banks and long-lived seeds often require control efforts over many years to eradicate exotic plants in a park, even if the species are quite localized.

Herbicides are frequently needed to control exotic plants because of the ineffectiveness or unavailability of biological control agents and the inapplicability of mechanical and cultural control methods in native systems. Biological control agents are available for only a few exotic plant species, and the research required to locate and test potential biological control agents is

costly. Most woody exotic plant species resprout from the cut stump, root crown, or roots when cut or disturbed without the application of herbicides.

Native plants may need to be planted or encouraged in those areas from which exotic vegetation has been removed. Exotic plants, as natural weedy invaders, usually colonize sites from which dense stands of exotic plants have been removed.

There are several common errors made in developing approaches to exotic plant control. One is the failure to prepare sufficiently detailed and accurate distribution maps prior to treatment. Without such maps, the scope of the project will not be accurately evaluated at the outset and populations will not be accurately treated. Another common failure is insufficient testing of treatment methods, particularly herbicides. Many woody plants are capable of resprouting as much as 12-18 months after treatment. Some plants can be very resilient and difficult to kill. A frequent error in cut-stump treatments is the failure to apply herbicide to stumps immediately after cutting. Plants vary greatly in their sensitivity to different herbicides, and a wide range of chemical controls may need to be tested to find an effective one. The label may be a partial guide to finding an effective herbicide. Only a few plant species are mentioned on labels. Plants which show sensitivity to an herbicide by the loss of leaves or the death of aerial portions may resprout. A common error is to increase the rate or concentration of herbicide. Often reduced rates of application or concentrations of these herbicides can be more effective because translocation is enhanced prior to the loss of physiological function. Higher rates may burn off leaves and reduce translocation. Poor timing of application can also reduce the effectiveness of herbicides and can increase the impact on nontarget plants.

IV. PRIORITIZING EXOTIC PLANT TREATMENT

The sheer magnitude of work required to manage exotic plants coupled with limited resources to devote to the problem resulted in a need to prioritize where treatment efforts will occur. A 3-tiered approach will be utilized to prioritize exotic plant management. The park is subdivided into units called Significant Ecological Area (SEA). The boundary of each SEA is subject to modification as new information becomes available. Each SEA represents a combination of the amount of significant natural resources, and propagule pressure from surrounding lands. Work in each SEA will entail a rapid assessment of the occurrence and abundance of exotic plants followed by a strategy for control and management, which is then followed by post-treatment evaluation.

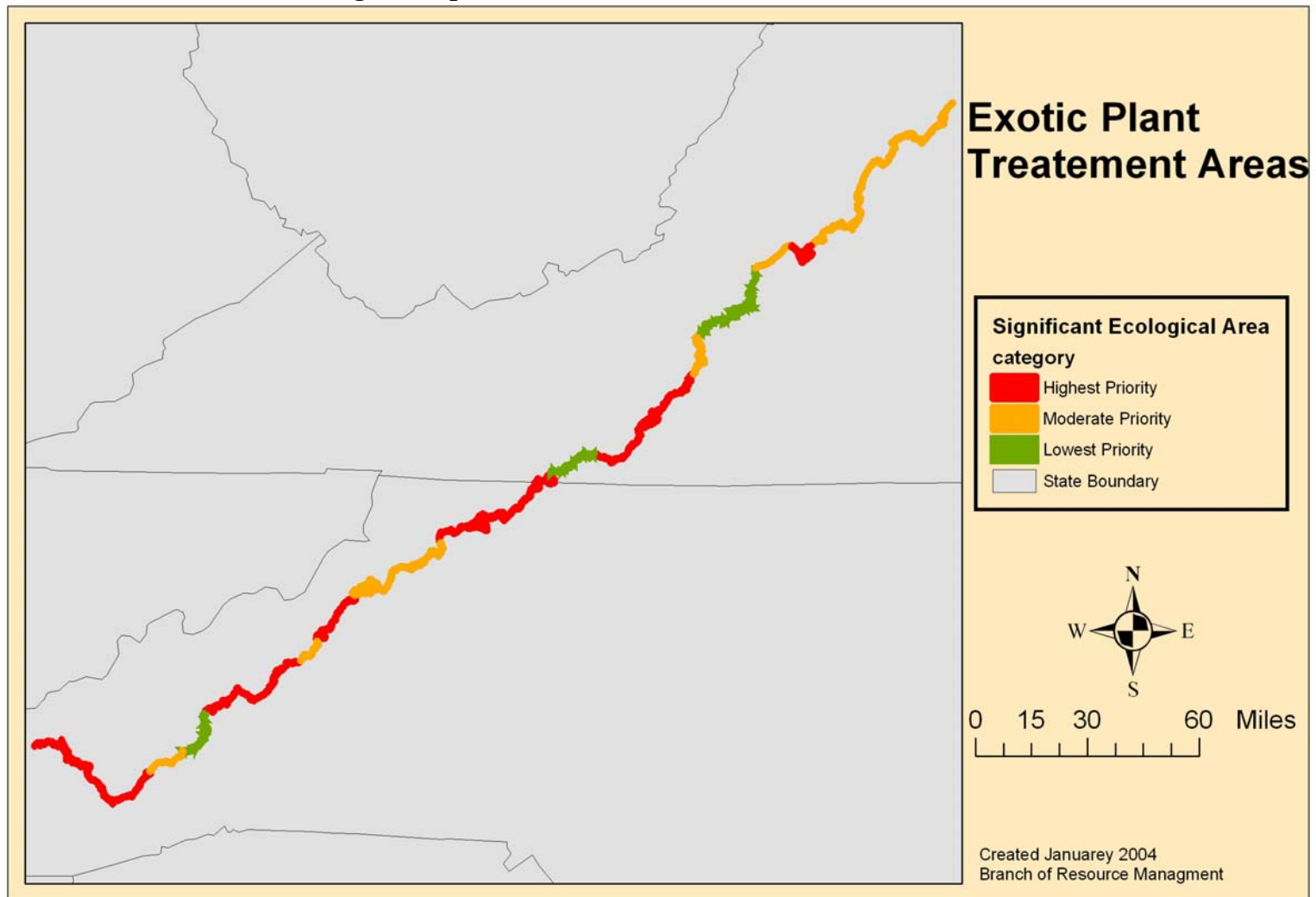
- **SEA I (HIGHEST)** – Sites with greatest amount of significant natural resources and the lowest pressure of propagules from surrounding lands, e.g., Devils Courthouse.
- **SEA II (MODERATE)** – Sites with fewer significant natural resources but surrounded by lands perceived to have few propagules, e.g., NPS lands surrounded by undeveloped land such as USFS.
- **SEA III (LOWEST)** – Sites with even fewer significant natural resources and surrounded by developed land presenting high propagule pressure from exotic plants, e.g., Asheville Basin.
-

Work will begin in **SEA I** areas; subsequent **SEA's** will be implemented only after exotic plants have been eradicated or controlled from the previous **SEA's**, i.e., **SEA II** areas will be treated only after **SEA I** areas have been successfully treated.

Table 1. Acreage and location of prioritized significant ecological areas.

SEA	Total Acreage	Milepost locations
Highest Priority SEA	51,695 acres	82-90, 149-195, 210-260, 300-320, 330-377, 408-469.
Moderate Priority SEA	8,186 acres	0-82, 90-103, 136-149, 260-300, 320-330, 393-408.
Lowest Priority SEA	30,712 acres	103-136, 195-210, 377-393.

Figure 1. Prioritized areas for treating exotic plants.



V. MANAGEMENT AND TREATMENT OF EXOTIC PLANTS

The steps involved in successful treatment of exotic plants include: conduct an initial survey of significant ecological area, develop a plan of work, pre-treatment activities, conduct treatment, and post-treatment activities (see figure 2). Each of these steps will be described.

A. Initial Survey of SEA

In this first step, a rapid assessment of what exotic plants are present, their abundance level, and where they are located are needed. This initial survey is not intended to be an exhaustive search for all exotics in a given SEA, but rather to identify hotspots where treatment is needed. The rapid survey often identifies large bodies of exotics and where the leading edge of the invasion occurs at a coarse level.

At locations in the park where the boundary is narrow and linear, rapid assessments can be made at every milepost. In places where the park boundary is relatively wide, such as at Peaks of Otter, Doughton Park, etc. a sampling grid is needed. At each sampling point a list of exotic plants occurring within a 50 m radius circular plot is recorded, as is estimated abundance, reproductive status, and habitat type.

B. Develop Plan of Work

The information gained from the rapid assessment survey is then used to develop a plan of work. The plan of work can be area-specific or it can encompass all work scheduled parkwide over a specified length of time. Revision of the plan of work will be done as needed as part of an adaptive management philosophy. Each plan of work will consider the location of rare and sensitive species in areas where exotic plant treatment is needed. If rare and sensitive species are present in an area, then measures will be taken to minimize any adverse effects. The various treatment options will be considered and formulated to account for site particularities, presence of rare and sensitive species, and the exotic plants being targeted. Resource needs will be determined and scheduled into workplans.

C. Pre-treatment Activities

On the ground pre-treatment activities involve detailed recognizance of targeted exotic plants, mapping and georeferencing target patches, photo documentation of pre-treatment conditions, and quick assessment of exotic abundance in target patches. The previous two steps identified where work is to occur. This step provides further detail of the work to be performed in a given year/season. Treatment crews need to focus on treatment and not looking for exotic plants, therefore, a search for patches of exotics are needed prior to treatment. As each patch is encountered the following data will be recorded: exotic species, location (GPS point/polygon), patch size, abundance level, and any logistical considerations. If possible, photo documentation of pre-treatment condition will also be obtained. The patch locations will be cross-referenced with known rare and sensitive species locations. If during the recognizance survey likely

habitats for rare species are observed then NPS specialists will be enlisted to conduct rare species surveys.

D. Conduct Treatment

There are several options available for treating exotic plants. Treatment methods can be categorized as mechanical or chemical. Biological control methods will be incorporated into this plan as information becomes available.

The use of **mechanical methods** involves using hand and/or power tools to dig, pull, and cut plants. Some methods may occur once, such as pulling garlic mustard, or repeatedly, such as continuously cutting multiflora rose until the plants energy reserves have been exhausted. When exotic populations are relatively small or the site contains sensitive resources then mechanical methods are viable treatment options.

The use of **herbicide chemicals** to treat and control invasive exotic plants is a viable treatment options when the target population is large. Herbicides may be applied only by personnel trained and certified in application or under the DIRECT supervision of state-certified personnel.

Herbicide can be applied using three methods: foliar application, cut surface application, and basal bark application.

Foliar Spray applications involve spraying green foliage with herbicide. Herbicides used for foliar application are mixed at low concentrations (typically 2% by volume) and are always mixed with water, though a surfactant may be added to increase absorption on species with waxy leaves. Foliar applications are made with a low pressure (20-50 psi) backpack sprayer at rates of one gallon or less per minute. All foliar treatments are made after full leaf expansion in the spring and before fall colors are visible. Allow herbicide treatments to dry for at least three hours at an air temperature above 60°F to ensure adequate absorption and translocation. In areas that receive significant public use, it may be necessary to close off the treatment area until the herbicide has completely dried. Herbicide is applied with a backpack or similar hand-operated pump sprayer equipped with a flat spray tip or adjustable cone nozzle. Herbicide is applied to the leaves and stems of target plants using a consistent back and forth motion. Herbicide should thoroughly cover foliage, but not to the point of run-off. All recommended herbicides require complete foliar coverage to be effective. Applications made while walking backward reduce the risk of the herbicide wicking onto the applicator's clothing.

Cut Surface applications include hack and squirt, girdle, and cut stump methods. Cut stump are usually mixed at higher concentrations (10-50% by volume) and mixed with either water or agricultural oil. The main advantages to these methods are: 1) they are very economical, 2) there is minimal probability of non-target damage, 3) minimal application time, and 4) they can be used in the winter as long as the ground is not frozen. Backpack sprayers or spray bottles are very effective for all of these methods.

Hack and Squirt Method: Using an axe or similar cutting tool, make uniformly spaced cuts around the base of the stem. The cuts should angle downward, be less than 2.5 cm (1 in) apart, and extend into the sapwood. **Apply herbicide to each cut to the point of over flow.** **Frill Method:**

Using an axe or similar cutting tool, make continuous cuts around the base of the stem. The cuts should angle downward, be less than 2.5 cm (1 in) apart, and extend into the sapwood. Apply the recommended herbicide to the entire cut area to the point of over flow. Cut Stump Method: Horizontally cut stems at or near ground level; all cuts should be level, smooth, and free of debris. Immediately apply the herbicide to the outer 20% (cambial area) of the stump; delayed treatment may reduce the effectiveness of treatment.

Basal bark applications involve applying herbicide to the bark of uncut stems at ground level. Basal bark applications are usually mixed at higher concentrations (10-50% active ingredient) and mixed with either water or vegetable oil. This method is used on species that sprout prolifically if the stem is cut (such as Tree of Heaven, or Princess Tree). A variant of this method is injecting stems/trunks with a small dose of herbicide. A device called EZ-Ject Lance is used to implement this method. Basal bark treatments are effective for controlling woody vines, shrubs, and trees. Treatments can be made any time of year, including the winter months, except when snow or water prevents spraying the basal parts of the stem. Proper plant identification is crucial during the dormant season due to the absence of foliage. Herbicide is applied with a backpack sprayer using low pressure (20-40 psi) with a straight stream or flat fan tip. To control vegetation with a basal stem diameter of less than 7.6 cm (3.0 in) apply specified herbicide-oil mixture on one side of the basal stem to a height of 15.25 cm (6 in) from the base. Herbicide is applied to the point of run-off; within an hour mixture should almost encircle the stem. For stems greater than 7.6 cm (3.0 in) basal diameter or with thick bark, treat both sides of the stem to a basal height of 30.5 cm (12 in) to 61 cm (24 in).

A non-toxic marking dye, which aids in detecting areas already treated, is typically mixed with the chemical in all three methods.

The primary herbicides that would be used to treat exotic plants are:

- glyphosate (Roundup™, Accord™, Rodeo™),
- triclopyr (Garlon 3A™, Garlon 4™, Ortho Brush B-Gon Brush Killer™),
- clopyralid (Transline™),
- metsulfuron methyl (Escort™)

Glyphosate is used to control grasses, herbaceous plants including deep rooted perennial weeds, brush, some broadleaf trees and shrubs, and some conifers. Glyphosate does not control all broadleaf woody plants. Timing is critical for effectiveness on some broadleaf woody plants and conifers. Glyphosate applied to foliage is absorbed by leaves and rapidly moves through the plant. It acts by preventing the plant from producing an essential amino acid. This reduces the production of protein in the plant, and inhibits plant growth.

Triclopyr is used to control woody plants and broadleaf weeds. Triclopyr acts by disturbing plant growth. It is absorbed by green bark, leaves and roots and moves throughout the plant. Triclopyr accumulates in the meristem (growth region) of the plant.

Clopyralid is used to control brush and weed species including mesquite, acacias, other broadleaf plants, thistle, perennial sow-thistle, coltsfoot, and many weeds. Clopyralid is absorbed by the

leaves and roots of the weed and moves rapidly through the plant. It affects plant cell respiration and growth.

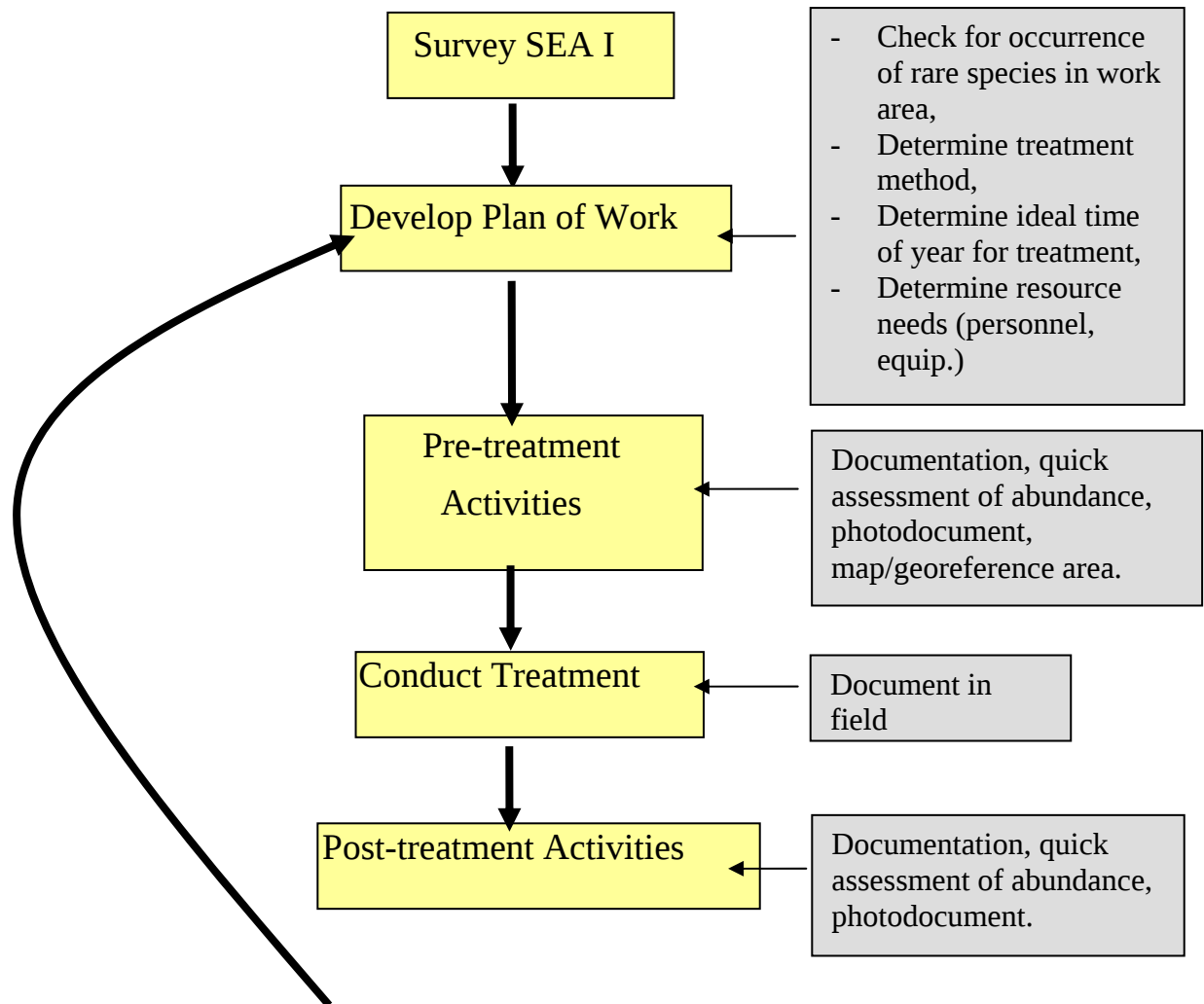
Metsulfuron methyl is used to control brush and certain unwanted woody plants, annual and perennial broadleaf weeds, and annual grassy weeds. Metsulfuron methyl is absorbed through the roots and foliage and moves rapidly through the plants. It inhibits cell division in the roots and shoots, which stops growth.

To avoid impacting non-target vegetation, herbicides can be applied when the native flora is dormant or in the case of cut stump or basal bark, herbicide can be applied with sufficient precision. All herbicides will be applied in accordance with specific label instructions, which include personal protective equipment and storage requirements. Surveys and existing park records will be used to identify the presence of rare species prior to any treatment method.

E. Post-treatment Activities

The effectiveness of treatment will be determined through post-treatment evaluation. The successfulness of treatments will be considered and the work plan revised accordingly.

Figure 2. Typical workflow for treatment of exotic plants.



VI. LEGAL AND COOPERATIVE AUTHORITIES

This Plan is written within the framework of existing legal and administrative guidelines, including:

- Blue Ridge Parkway enabling legislation;
- General Management Plan (draft)
- Code of Federal Regulations
- NPS Policies 2001
- NPS-77, Natural Resources Management Guidelines.

List of regulations and authorities

- o Executive Order 13112 of February 3, 1999, on Invasive Species Management
- o 1998 CFR Title 7, Volume 5 Chapter III-Animal and Plant Health Inspection Service
Dept. of Agriculture Part 330 Federal Plant Pest Regulations, General ; Plant pests; Soil,
Stone and Quarry products; Garbage Basis
- o Federal Plant Pest Regulations, 7CFR part 330, Subpart-Movement of Plant Pests
330.200-330.212
- o National Wildlife Refuge System Improvement Act of 1997
- o The Federal Insecticide, Fungicide, and Rodenticide Act of 1947, as amended by the
Food Quality Protection Act 1996
- o Invasive Species Act of 1996
- o Federal Plant Pest Act, amended 1994
- o Presidential Memorandum on Environmentally Beneficial Landscaping of April 26, 1994
- o Environmental Leadership Executive Order 13148 section 704 on Federally Landscaped
Executive Order 13148, 49, 50
- o 16 U.S.C. 4701 et. seq. Non-indigenous Aquatic Nuisance Control Act of 1990.
- o 42 U.S.C. 9601-9675, The Comprehensive Environmental Response, Compensation and
Liability Act of 1980 as amended
- o Presidential Memorandum of August 2, 1979 directing all federal agencies to implement
Integrated Pest Management
- o 42 U.S.C. 6901-6992, The Resource Conservation and Recovery Act of 1976 as amended
- o Toxic Substances Control Act of 1976
- o 7 U.S.C. 2801 et seq. Federal Noxious Weed Act of 1974
- o Endangered Species Act of 1973
- o Control and Eradication of Plant Pests
- o National Historic Preservation Act
- o Occupational Health and Safety Act 1970
- o The National Environmental Policy Act of 1969, as amended
- o National Wildlife Refuge System Administration Act of 1966
- o Fish and Wildlife Act of 1956
- o 1955 Clean Air Act
- o 1948 Federal Water Pollution Control Act (also known as the Clean Water Act)
- o The Lacey Act 1900, as amended

- o Fish and Wildlife Coordination Act of 1934
- o Organic Act (1944)
- o Animal Damage Control Act of 1931
- o Plant Quarantine Act of 1912

National Environmental Policy Act (42 USC 4321-4370d). Pest management actions must be addressed in the form of a memo to the file, categorical exclusion, environmental assessment, or environmental impact statement. For further details, refer to Director's Order #12: Conservation Planning, Environmental Impact Analysis and Decision-making, and its accompanying handbook, and to Director's Order #28: Cultural Resources Management, and its accompanying guideline.

Endangered Species Act, Section 7 Consultation (16 USC 1536). If pest management actions may affect federal or state-listed rare, threatened, or endangered species or critical habitat, the Regional Endangered Species Coordinator must be contacted to determine whether a Section 7 consultation with U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) will be necessary.

National Historic Preservation Act, Section 106 Consultation (16 USC 470g). Environmental analysis also includes an evaluation of the impact on cultural resources if cultural resources may be impacted. The regional cultural resources staff will be contacted to determine whether formal section 106 consultation with the State Historic Preservation Office is necessary.

Migratory Bird Treaty Act (16 U.S.C. § 703-712) (MBTA). The act is the domestic law that implements the U.S. commitment to four international conventions (with Canada, Mexico, Japan, and Russia) for the protection of migratory birds. While the U.S. has signed specific agreements with these other countries to protect migratory birds and their habitats, the authority of the MBTA includes birds that migrate across many other international boundaries. The species protected by the MBTA are listed in 50 CFR § 10.13. If pest management actions may result in take or harassment of migratory birds, the regional or national migratory bird coordinator should be contacted.

Section 7 Endangered Species Consultation (16 USC 1536). If pest management actions may affect federal or state listed rare or threatened species or critical habitat, the Endangered Species Coordinator must be contacted to determine whether a Section 7 Consultation with U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) will be necessary.

Section 106 Consultation (16 USC 470g). Environmental analysis also includes an evaluation of the impact on cultural resources if cultural resources may be impacted. The regional cultural resources staff will be contacted to determine whether formal section 106 consultation with the State Historic Preservation Office is necessary.

National Environmental Policy Act (42 USC 4321-4370d). Pest management actions must be addressed in the form of a memo to the file, categorical exclusion, environmental assessment, or environmental impact statement. For further details, refer to Director's Order #12: Conservation

Planning, Environmental Impact Analysis and Decision-making, and its accompanying handbook, and to Director's Order #28: Cultural Resources Management, and its accompanying guideline.

Migratory Bird Treaty Act (16 U.S.C. § 703-712). The act is the domestic law that implements the United States' commitment to four international conventions (with Canada, Mexico, Japan and Russia) for the protection of migratory birds. While the United States has signed specific agreements with these other countries to protect migratory birds and their habitats, the authority of the MBTA includes birds that migrate across many other international boundaries as well. The species protected by the MBTA are listed in 50 CFR § 10.13. If pest management actions may result in take of migratory birds, the regional or national migratory bird coordinator should be contacted.

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**APPENDIX A. INVASIVE EXOTIC PLANTS – HIGH PRIORITY
FOR MANAGEMENT**

Scientific Name	Common Name
<i>Ailanthus altissima</i>	Tree of Heaven
<i>Albizia julibrissin</i>	Mimosa Tree
<i>Alliaria petiolata</i>	Garlic Mustard
<i>Ampelopsis brevipedunculata</i>	Porcelain Berry
<i>Celastrus orbiculatus</i>	Oriental Bittersweet
<i>Centaurea biebersteinii</i>	Spotted Knapweed
<i>Coronilla varia</i>	Crown Vetch
<i>Dioscorea oppositifolia</i>	Chinese Yam
<i>Elaeagnus umbellata</i>	Autumn Olive
<i>Elaeagnus pungens</i>	Russian Olive
<i>Ligustrum sinense</i>	Chinese Privet
<i>Lonicera japonica</i>	Japanese Honeysuckle
<i>Lonicera fragrantissima/maackii</i> morrowii	Bush Honeysuckle
<i>Lythrum salicaria</i>	Purple Loosestrife
<i>Microstegium vimineum</i>	Japanese Stilt grass
<i>Miscanthus sinensis</i>	Japanese Plume Grass
<i>Paulownia tomentosa</i>	Princess Tree
<i>Pueraria montana</i> var. <i>lobata</i>	Kudzu
<i>Rosa multiflora</i>	Multiflora Rose
<i>Rubus phoenicolasius</i>	Wineberry
<i>Spiraea japonica</i>	Japanese Spiraea
<i>Tussilago farfara</i>	Coltsfoot
<i>Wisteria floribunda</i>	Japanese Wisteria

**APPENDIX B. OTHER EXOTIC PLANTS THAT OCCUR ON
THE BLUE RIDGE PARKWAY BUT ARE NOT INVASIVE**

Scientific Name

Achillea millefolium
Allium vineale
Anthemis arvensis
Anthoxanthum odoratum
Arabidopsis thaliana
Arctium minus
Arrhenatherum elatius
Arthraxon hispidus
Barbarea verna
Barbarea vulgaris
Berberis thunbergii
Brassica napus
Buglossoides arvensis
Calystegia sepium
Cardamine hirsuta
Cardamine impatiens
Castanea mollissima
Cerastium fontanum
Chamaecyparis pisifera
Cichorium intybus
Cirsium vulgare
Commelina communis
Dactylis glomerata
Daucus carota
Dianthus armeria
Duchesnea indica
Galium verum
Geranium columbinum
Hemerocallis fulva
Hesperis matronalis
Hieracium caespitosum
Hieracium pilosella
Holcus lanatus
Holosteum umbellatum
Hypericum perforatum
Ipomoea hederacea
Iris pseudacorus
Lamium purpureum
Leonurus cardiaca
Lepidium campestre
Lespedeza cuneata

Leucanthemum vulgare
Linaria vulgaris
Lolium pratense
Malus pumila
Malva sylvestris
Matricaria discoidea
Medicago lupulina
Melilotus officinalis
Microthlaspi perfoliatum
Nepeta cataria
Pastinaca sativa
Perilla frutescens
Phleum pratense
Picea abies
Plantago lanceolata
Poa trivialis
Polygonum convolvulus
Potentilla recta
Prunus avium
Prunus cerasus
Prunus persica
Pyrus communis
Ranunculus bulbosus
Ranunculus repens
Ribes rubrum
Rumex acetosella
Rumex crispus
Rumex obtusifolius
Salix X sepulcralis
Saponaria officinalis
Sedum sarmentosum
Senecio jacobaea
Silene latifolia ssp. alba
Silene vulgaris
Stellaria media
Thlaspi arvense
Tragopogon pratensis
Trifolium aureum
Trifolium campestre
Trifolium hybridum
Trifolium pratense
Trifolium repens
Verbascum blattaria
Verbascum thapsus
Veronica arvensis
Veronica hederifolia

Veronica persica
Vicia cracca
Vicia villosa
Vinca minor

APPENDIX C. INTEGRATED PEST MANAGEMENT PLANS FOR INVASIVE PLANTS

*Note: Presented below are working IPM plans and as such will be modified as new information is obtained.

Ailanthus altissima (Tree of Heaven)

Tree-of-heaven was first introduced to America by a gardener in Philadelphia, PA, in 1784, and by 1840 was commonly available from nurseries. The species was also brought into California mainly by the Chinese who came to California during the goldrush in the mid-1800s. Today it is frequently found in abandoned mining sites there. The history of ailanthus in China is as old as the written language of the country.

Biology/Description

- Height: 50-80 feet.
- Leaves: The alternate, odd-pinnately compound, deciduous fern-like leaves have from 13-25 leaflets (sometimes more), each 3-5 inches long, 1-2 inches wide and broadly lance-shaped. At the base of each leaflet is a small tooth, with a swollen scent gland. Crushed foliage has a disagreeable odor.
- Bark: The smooth, striped, gray-brown or light brown bark cracks with age.
- Twigs: Light brown, very stout; covered with fine hairs when young; with brown pith.
- Flowers: The ill-smelling male flowers and the small female flowers are borne on separate trees. They are ¼ inch long with 5 yellowish-green petals in terminal branched clusters 6-10 inches long. Blooms in late spring and early summer.
- Fruit: 1-1/2 inches long; showy reddish-green or reddish-brown narrow, flat, winged, 1-seeded, 1-6 per flower; mature in late summer and fall. The fruit occurs in dense clusters that persist through the winter.
- Habitat: *Ailanthus altissima* thrives in waste ground, embankments, and woodland borders, and seems invincible against smoke, dirt, and insects. It spreads rapidly by suckers.
- Origin: A native of China, *Ailanthus* was brought to this country as food for silkworms.

Comments: An individual tree can produce 325,000 seeds per year, which are easily wind-dispersed. Seedlings produce a well-formed taproot in less than 3 months. Extremely tolerant of pollutants and acid soil. *Ailanthus* has a high degree of shade tolerance and produces growth-inhibiting toxins.

Identification: Correct identification of *Ailanthus* is essential. Several native shrubs, like sumacs, and trees, like ash, black walnut and pecan, can be confused with *Ailanthus*. Staghorn sumac (*Rhus typhina*), native to the eastern U.S., is distinguished from *Ailanthus* by its fuzzy, reddish-brown branches and leaf stems, erect, red, fuzzy fruits, and leaflets with toothed margins.

Management options

1. Mechanical Controls

Cutting: Cut trees at ground level with power or manual saws. Cutting is best done when the trees have begun to flower. Because *Ailanthus* spreads by suckering, resprouts are common when a tree is cut down. Therefore, cutting should be utilized only as an initial control measure and may require an herbicidal control for resprouts.

Girdling: Using a manual sawing instrument, cut 1/8-1/4 inch ring of bark from the trunk of the tree. This method will kill the top of the tree. Resprouts are common; herbicidal control of the resprouts may be necessary.

Hand pulling: *Ailanthus* is probably best controlled by manual removal of young seedlings. Plants should be pulled as soon as they are large enough to grasp but before they produce seeds. Seedlings are best pulled after a rain when the soil is loose.

2. Biological Controls

None.

3. Chemical Controls

Foliar Spray Method: This method should be considered for large thickets of *Ailanthus* seedlings where risk to non-target species is minimal. Air temperature should be above 65 °F to ensure absorption of herbicides. Glyphosate: Apply a 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Glyphosate is a nonselective systemic herbicide that may kill non-target partially-sprayed plants. Triclopyr: Apply a 2% solution of triclopyr and water plus a 0.5% non-ionic thoroughly wetting all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around *Ailanthus*, triclopyr can be used without non-target damage.

Cut Stump Method: This control method should be considered when treating large individual trees or where the presence of desirable species precludes foliar application. Stump treatments can be used as long as the ground is not frozen. Glyphosate: Horizontally cut stems at or near ground level. Immediately apply a 50% solution of glyphosate and water to the cut stump making sure to cover the outer 20% of the stump. Triclopyr: Horizontally cut stems at or near ground level. Immediately apply a 50% solution of triclopyr and water to the cut stump making sure to cover the outer 20% of the stump.

Basal Bark Method: This method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the tree to a height of 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.

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Albizia julibrissin
(Mimosa)

Silk tree was introduced to the U.S. in 1745. Silk tree continues to be a popular ornamental because of its fragrant and showy flowers.

Biology/Description

- Height:** 20-40 feet
- Leaves:** Feathery, fernlike bipinnately compound leaves; 5-8 inches long; deciduous. On being handled, leaflets close like pages of a book.
- Bark:** Light brownish; nearly smooth.
- Twigs:** Brown or gray; twigs are hairless, slender, often angled.
- Flowers:** More than 1 inch long; long threadlike pink stamen, whitish toward base; Crowded in long-stalked ball-like clusters 1 ½ to 2 inches wide; grouped At end of twigs; blooms May to August.
- Fruit:** Yellow-brown bean-like pod, 2-3 inches long. Matures in summer but remains closed. Blooms July to November. Mimosa seeds have impermeable seed coats that allow them to remain dormant for years. One study showed 90% viability after five years.
- Habitat:** Mimosa takes advantage of disturbed areas, often spreading by seed from ornamentals nearby or from seed brought in on fill dirt. It prefers full sun and is often seen along roadsides and open vacant lots in urban/suburban areas. Mimosa can tolerate partial shade but is seldom found in forests with full canopy cover, or at higher elevations (above 900 m or 3,000 ft), where cold-hardiness is a limiting factor. It can, however, become a serious problem along riparian areas, where it becomes established along scoured shores and its seeds are easily transported in water.
- Life History:** Mimosa seeds have impermeable seed coats that allow them to remain dormant for years. One study showed 90% viability after five years; another *Albizia* species had 33% germination of seeds after 50 years in open storage. The trees grow rapidly under good conditions but have weak, brittle wood and are short-lived. They resprout quickly if cut or top-killed.
- Origin:** There are about 50 species of the genus in subtropical and tropical Asia, Africa, and Australia. Mimosa is native to Asia, from Iran to China and was introduced to the U.S. in 1745.

Comments: The hardiest tree of its genus, mimosa has an unusually long flowering period. Mimosa leaflets fold up at night.

Similar Species: Mimosa can be confused with other bipinnately compound legumes, especially in the smaller seedlings stages. Sensitive brier, *Shrankia microphylla* (Dry. ex Sm.) J.F. Machr., is a weakly arching perennial vine with prickly stems. Partridge pea, *Chamaecrista fasciculata* (Michx.) Green, is a non-woody, evenly pinnate annual herb.

Management options

1. Mechanical Controls

Cutting: Cut trees at ground level with power or manual saws. Because resprouts are common when a Mimosa tree is cut down, removal should be utilized only as an initial control measure. A foliar spray of glyphosate (Roundup) may be necessary to control the sprouts.

Girdling: Using a manual-sawing instrument, cut a 1/8-1/4" ring of bark from the trunk of the tree. This method will kill the top of the tree; resprouts are common below the girdled area. Herbicidal control of the resprouts may be necessary.

2. Biological Controls

Mimosa Wilt: *Fusarium oxysporum* f. *perniciosum* is a fungus that attacks mimosa in the U.S. and is transferred through the soil. It infects its host through the root system and may be fatal to the tree. It is not used at present and further research is needed.

3. Herbicidal Controls

Foliar Spray Method: This method should be considered for large thickets of mimosa seedlings where risk to non-target species is minimal. Air temperature should be above 65 °F to ensure absorption of herbicides. Glyphosate: Apply a 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Glyphosate is a nonselective systemic herbicide that may kill non-target partially-sprayed plants. Triclopyr: Apply a 2% solution of triclopyr and water plus a 0.5% non-ionic thoroughly wetting all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around ailanthus, triclopyr can be used without non-target damage.

Cut Stump Method: This control method should be considered when treating large individual trees or where the presence of desirable species precludes foliar application. Stump treatments can be used as long as the ground is not frozen. Glyphosate: Horizontally cut stems at or near ground level. Immediately apply a 50% solution of glyphosate and water to the cut stump

making sure to cover the outer 20% of the stump. Triclopyr: Horizontally cut stems at or near ground level. Immediately apply a 50% solution of triclopyr and water to the cut stump making sure to cover the outer 20% of the stump.

Basal Bark Method: This method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the tree to a height of 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.

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Alliaria petiolata
(Garlic mustard)

Garlic mustard gets its name from its characteristic odor of garlic when the plant is crushed and its mustard-like appearance. It is a naturalized European biennial herb that poses a significant threat to lowland natural areas as well as gardens and field crops. It belongs to the Brassicaceae (Mustard) family.

Biology/Description

- Height:** First-year plants are up to 10 cm (4 inches) high. Flowering stems may reach 0.6-1.1 m (2-3.5 feet).
- Leaves:** First-year leaves (which remain the second year) are round to kidney-shaped and are on stems approximately 5-6.5 cm (2-3 inches tall). Leaves on flowering plants are alternate and are larger near the base of the stem. They are large-tooth, triangular in shape, and approximately 2.54 cm (1 inch) long and 5-7.5 cm (2-3 inches) wide.
- Flowers:** Grow in clusters at the end of the stems. Each flower has four white petals (0.2 inch or 0.5 cm long). Blooms in spring, usually in May on the Parkway. Occasionally some plants will bloom again in July-August.
- Fruit:** A long 2.5-6.3 cm (1-2.5 inch) green capsule called a silique, containing many seeds. Siliques are produced summer to early fall. The capsules burst open when mature and throw out seeds. Small, black seeds grow in a row inside the silique. Seeds may remain viable for up to 5 years. Plants can produce up to 868 seeds depending on habitat and population density. Seeds are dispersed by human/animal vectors or by water in riparian areas.
- Life History:** Garlic mustard is a cool-season obligate biennial herb. Seeds germinate in early spring (April-May) of the first year resulting in initially high seedling densities. Natural mortality during the first year results in only 2%-4% of the plants surviving to flower the following spring. Garlic mustard is self- or cross-pollinated and a single plant can populate an entire site. Adult plants set and disperse seed in late spring (May-June) the second year and produce an average of 165-868 seeds. The seeds are dormant for 20 months germinating in early spring of year four.
- Habitat:** Uplands, floodplains, shaded and open woodlands, stream banks, and roadsides. Prefers some shade but grows extremely well in full sun. Garlic mustard is tolerant of a wide variety of soil substrates and moisture levels.

Origin: Garlic mustard was introduced from Europe as food or a medicinal herb. It was first recorded in the U.S. in 1868 in Long Island, New York. By 1991, this exotic plant had spread to 28 midwestern and northeastern states.

Similar Species: Garlic mustard is distinguished from other woodland herb species by its characteristic garlic odor. As the odor gradually dissipates by autumn, first-year rosettes may be mistaken for violets (*Viola* spp.) or immature white avens (*Geum canadense* [Jacquin]). Garlic mustard can be distinguished by its slender white taproot with a crook or "S" shape just below the base of the stem.

Management Options

1. Mechanical

Hand Pulling: This is an easy method of control for small populations of garlic mustard, since plants pull up easily in most forested habitats. Hand pulling is an extremely effective method of reducing population and seed productivity. Hand-pulling of plants can be done during most of the year. If plants have blooms and/or seed capsules present, they should be bagged and disposed of in a trash dumpster (to prevent seeds from dropping or parts of the plant from re-rooting and begin re-established). Care should be taken to disturb the soil as little as possible. Re-sprouts from roots are not common but can occur. This method will have to be continued until all seed reserves are depleted.

Cutting: Cutting the stems off 5 cm (2 inches) above the soil is very effective in controlling *Alliaria petiolata*. Cutting may be done by hand with shears or by using a scythe or weed eater in large or dense stands. Cutting is most effective when the plants are in full bloom (May). If cutting is done after seeds are formed, these should be collected, bagged, and disposed of in a trash dumpster (to prevent further re-establishment) or burned. Cutting is most effective if plants are cut off 5 cm (2 inches) above the ground, rather than at a height of 10 cm (4 inches) or more.

2. Herbicidal Controls

Glyphosate Foliar Spray: This method is effective on populations where mechanical control measures are not feasible or are impractical. Apply a 2% solution of glyphosate and water plus a non-ionic surfactant using a tank or backpack sprayer to thoroughly cover all leaves. Do not apply so heavily that herbicide drips off the leaf surface. Glyphosate is a non-selective herbicide requiring caution not to spray nontarget species. Treatments should be done in the early spring when most other nontarget vegetation is dormant. Refer to manufacturer's label for specific information and restrictions regarding use.

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Ampelopsis brevipedunculata

Porcelain berry

Porcelainberry was originally cultivated as a bedding and landscape plant. In spite of its aggressiveness in some areas, it is still used in the horticultural trade (for example, the ornamental *A. brevipedunculata* 'Elegans' is often recommended as a landscape plant with a cautionary note that "care must be taken to keep it from overtaking and shading out small plants"). The characteristics that make porcelainberry a desirable plant for the garden -- its colorful berries, good ground coverage, trellis-climbing vines, pest-resistance, and tolerance of adverse conditions -- are also responsible for its presence in the United States as an undesirable invader.

Biology/Description

- Height:** Porcelainberry is a deciduous, woody, perennial vine of the grape family, Vitaceae. It is related to the North American raccoon-grape and peppervine, and is sometimes referred to as Amur peppervine or porcelain ampelopsis. The plant climbs by tendrils that grow opposite the leaves on the stem.
- Leaves:** The simple, heart-shaped leaves of porcelainberry are dark green with coarsely toothed edges, and are shiny underneath with delicate hairs along the veins. The leaves vary from slightly 3-5 lobed to deeply dissected, the latter being distinctively recognizable. The leaves are arranged alternately on vines that grow to heights of 15 to 20 feet.
- Flowers:** Small, greenish-white flowers appear in clusters on porcelainberry in June, July, and August.
- Fruit:** The colorful berries of porcelainberry, its most distinguishing feature, appear in September-October. The berries, about 1/4-inch in diameter, range in color from white to yellow, to pastel shades of green, lilac and amethyst purple, to turquoise and sky blue. All colors of the berry are often found growing on the same plant at the same time while the plant is still in full foliage. The colorful berries (carrying 2-4 seeds each) attract birds and other small animals that eat the berries and disperse the seeds in their droppings. Because the plant is often found growing in riparian areas downstream from established plant colonies, it is thought that the seeds may also be dispersed in stream water.
- Similar Species:** There are several US native species of *Ampelopsis* that could be confused with this exotic.
- Habitat:** Porcelainberry grows well in most soils, especially in pond margins, stream banks, thickets, and waste places, where there is full sunlight to partial shade, and where it is not permanently wet. Like its relative the grape, porcelainberry appears to be less tolerant of heavily shaded areas, such as that found in mature forest.

Management Options:

1. Mechanical Control

Hand-pulling, digging and cutting are effective to control small or young populations of porcelainberry. However, these are difficult and labor-intensive methods and are not suitable for large populations. Because flowers are produced on the current season's growth, hand-pruning 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 spread of seeds. If the plants are pulled while in fruit, the fruits should be bagged and burned before they ripen. This method can be difficult in areas where the plant is well established since pulling up the plant often pulls out native plants with intermingled roots. Cut aboveground vines and, if possible, pull from trees to allow the trees to recover and recut repeatedly as needed.

2. Biological Control

There are no biological control agents available for porcelainberry.

3. Chemical Control

The herbicides triclopyr (e.g., Garlon 3a and Garlon 4) and glyphosate (Roundup and Rodeo) have been used with varying success to battle infestations of porcelainberry.

Foliar applications: Smaller infestations of porcelainberry can be controlled to some extent with spot applications of glyphosate to leaves, used sparingly to avoid contact of desirable plants with spray. Cut vines back during the summer and allow resprouting before applying herbicide, or apply glyphosate to leaves in early autumn, just prior to senescence. More 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 first, allow to regrow, and then apply triclopyr to new growth.

Basal bark applications: Apply a mixture of 20-30% Garlon 4 (triclopyr ester) with an equal volume of commercially available basal oil, diesel fuel, No. 1 or 2 fuel oil, or kerosene. Other oils, such as horticultural oil can be substituted if the label for the oil recommends it for basal bark application. Application should be during any season when temperatures are around 60 degrees Fahrenheit or more for several days, around the basal portions of vines.

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Celastrus orbiculatus
(Oriental bittersweet)

Introduced into the U.S. in the 1860s as an ornamental plant, oriental bittersweet is often associated with old homesites, from which it has escaped into surrounding natural areas. Oriental bittersweet is still widely planted and maintained as an ornamental vine, further promoting its spread. Oriental bittersweet is a serious threat to plant communities due to its shade tolerance, high reproductive rate, long range dispersal, ability to root sucker, and rapid growth rate. Climbing Oriental bittersweet vines severely damage native vegetation by constricting and girdling stems. Vines can shade, suppress, and ultimately kill native vegetation. Oriental bittersweet has been shown to hybridize with the relatively rare American bittersweet (*Celastrus scandens* L.). Hybridization may lead to the loss of American bittersweet's genetic identity through introgression. Both are members of the Celastraceae (Stafftree) family.

Biology/Description

- Height:** It is a relatively high climbing (60 feet), weedy vine which may become a spreading, trailing shrub. Reported growth rate is from 1-12 feet annually; with little additional growth after about 7 years. It may grow to 4 inches in diameter.
- Leaves:** Leaves of oriental bittersweet are glossy, rounded, finely toothed and arranged alternately along the stem.
- Flowers:** Few-flowered (1-3) inflorescences located on the leaf axils on typically short lateral branches of the current years growth; can be dioecious (male and female are present on separate plants).
- Fruit:** Fruit is green changing to bright yellow upon maturity. The globose fruits are 6-8 mm (0.2-0.3 in) in diameter, three valved with each fruit containing one to three seeds. Matures August-September.
- Seeds:** A red berry; germinates best in late spring in partial or even dense shade.
- Life History:** Oriental bittersweet flowers in May. Hymenopterous insects, especially bees, are the primary pollinators, but wind pollination is also successful. Fruit ripens in August through September and remains on the stem into the winter. Seed dispersal is by birds or small mammals. Seedling germination is generally high (up to 95%) and begins in mid to late spring. The highest rate of seed germination is in lower light intensities. Seedlings increase photosynthesis two-fold when exposed to direct sunlight. The plants develop and expand by layering stolons and rootsuckers. Annual growth rate is from 0.3-3.0 m (1-12 ft) with little additional growth after about seven years.
- Habitat:** Roadsides, open areas, old homesites, mesic forests, full to partial sunlight.

Origin: Oriental bittersweet is native to Japan, Korea, and northern China. It was introduced into the U.S. in 1860. Naturalized plants were first collected in Connecticut in 1916. Oriental bittersweet has become naturalized in 21 of 33 states in which it is cultivated. Present distribution is throughout the northeastern and southeastern U.S. extending to the southeastern Great Plains.

Similar Species: Oriental bittersweet is similar in appearance to American bittersweet and anyone surveying for Oriental bittersweet should verify identification. Oriental bittersweet differs from American bittersweet by having axillary inflorescences instead of terminal flower clusters. However, inflorescences are sometimes terminal in male Oriental bittersweet plants. A less reliable difference is the color of the outer covering of the fruit. The fruit of Oriental bittersweet is yellow while American bittersweet fruit is orange.

Management Options

1. Mechanical Controls

Cutting: Manual eradication is suggested for small infestations. Vines (including runners) are chopped just above ground level, and the pieces destroyed by burning or placing in plastic bags and depositing in a trash dumpster. Early in the season, cutting is repeated at 2-week intervals in order to weaken the crown and prevent resumption of photosynthesis. Later in the season, when the stored energy in the taproot has been reduced, the interval between cuttings can be extended. Cutting does not affect the roots.

Grubbing: This consists of mechanical removal and destruction of the entire plant, including the taproot. If all root tissue is removed, no re-growth can occur; repetition should not be necessary. Removed vegetation should be destroyed by burning or by placing in plastic bags and disposing of in trash dumpsters. Because many roots exceed 6 feet in length, elimination by this process is very difficult. However, this process is extremely effective on small vines and newly invading individuals.

Mowing: Large populations should be mowed during bloom and/or before seeds mature to prevent seed production. This may be accomplished by means according to terrain and size of individual population.

2. Biological controls

None.

3. Herbicidal controls

Cut Stump Treatment: Use this method in areas where vines are established within or around non-target plants, or where vines have grown into the canopy. *Glyphosate:* Cut the stem 5 cm (2 in) above ground level. Immediately apply a 25% solution of glyphosate and water to the cross-section of the stem. This procedure is effective at temperatures (as low as 40°F) and may require a subsequent foliar application of glyphosate. *Triclopyr:* Cut the stem 5 cm (2 in) above ground

level. Immediately apply a 25% solution of triclopyr and water to the cross-section of the stem; this procedure remains effective at low temperatures (<60°F) as long as the ground is not frozen. A subsequent foliar application may be necessary to control new seedlings.

Foliar Spray Method: 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. *Glyphosate*: Apply a 2% solution of glyphosate and water plus 0.5% non-ionic surfactant to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. Glyphosate is a non-selective systemic herbicide that may kill non-target partially sprayed plants. Ambient air temperature should be above 65°F. *Triclopyr*: Apply a 2% solution of triclopyr and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. The ideal time to spray is after surrounding native vegetation has become dormant (October-November) to avoid affecting non-target species. A 0.5% concentration of a non-ionic surfactant is recommended in order to penetrate leaf cuticle. Ambient air temperature should be above 65°F.

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Centaurea biebersteinii (maculosa)

(Spotted knapweed)

Spotted knapweed probably spread into North America in the early 1900's as a seed contaminant in hay or alfalfa shipments from Europe or Asia. Although most widespread in the western United States and British Columbia, there are many established populations in the eastern United States as well. Spotted knapweed readily invades disturbed areas, such as construction sites and pastures. The seeds are especially prone to travel in mud or dirt adhering to passing vehicles. Spotted knapweed has invaded the Blue Ridge Parkway along the recently constructed Grandfather Mountain corridor (possibly through contaminated seed/hay) and is present on grazed areas in the Moses Cone Estate and surrounding area.

Biology/Description

- Height:** First year seedlings produce low-growing rosettes. Year-old and older Plants may reach a height of from 0.3-1.2m (1-4 feet).
- Leaves:** Alternate, pale green leaves. Upper leaves are linear and the divided leaf margins of the lower leaves have a rough surface. Rosette leaves are much more divided than are the leaves on flowering stems.
- Flowers:** Flowers are pink to light purple in color, with a few individuals occasionally paler. The flowers are surrounded by stiff, black-tipped bracts, which give the flower head a spotted appearance. The flower heads open from June-August and bloom for 2-6 days, after which the bracts close. After about 20 days, the bracts reopen and seeds are dispersed.
- Fruit:** Reproduces solely by seeds.
- Seeds:** Seeds are brownish, less than ¼ inch long, notched on one side of the base, and have a short tuft of bristles at the tip.
- Habitat:** Flourishes in disturbed soil (roadsides, pastures, etc.). Will grow in sandy, gravelly, or organic substrates. Ranges in elevation and humidity, but seems to be restricted in areas with very high annual rainfall.
- Origin:** Europe, Asia.
- Natural enemies:** None known.
- Comments:** *Centaurea maculosa* is a long-lived perennial or biennial plant. Although it is not known just how many years a plant would live under optimal conditions, plants have recorded to sprout up to seven years from root buds. It is an aggressive

competitor for nutrients and may be allelopathic, releasing cnicin (a growth inhibitor) into the soil. It is also quite resistant to drought.

Management Options

1. Prevention

The first line of defense against *Centaurea*'s invasion is prevention of its arrival and establishment. Surveying, especially disturbed areas, and removing initial or small incursions of the species is the first step towards prevention of large, potentially unmanageable populations.

2. Mechanical Controls

Mowing/Cutting: Mowing has proven to be very effective in prevention of seed production. Plants should be mowed when approximately 50% of the flower heads are blooming. If plants are mowed/cut after more than 50% have bloomed, some seed set is possible and any blooms cut should be collected, bagged, disposed of in a trash dumpster (to prevent re-establishment) or burned.

Grubbing/Digging: This consists of mechanical removal and destruction of the entire plant. Put plants in plastic bags, including the roots, and transport to a trash container or burn. If all root tissue is removed, no re-growth can occur. However, disturbance of the soil will encourage propagation of new plants from seed. If chosen, this method will have to be continued until the seed bank is depleted. The disturbed ground must be re-seeded with appropriate native vegetation.

Fire: Fire has not proven to be effective on control of *Centaurea*.

3. Biological Controls

The following insects have been imported for control of *Centaurea maculosa*. However, they may not be appropriate or available for use on Parkway populations.

Urophora affinis and *U. quadrifasciniata* – Seed-head attacking flies.

Metzneria paucipunctella – A small moth which feeds on flowers and seeds

Sphenoptera jugoslavica - A root-mining beetle

Agapeta zoegana and *Pelochrista medullana* – Root-mining moths

4. Herbicidal Controls

None known.

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Coronilla varia

(Crown vetch)

Trailing crown vetch is an aggressive exotic, which spreads rapidly by seed and root growth. It has been widely planted as an erosion control, bank stabilizer, and fertilizer crop. Most research done on *Coronilla varia* has been on how to plant and maintain it. It readily invades disturbed areas, roadsides, and open areas, displacing native species.

Biology/Description

- Height:** Trailing, reclining stems up to 6 feet long.
- Leaves:** The compound leaves range from 5 to 10 cm in length and have nine to twenty-five leaflets. Leaflets are one to two cm long, oblong with persistent stipules.
- Flowers:** Five to twenty pea-like flowers are umbellate and borne on a stalk 5 to 15 cm long. Flower color is somewhat variable from pink, rose, or lilac. Flowers appear in late May-August
- Fruit:** A long slender green pod, containing many seeds.
- Life History:** Crown vetch spreads vegetatively by underground roots or rhizomes and by seeds. These perennial roots primarily serve to anchor the plant and as a storage structure. Flowers emerge May through August and seeds will mature by September. Seeds remain viable in the soil for several years requiring consistent post treatment monitoring.
- Habitat:** Open areas, roadsides and fields.
- Origin:** Crown vetch is native to Europe, Asia and Africa. It is widely cultivated as a ground cover and for erosion control in the U. S. since the 1950's. It has become naturalized in much of the U.S. and southern Canada. In some areas, crown vetch will totally dominate pastures and abandoned fields
- Natural enemies:** None known in the United States (Is grazed).
- Comments:** Crown vetch may be confused with partridge pea (*Cassia fasciculata*), other native vetches (*Vicia* sp.) and non-native plants in the Pea family. Distinguishing characteristics include compound leaves with an odd number of leaflets, flowers stalks and leaves that arise from the main stem, and flowers in the form of an umbel.

Management Options

1. Mechanical Controls

Hand pulling of mature plants can be effective when controlling small initial infestations. Mowing plants in the flower bud stage for two or three consecutive years may reduce the vigor and control further spread. Plants should be cut before seeds mature and as low to the ground as possible. Impact to adjacent native plants should be minimized as much as possible.

2. Biological Controls

None known.

3. Chemical Controls

Foliar applications

Spot Treatments: For herbicidal controls to be effective, herbicides should be applied while the plants are actively growing. Glyphosate, triclopyr and metsulfuron have been shown to be effective in controlling crown vetch. A 1%-2% solution triclopyr or glyphosate thoroughly mixed with water is effective during the vegetative stage prior to branching or during flowering. Triclopyr is selective to broad-leaved plants and can be used in areas where native grasses are intermingled with the target plants. Glyphosate is non-selective and will affect any plant it comes in contact with. Metsulfuron should be applied at a rate of 0.3g/gallon of water. Treatments should cover the leaves and stems of plants to the point of runoff. The addition of a non-ionic surfactant at a concentration of 0.5% improves the effectiveness of foliar treatments. Read the herbicide label thoroughly prior to use. **Broadcast:** Broadcast treatments are appropriate for large infestations such as fields or prairies. Since native plants will be intermingled with lespedeza, triclopyr and metsulfuron are the preferred herbicides due to their selective characteristics. Apply triclopyr at a rate of 1.0-1.5 pints per acre. Metsulfuron should be applied at a rate of 0.5 oz per acre. Use a non-ionic surfactant according to manufacturer's instructions to improve effectiveness.

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Dioscorea oppositifolia

(Chinese yam)

Chinese yam is a deciduous perennial vine native to China. It is a member of the Dioscoreaceae or Yam family. The genus *Dioscorea* has economic value as a food plant and is used as a traditional Chinese medicine.

Biology/Description

- Height:** Chinese yam is a creeping and climbing vine that may reach up to 5 meters in height given support from trees and shrubs. The vines twine from left to right.
- Leaves:** The leaves are acute to acuminate with a cordate (heart-shaped) base. The leaves can be alternate or opposite in arrangement on the stem. Typically, leaves are 4 to 8 cm long and up to 4 cm wide with 7 to 9 veins. The margins, petioles and stems are purplish to red in color.
- Flowers:** The small yellowish-white flowers arise from the axils of the leaves. The perianth is bell-shaped and the staminate (male) flowers are in bundles, spikes or panicles at the end of the branches. Flowers may have a spicy fragrance similar to cinnamon. Arrangement may be paniculate or spicate.
- Bulbils:** Bulbils or small aerial tubers (0.7 to 3 cm long) are produced in the axils of the leaves.
- Seeds:** The seeds are borne in a three-angle membranous capsule.
- Life History:** Chinese yam is a deciduous perennial vine that reproduces primarily vegetatively through aerial tubers or bulbils. Although the production of seeds has been seen, sexual reproduction has not been verified in the United States. The bulbils form on the axils of the leaves in late summer and fall. The mature bulbils fall from the plant and are spread primarily by gravity. Animals may also play a role in dispersal. Since the bulbils float and Chinese yam is commonly found in alluvial soils, water may play a role longer-range dispersal. The aerial tubers are covered with adventitious buds and damaged or partially eaten tubers can produce new plants. The large tuberous root of Chinese yam is capable of resprouting if it is fractured or damaged.
- Origin:** Chinese yam is native to China. It was introduced to the United States as an ornamental or edible food crop in the 1800's. Since that time, it has been identified in most of the Eastern United States from Texas to Florida and Vermont to Kansas.
- Similar Species:** The native wild yam (*Dioscorea villosa*) may resemble Chinese yam. Main distinguishing characteristics of wild yam include vines that twine right to left, pubescence present on the upper leaf surfaces, and the absence of aerial tubers.

Greenbrier (*Smilax* sp.) has a similar leaf shape to Chinese yam but lacks the bulbils, has thorns (on some but not all species), and has blue to purple berries. Morning glory (*Ipomoea* sp.) and bindweed (*Convolvulus arvensis*) have a cordate leaf shape but lack the aerial tubers.

Habitat: Chinese yam is found in rich alluvial soils along streams, seasonal creeks and rivers. It can tolerate semi-xeric sites with rocky soils. It grows in full sun and can tolerate all but the deepest shade. *D. oppositifolia* can be found along roadways, waste places, old home sites, and disturbed areas.

Management Options

1. Mechanical controls

Mowing/Cutting: This method is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Mowing or cutting will control the spread of Chinese yam, but will not eradicate it unless it is continued for several growing seasons or until the root reserves are exhausted. Stems should be cut at least once per growing season as close to ground level as possible. Treatment should be completed prior to bulbil production typically in July.

Grubbing: This method is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Using a pulaski or similar digging tool, remove the entire plant, including all roots and bulbils (if present). Juvenile plants can be hand pulled depending on soil conditions and root development. Any portions of the root system not removed will potentially resprout.

Mulching: Mulching is an effective control on small infestations or in areas where herbicides cannot be used. Cover the entire infestation with several inches of mulch. This may include wood chips, grass clippings, hay or similar degradable plant material. Shredded or chipped wood may be the best option since hay and grass may potentially carry weed seeds. Covering the area with cardboard may improve the effectiveness and longevity of this method. The mulch should stay in place for at least two growing season and may need to be augmented several times.

2. Biological Control

No biological controls are currently available for Chinese yam.

3. Chemical Control

Foliar Application

Use this method to control large populations. The most effective time to treat plants is after the leaves are fully expanded but before the aerial tubers are ripe. *Glyphosate*: Apply a 4% solution of glyphosate and water plus 0.5%-1% non-ionic surfactant to thoroughly wet all foliage. Do not

apply so heavily that herbicide will drip off leaves. Glyphosate is a non-selective systemic herbicide that may kill non-target partially sprayed plants. Ambient air temperature should be above 65°F. *Triclopyr*: If native grasses are intermingled with the Chinese yam, triclopyr is preferred since it is selective to broadleaved plants. Apply a 4% solution of triclopyr and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. A 0.5%-1% non-ionic surfactant is recommended in order to penetrate the leaf cuticle, and ambient air temperature should be above 65°F.

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Elaeagnus pungens/umbellate

Russian Olive Autumn olive

Autumn olive is an introduced, fast-growing woody shrub in the Elaeagnaceae (Oleaster) family. Used extensively for wildlife habitat, strip mine revegetation, and shelter belts, autumn olive thrives in disturbed areas open to full sun. It is adaptive, competitive, and vigorous, especially on open, sunny sites and it produces abundant fruit crops. These species were first introduced in the 1800's from Asia as ornamentals. They quickly become established on all but the wettest soils and the densest forests. Capable of thriving in poor soils (they are nitrogen-fixing), they rapidly invade disturbed areas. The abundant seeds produced have a high rate of germination and plants grow quickly. Autumn olive is one of the earliest species to break dormancy in late winter, giving it an advantage for competition for nutrients. These species are able to crowd out native shrubs and herbaceous plants. Although they have been considered desirable as food sources for wildlife, research shows that they lack the nutrient contents valuable to wildlife that is provided by native species.

Biology/Description

- Height: Autumn olive grows to a height of 6 m (20 ft). Its growth habit is bushy with a spreading crown.
- Leaves: Deciduous leaves are alternate, short-petioled, elliptic to ovate, and oblong. They are glabrous, dark green above, conspicuously silvery beneath.
- Twigs: The silvery or golden brown twigs often have prominent spines.
- Flowers: Fragrant flowers are axillary, pedicellate, tube-shaped, and yellowish-white, with 4 sepals and 4 stamens. Blooms May-June.
- Fruit: Fruits are abundant, juicy, round drupes up to 1 cm (0.4 in) in length. Silvery fruit turns to red as it matures and is speckled with brown to silvery scales. Matures September-October.
- Life History: *Elaeagnus* spp. are among the few non-legumes that fix nitrogen in the soil by means of bacterial root nodes. Plants flower and develop fruits annually after reaching three years of age. An individual can produce up to 3.6 kg (8 lbs) of fruit that are consumed and spread by birds and small mammals.
- Origin: Autumn olive was introduced into the United States in 1830 from China and Japan. It has been actively promoted by state and federal agencies for shelter belts, erosion control, strip mine reclamation, wildlife habitat, and was widely marketed as an ornamental. The shrub has now become naturalized in suitable habitats scattered throughout the eastern and Midwestern U.S.

Similar Species: Several other *Elaeagnus* species have become naturalized in the U.S. A native species *E. commutata* (Bernh.) is found in the far northern states and Canada. Minnie bush (*Menziesia pilosa* [Michx. ex Lam] Jussieu ex Pers.), a high elevation, southern Appalachian endemic, is somewhat similar but has glands, not scales, on the midrib.

Habitat: Autumn olive grows well in disturbed areas, open fields, margins of forests, roadsides, and clearings. Being tolerant of drought, it does not grow well in wet sites. It is intolerant of shade and will not invade areas of dense forest. Because the fruits are eaten by a variety of wildlife, the seeds may be distributed into forest openings or open woodlands.

Management Options

1. Mechanical Control

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

Girdling: Use this method on large trees where the use of herbicides is not practical. Using a hand-axe, make a cut through the bark encircling the base of the tree, approximately 15 cm (6 in) above the ground. Be sure that the cut goes well into or below the cambium layer. This method will kill the top of the tree but resprouts are common, and may require follow-up treatments for several years until roots are exhausted.

Hand Pulling: Autumn olive is effectively controlled by manual removal of young seedlings. Plants should be pulled as soon as they are large enough to grasp, but before they produce seeds. Seedlings are best pulled after a rain when the soil is loose. The entire root must be removed since broken fragments may resprout.

2. Biological Control

No biological controls are indicated.

3. Chemical Control

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

pressure and coarse spray pattern to reduce spray drift damage to non-target species. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around autumn olive, triclopyr can be used without non-target damage.

Cut Stump Method: This control method should be considered when treating individual trees or where the presence of desirable species preclude foliar application. Stump treatments can be used as long as the ground is not frozen. *Glyphosate*: Horizontally cut stems at or near ground level. Immediately apply a 50% solution of glyphosate and water to the cut stump, covering the outer 20% of the stump. *Triclopyr*: Horizontally cut stems at or near ground level. Immediately apply a 50% solution of triclopyr and water to the cut stump, covering the outer 20% of the stump.

Basal Bark Method: This method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the tree to a height of 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.

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Ligustrum spp.

Privet

Several species of privet have been widely planted primarily as a hedge in landscaping. They are difficult to distinguish and include common privet (*L. vulgare* L.), Chinese privet (*L. sinense* Lour.), and Japanese privet (*L. japonicum* Thunb.). All belong to the Oleaceae (Olive) family and easily escape cultivation to invade adjacent areas and form dense monocultural thickets.

Biology/Description

- Height:** Privet can grow up to 5 m (16 ft) tall and to a diameter of 2.5-25 cm (1-10 in).
- Bark:** Privet bark is whitish-tan to gray in color and smooth in texture. Young branches are minutely hairy.
- Twigs:** Slender twigs are straight, rounded or four-angled below the nodes, and gray-green in color. Terminal buds are present.
- Leaves:** These deciduous or half-evergreen plants hold foliage into winter, but drop it before spring. Leaves are elliptic to ovate in shape. They are oppositely arranged on slender twigs and have 4-5 pairs of indistinct veins. Privet leaves are less than 6 cm (2.5 in) long, glabrous, leathery and thick, with a glossy cuticle on upper surface.
- Flowers:** The perfect flowers are small and white. Bloom time is June-July.
- Fruit:** The black, berrylike fruits contain 1-4 seeds and are borne in terminal clusters. Fruits are subglobose or ovoid and are 6-8 mm (0.25 in) long. The fruit clusters ripen during September and October and persist through the winter. Mature specimens can produce hundreds of fruit.
- Life History:** Privet is a perennial shrub that readily grows from seed or from root and stump sprouts. Privet escapes cultivation by movement of seed, which is eaten and subsequently transported by wildlife, particularly birds. The seeds are reported to have a low germination rate: 5%-27% in two tests.
- Origin:** The privets are native to Europe, North Africa, and Asia. This ornamental landscape plant has been cultivated since ancient times and has been developed into several horticultural varieties. Date of introduction to the United States is unknown.
- Similar Species:** The leaves of the native shrub coralberry, *Symphoricarpos orbiculatus* (Moench.), are similar in shape to common privet. Coralberry is distinguished by its very slender twigs, deciduous leaves, red berries borne in axillary clusters, and the lack of a terminal bud.

Habitat: Privet is often seen along roadsides and other areas of disturbed soil at elevations less than 915 m (3000 ft). Privet also becomes established in old fields and landscapes that have abundant sunlight. Blunt-leaved privet, *L. obtusifolium* (Sieb. and Zucc.), was found invading an old field succession site in Illinois. The field had an average of more than 6,082 plants per ha (2.5 acres). Privet can also spread into forests, though it does not produce fruit in low light.

Management Options:

1. Mechanical Control

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

Hand Pulling: Privet is effectively controlled by manual removal of young seedlings. Plants should be pulled as soon as they are large enough to grasp but before they produce seeds. Seedlings are best pulled after a rain when the soil is loose. Larger stems, up to 6 cm (2.5 in), can be removed using a Weed Wrench or similar uprooting tools. The entire root must be removed since broken fragments may resprout.

2. Biological Control

Although no known biological controls are reported, there are many known pests of *Ligustrum*. These include *Macrophya punctumalbum*, a foliage-feeding insect, at least two other leaf-feeding weevils, privet rust mite, white peach scales, *Pseudocercospora ligustri* (a fungal leaf spot), and *Agrobacterium tumefaciens* (a root crown bacteria).

3. Chemical Control

Foliar Spray Method: This method should be considered for large thickets of privet where risk to non-target species is minimal. Air temperature should be above 65°F to ensure absorption of herbicides. The ideal time to treat is in late fall or early spring when many native species are dormant. *Glyphosate:* Apply a 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray-drift damage to non-target species. Glyphosate is a non-selective systemic herbicide that may kill non-target partially-sprayed plants. *Triclopyr:* Apply a 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant, to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray-drift damage to non-target species. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around privet triclopyr can be used without non-target damage.

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

level. Immediately apply a 25% solution of glyphosate and water to the cut stump making sure to cover the entire surface. *Triclopyr*: Horizontally cut privet stems at or near ground level. Immediately apply a 25% solution of triclopyr and water to the cut stump making sure the entire surface is covered.

Basal Bark Method: This method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the shrub to a height of 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.

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Lonicera fragrantissima*, *L. maackii*, *L. Morrowii*, *L. tartarica*, *L. X bella

Bush honeysuckle

Bush honeysuckles were introduced in the late 1800's as ornamentals and for wildlife habitat. They spread rapidly and are present throughout much of the US. They readily invade a variety of habitats, including disturbed successional communities, woodland edges and open forests. While most species seem to prefer upland areas, at least Morrow's is known to invade a number of wetland habitats. Reproduction may be vegetative as well as through seed. They form thick shrub layers which out-compete native vegetation for sunlight and nutrients. In addition, it is believed that the bush honeysuckles are allelopathic, producing chemicals which suppress the growth of other vegetation. Although they were once planted as food to improve lands for wildlife, the fruits of these bushes are not as rich in nutrients and fat content as many native plant species. This can be detrimental to several species, including neotropical migrants. They also compete with native plants for pollinators.

Biology/Description

- Height: All four species of bush honeysuckles grow to heights of 1.8-6.0 m (6-20 ft).
- Twigs: The twigs of all the bush honeysuckles are generally glabrous, thornless, and have a hollow brown pith when mature. The leaf scars are small and inconspicuous. The buds are blunt to acute.
- Leaves: Leaves of all these species are opposite, narrowly elliptic, ovate, to lance-ovate. The significant differences between individual species are dependent on the presence of pubescence.
- Flower: The differences between the flowers of these four species are dependent on corolla and pedicel length. Tartarian honeysuckle is typically pink but may vary from red to white. Amur and Morrow's honeysuckle flowers are white, changing to yellow. Belle honeysuckle may vary between the character of both parents. Blooms May-June.
- Fruit: The globose berries are typically dark red, occasionally yellow, and found in pairs in the axils of the leaves. They may remain on the shrub through winter. Each berry contains 2-6 seeds. Fruit matures September-October.
- Life History: The distribution of bush honeysuckle seeds is primarily accomplished by birds and small mammals. Following a period of cold stratification, seeds germinate in areas of sparse vegetation and can tolerate moderate shade but produce more seeds in full sun. It is suspected that bush honeysuckle produces an allelopathic chemical that suppresses the growth of surrounding vegetation. Leaves appear early in the spring and remain into late fall, giving bush honeysuckle a competitive advantage over native plants.

Origin: Bush honeysuckles are native to Asia and Western Europe. Tartarian honeysuckle was first cultivated in North America in 1752. Morrow's and Amur honeysuckles were introduced into the U.S. in 1875 and 1855 respectively. Bush honeysuckle has been promoted by state and federal agencies to improve wildlife habitat and as a popular ornamental. They are present throughout Tennessee, the Northeast, and the Midwest.

Similar Species: The bush honeysuckles are similar to Canadian honeysuckle (*Lonicera canadensis* Bartr.), red honeysuckle (*Lonicera dioica* L.), yellow honeysuckle (*Lonicera flava* Sims.), grape honeysuckle (*Lonicera reticulata* Raf.), coralberry (*Symphoricarpos orbiculatus* Moench), and bush-honeysuckle (*Diervilla sessilifolia* Buckl.). Canadian honeysuckle grows at high elevations and reaches a maximum height of 2 m (6.5 ft). The remainder of the native honeysuckles are twining vine species and morphologically distinct. Coralberry has slender purple to brown twigs and the leaves of *D. sessilifolia* (Buckl.) are lanceolate and finely toothed.

Habitat: The bush honeysuckles are tolerant of a variety of edaphic and environmental conditions. Typical habitats include disturbed successional communities, wetlands, prairie, woodland edges, and partially closed forests. Most communities found in natural areas have the potential to support a population of one of the bush honeysuckle species. These shrubs are moderately shade tolerant, taking advantage of canopy gaps created by wind throw or insect defoliation. Honeysuckle bushes are commonly found growing under trees, tall shrubs, and along fence rows that act as perch sites for birds.

Management Options

1. Mechanical Control

Grubbing: This method is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Using a pulaski or similar digging tool remove the entire plant, including all roots. Juvenile plants can be hand pulled depending on soil conditions and root development. Larger stems, up to 6 cm (2.5 in), can be removed using a Weed Wrench or similar uprooting tools. Any portions of the root system not removed may resprout. All plant parts, including mature fruit, should be bagged and disposed of to prevent reestablishment.

2. Biological Control

No biological controls are indicated.

3. Chemical Control

Foliar Spray Method: This method should be considered for large thickets of bush honeysuckle where risk to non-target species is minimal. Air temperature should be above 65°F to ensure absorption of herbicides. *Glyphosate:* Apply a 2% solution of glyphosate and water plus a 0.5%

non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Glyphosate is a non-selective systemic herbicide that may kill non-target partially-sprayed plants. *Triclopyr*: Apply a 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around bush honeysuckle, triclopyr can be used without non-target damage.

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

Basal Bark Method: This method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the shrub to a height of 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.

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Lonicera japonica
(Japanese honeysuckle)

The perennial climbing or trailing woody vine was introduced from Japan for its value as an ornamental, erosion control, wildlife cover and food source. It escaped and became widely established in the United States by the early 1900's has now spread over the Eastern, southeastern, and Midwestern United States. Its spread is partially due to plantings along railroads.

It is a fast-growing climber that can engulf woodland and strangle trees; it is a serious competitor with the native flora. Although honeysuckle has some economic value for grazing, the problem is one confining it to specified areas. It is reported to grow as much as 30 feet in a single year and is difficult to eradicate. Its presence can alter vertical structure, vegetation, and natural succession in forest communities as well as understory bird populations. Its invasion of moist woodlands is exceptionally successful.

Biology/Description

- Height:** It is a high climbing or trailing weedy vine reaching 30-40 feet.
- Leaves:** To 3 inches long, semi-evergreen to evergreen, hairy; opposite, and ovate. The simple mature leaves are generally entire, although there may be a toothed form. Young leaves may be toothed or lobed.
- Twigs:** Hairy.
- Flowers:** 1-1/2 inches long; long curved stamens project from 2-lipped, 5-lobed corolla (white and yellow) very fragrant; blooms April-August, occasionally into fall. Flowers are born in pairs in the axils.
- Fruit:** A small (4-6 mm in diameter) black berry containing 2-3 seeds. Produced August-October, spread by birds.
- Habitat:** Woodlands, roadsides, fence rows and pastures, light gaps and thickets.
- Origin:** A native of Japan, honeysuckle was introduced for its delicious odor at blossom time as well as its horticulture uses.
- Comments:** Honeysuckle is tolerant of air pollutants, including heavy metals and SO₂. Japanese honeysuckle reproduces by seeds, which are widely dispersed by birds, and spreads by layering, the runners developing new roots and shoots at short intervals. It starts growing at temperatures of 34 degrees to 48 degrees F. It has a rather shallow root system that grows to a depth of 6-12 inches on moist sites. Although unable to twine around large trees (>15 cm in diameter), it will attain the canopy height by twining around and growing/traveling with other vegetation. The persistent green leaves which emerge with the earliest spring flowers, are

able to continue photosynthesis during many months when surrounding vegetation is dormant. This feature allows control methods to be effective during late fall and early spring. Honeysuckle thrives on fertile, nitrogen-rich soil, where an established colony spreads in geometric proportions to its perimeter until nitrogen-poor sites are encountered.

Management Options

1. Mechanical controls

Grubbing: Dig plants up, including all roots. Removing the root system in this way will kill the plant. Take care not to leave behind berries that will sprout. All plant parts should be bagged and removed to a trash dumpster to prevent reestablishment. Any root pieces left behind will re-sprout.

Plowing: Open grown stands of honeysuckle can be plowed with a heavy-duty tandem harrow if terrain allows. This method will reduce foliage volume and will provide a more uniform shallow cover. However, pre-harrowing seems to create a problem if delayed sprouting from stolons and rhizomes buried at various depths. Harrowing after the plants are weakened from herbicide application is a better follow-up treatment than pre-treatment.

Mowing: Mowing mats of honeysuckle appears to increase the total yield of both plants and runners. Mowing will only limit the spread of *Lonicera japonica* and should only be used as a temporary control method until other methods are possible.

Burning: Controlled burning should only be used in habitats which are fire-adapted. Burning destroys aboveground growth. Fire will burn up the stolons and seed in the duff, and possibly destroy young seedlings and early season root systems that spring from stolons. Soil is a poor conductor of heat and that generated by burning honeysuckle does not penetrate far into the soil. Lush honeysuckle does not burn well; but when pine litter is present, fire will burn through it rather slowly and consume the ground cover of *Lonicera* to the bare soil. Re-sprouting will occur after fire treatment. In some areas, as much as 80% cover has occurred without follow-up treatment for spraying with herbicides, and it can also be used to advantage as a follow-up treatment to spraying. The dead ground cover of honeysuckle burns readily; fire consumes the seed in the litter and exposes future sprigs for mop-up spraying.

2. Biological controls

None known.

3. Herbicidal controls

Cut Stump Treatment: Use this method in areas where vines are established within or around non-target plants, or where they have grown into the canopy. This treatment remains effective at low temperatures as long as the ground is not frozen. Glyphosate: Cut the stem 5 cm (2 in) above

ground level. Immediately apply a 25% solution of glyphosate and water to the cross-section of the stem. A subsequent foliar application of glyphosate may be required to control new seedlings and resprouts. Triclopyr: Cut the stem 5 cm (2 in) above ground level. Immediately apply a 25% solution of triclopyr and water to the cross-section of the stem. A subsequent foliar application may be necessary to control new seedlings.

Foliar Spray Method: 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. Glyphosate: Apply a 2% solution of glyphosate and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. The ideal time to spray is after surrounding vegetation has become dormant (October- November) to avoid affecting non-target species. A 0.5% non-ionic surfactant is recommended in order to penetrate the leaf cuticle. Ambient air temperature should be above 65°F. Triclopyr: Apply a 2% solution of triclopyr and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. The ideal time to spray is after surrounding vegetation has become dormant (October- November) to avoid affecting non-target species. A 0.5% non-ionic surfactant is recommended in order to penetrate the leaf cuticle. Ambient air temperature should be above 65°F.

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Lythrum salicaria
(Purple loosestrife)

Purple loosestrife was introduced into the United States early in the 1800's by horticulturists, beekeepers, and gardeners. Since that time, it has spread across the northern half of the United States and into the southern provinces of Canada. The southern extent of its movement currently seems to be North Carolina where it was recently added to the state list of noxious weeds.

Purple loosestrife thrives in wetland areas but also occurs in ditches and disturbed wet soils. It quickly outcompetes native vegetation. While purple loosestrife seems to provide little or no food for wildlife, other than nectar for bees and butterflies, it often replaces species that are important food, shelter, and nesting sources for wildlife. *Lythrum salicaria* appears to go through a rather quite period of acclimation when first inhabiting an area before revealing its invasive nature.

Purple loosestrife is present in several wet areas on the Blue Ridge Parkway, including the lakeshore at Bass Lake. Its presence disrupts the native ecosystems and cultural scenes that are to be preserved by the Parkway.

Biology/Description

Height: 0.6 meters (2-10 feet). Stem is stiff, 4-sided, and may become woody at the base with age.

Leaves: Mostly alternate, but may be opposite or in whorls of 3. Leaves are up to 7 cm (2.7 inches) long and 14 mm (1/2 inch) wide, and are lanceolate or elliptical in shape. The base of the leaves are cordate or clasping.

Flowers: Flowers are rose-purple or magenta in color, but are occasionally white or light pink. Blooms have 8-10 stamens and 5-7 petals and grow in dense compound, terminal bracted spikes which may be 15-20 cm (6-8 inches) high. The calyx and bracts are greenish. The flowers are trimorphous (in three different forms) in the relative lengths of the stamens and style (see illustration). Purple loosestrife blooms from early July through Early September and the flower stalks standing through the winter.

Fruit: A capsule containing an average of 120 tiny (0.06 mg) orangish seeds. Each plant may contain up to 900 capsules. Seeds are dispersed from late summer through the winter.

Habitat: Marshes, bogs, fens, wet meadows, floodplains, stream banks, and ditches.

Origin: Eurasia

Natural enemies: None.

Comments: Although commonly wind-dispersed, the seeds have been known to be transported by water (seeds are buoyant), birds and waterfowl, and animals. Beekeepers have sown *Lythrum salicaria* to provide nectar sources for bees. Seed germination takes 8-10 weeks. *Lythrum salicaria* reproduces sexually (seeds) and asexually (sprouting from pieces of root or stem). If uncontrolled, purple loosestrife can produce a monoculture, totally eliminating native vegetation.

Management Options

1. Mechanical Controls

Hand-Pulling: Young plants (1-2 years old) are best removed by hand-pulling before flowering begins. All plant parts should be bagged, removed from the site, and placed in a dumpster or burned to prevent the plant from re-rooting.

Grubbing: Older plants (more than 2 years old) should be dug out, with care taken to leave no rootstock. All plant parts should be disposed of as in 2.a. above. If seeds are present, care should be taken to keep seeds from falling to the ground and becoming re-established during plant removal.

Grubbing/Replacement: If available, millet (*echinochloa frumentacea*) or nodding, pale, or dock-leaved smartweed (*Polygonum lapathifolium*) may be sown in areas disturbed by loosestrife removal, since millet seedlings will out compete any loosestrife seedlings for a season.

Mowing: DO NOT mow because cut parts may re-root and or sprout.

2. Biological Controls

Although several European species offer excellent prospective for control, no biological controls are available for Blue Ridge Parkway use at this time. While herbicides and hand removal may be useful for controlling individual plants or small populations, biological control is seen as the most likely candidate for effective long term control of large infestations of purple loosestrife. As of 1997, three insect species from Europe have been approved by the U.S. Department of Agriculture for use as biological control agents. These plant-eating insects include a root-mining weevil (*Hylobius transversovittatus*), and two leaf-feeding beetles (*Galerucella californiensis* and *Galerucella pusilla*). Two flower-feeding beetles (*Nanophyes*) that feed on various parts of purple loosestrife plants are still under investigation. *Galerucella* and *Hylobius* have been released experimentally in natural areas in 16 northern states, from Oregon to New York. Although these beetles have been observed occasionally feeding on native plant species, their potential impact to non-target species is considered to be low.

3. Herbicidal Controls

Small infestations of young purple loosestrife plants may be pulled by hand, preferably before seed set. For older plants, spot treating with a glyphosate type herbicide (e.g., Rodeo for wetlands, Roundup for uplands) is recommended. These herbicides may be most effective when applied late in the season when plants are preparing for dormancy. However, it may be best to do a mid-summer and a late season treatment, to reduce the amount of seed produced.

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Microstegium viminium

(Japanese grass)

Microstegium is an annual grass which is an opportunistic and pernicious invader of a variety of habitats. It is most common in disturbed areas which are somewhat moist. The species is shade-tolerant. Japanese grass is a colonial grower which spreads by rooting at stem nodes and also produces large numbers of seeds. Mowing and other disturbances promote the spread of this grass. It readily displaces native vegetation, including wetland species, as it forms dense patches. It has become well-established in several areas of the park above 4,000 feet.

Biology/Description

- Height: Microstegium is a decumbent and branched annual grass reaching a height of 60-100 cm (24-39 in).
- Stem: Culms are 1.5 m (59 in) long with glabrous nodes and internodes.
- Leaves: Cauline leaves are alternate, lanceolate, 10 cm (4 in) long, 2-15 mm (0.08-0.6 in) wide, and sparsely pubescent on both surfaces with ciliate margins.
- Flowers: Racemes are terminal and may be solitary or in a set of two or three. Spikelets are in pairs, one sessile and one pedicellate, and 4.5-5mm (0.17-0.2 in) long. Blooms August-September.
- Seeds: Grain is yellow to red, ellipsoid, 2.8-3.0 mm (0.1-0.12 in) long. Seeds mature over a period of about two weeks in September-October.
- Life History: Microstegium is an annual C-4 shade tolerant grass in the Poaceae family. It is colonial in nature, rooting from the nodes, and may form dense monotypic stands. Reproduction is exclusively from seed. Each plant may produce from 100-1,000 seeds that remain viable in the soil for five or more years. Seed dispersal is primarily by animals, flooding, and deposition with fill dirt. This plant spreads rapidly into disturbed areas but can invade undisturbed areas by forming satellite populations brought in by animals or flooding. On fertile mesic sites Japanese grass can replace competing ground vegetation within 3-5 years. Microstegium is adapted to low light conditions. At 18% of full sunlight dry matter production is not significantly reduced from production in full sunlight. It will grow and produce seed in light levels as low as 5% of full sunlight.
- Origin: Microstegium is native to Japan, Korea, China, Malaysia, and India. It was first identified in the U.S. at Knoxville, Tennessee in 1919, and in 1933 was collected in western North Carolina. By 1964, the grass had spread to 35 counties in North Carolina. By 1972, it had been identified in 14 eastern states, and in 1978, it was collected in Arkansas.

Similar Species: Microstegium may be confused with cutgrass (*Leersia virginica* Willd.) or knotweed (*Polygonum persicaria* L.). Cutgrass has distinctly longer leaves (1.5 dm [6.0 in]) and shorter spikelets (2.5-3 cm [1.0-1.2 in]) than microstegium. Knotweed is distinguished from microstegium by pale to dark pink calyx and glossy black nutlets.

Habitat: Alluvial soil found in flood plains and stream sides is ideal habitat for microstegium. Other typical habitats include damp fields, lawns, mesic woodland edges, roadsides, and ditches. It is commonly found in areas of natural (e.g., flood scouring) or artificial (e.g., mowing, tilling) disturbance, but can invade undisturbed areas. Microstegium has been observed growing at an elevation of 1,200 m (3,840 ft), but typically is not found on upland sites. Deer avoid microstegium, which allows it a competitive advantage in over browsed areas.

Management Options:

1. Mechanical Control

Hand-pulling of the stems in small populations may be effective if sufficient labor is available for repeated actions through the course of the growing season as well as for several successive seasons. However, this action may also further disturb the soil, providing for germination of new seeds. As with any invasive species, hand-grubbed vegetation must be properly disposed of to prevent recontamination or contamination of new areas. Mowing the stems close to the ground before seed is produced will provide control but must be continued until existing seed bank is depleted. (Seeds may remain viable for 5 or more years). Problems with mowing are: 1) seed production may vary significantly given the elevation range of the various populations; 2) mowing too late will actually promote seed dispersal and contribute to the spread and increase of populations, and 3) Mowing too early may result in the production of new seed heads.

2. Biological Control

No biological controls are available for *Microstegium*.

3. Chemical Control

Foliar Applications: Herbicide treatments should be made late in the growing season but, before the plants set seed. Treatments made earlier in the growing season may allow a second cohort of plants to produce seeds. *Glyphosate:* Apply a 2% solution of glyphosate and water plus a 0.5% 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 rainfall is expected within two hours following application.

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Miscanthus sinensis
(Plume, Grass, Eulalia)

This plant was introduced from eastern Asia to be grown as an ornamental. It has escaped and manages to grow and proliferate along roadsides and in old fields. It is a serious competitor with native flora.

Biology/Description

- Height: 3 to 6 feet tall.
- Leaves: Single branch, grows in clumps, blades green or green and white banded, up to 9 feet high and $\frac{3}{4}$ inches wide.
- Flowers: The plumes are covered with white-gray hairs.
- Seeds: From September-November.
- Habitat: Roadsides, ditches, fields, and woodland borders.
- Origin: Native of Asia.

Management Options

1. Mechanical Controls

a. Grubbing: Dig plants up including all roots. If seed heads are present, place the plant in a plastic bag to eliminate the spread of seeds by the wind. Dispose of off Parkway lands; i.e. local dump, etc. Sites should be inspected at least yearly for seedlings, as ground disturbance will facilitate the germination/sprouting of existing seeds.

At a minimum, until plants can be grubbed, seed heads should be cut from plants prior to seed production, placed in plastic bags, and disposed of in trash dumpster.

b. Mowing: Mowing is an effective means of controlling the spread and the production of seed and can be used as a control method until grubbing is possible. Clumps should be mowed repeatedly during the growing season.

2. Biological controls

Allow forest canopy to close through natural succession. This process will shade out *Miscanthus sinensis* and will virtually eliminate the population.

3. Herbicidal Controls

Unknown

Paulownia tomentosa
(Princess tree, elephant ears)

This is a rapidly growing species which was introduced from China. It closely resembles a catalpa. It grows readily and rapidly in waste places, roadside and open areas and is tolerant of air pollutants. It was first discovered growing in western North Carolina and Virginia in the late 1800's. The flowers and the persistent fruit litter the ground.

Biology/Description

Height: 30-60 feet

Diameter: 1-2 feet

Leaves: Large paired heart-shaped leaves, opposite, 6-16 inches long, 4-6 inches wide; broadly ovate, not whorled, short-pointed at tips with several veins from notched-base; sometimes slightly 3-toothed or lobed; dull light green and slightly hairy above; paler and densely covered with hairs beneath; leafstalks, 4 inches long.

Bark: Trunk bark rough with interlaced, smooth, often shiny, areas; gray-brown.

Twigs: Light brown, stout; densely covered with soft hairs when young; leaf scars are circular.

Flowers: About 2 inches long; bell-shaped pale violet corolla ending with five rounded unequal lobes; fragrant; in upright clusters, 6-12 inches long on stout hairy branches; blooms in early spring (April-May) rounded brown hairy buds formed previous summer (before leaves emerge). Petals have darker spots and inner yellow strips.

Fruit: 1-1/2 inches long; egg-shaped, brown, 2-valved capsule, 1-2 inches long. The seedpod has 4 compartments that contain as many as 2,000 tiny wedged seeds. The husks mature in autumn and remain attached all winter.

Habitat: Waste places, roadsides and open areas.

Life History: *Paulownia* can reproduce from seed or from root sprouts; the latter can grow to over 5m (15 ft) in a single season. The root branches are shallow and horizontal without a strong taproot. Seed-forming pollen is fully developed before the onset of winter, and in spring the flowers are pollinated by insects. Seeds germinate within a few days on suitable substrate; seedlings grow quickly and flower in 8-10 years. Mature trees are often structurally unsound and rarely live more than 70 years.

Origin: *Paulownia* is native to western and central China where historical records describe its medicinal, ornamental, and timber uses as early as the third century

B.C. It has been cultivated for centuries in Japan where it is valued in many traditions. It was imported to Europe in the 1830s by the Dutch East India Company and brought to North America a few years later. *Paulownia* has been naturalized in the eastern U.S. for more than 150 years and is also grown on the west coast. USDA hardiness zones 7-10 are most favorable.

Similar Species: *Paulownia* belongs to the Scrophulariaceae (Figwort) family, which in North America is otherwise composed of herbaceous species. It resembles the native catalpa tree (*Catalpa speciosa* [Warder ex Barney]) in size, leaf and flower structure. Notable differences are found in pith, leaves, and seed pods. *Paulownia* has a hollowed or chambered pith, while that of the catalpa is solid and whitish. Catalpa leaves are whorled and more distinctly pointed at the tip than *Paulownia* leaves, which are not whorled and have a less elongated tip. Catalpa fruits are long, slender pods measuring 20-46 cm (8-18 in). Fruits of the princess tree measure only 3-8 mm (1.5 in) and appear in clusters of round capsules. Catalpa flowers have a two-lipped calyx and appear on the current year's growth; *Paulownia* has a five-lobed calyx and flowers on the second year's growth.

Management options

1. Mechanical Controls

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

Girdling: Use this method on large trees where the use of herbicides is impractical. Using a hand-axe, make a cut through the bark encircling the base of the tree, approximately 15 cm (6 in) above the ground. Be sure that the cut goes well into or below the cambium layer. This method will kill the top of the tree but resprouts are common and may require a follow-up treatment with a foliar herbicide.

Hand Pulling: *Paulownia* is effectively controlled by manual removal of young seedlings. Plants should be pulled as soon as they are large enough to grasp but before they produce seeds. Seedlings are best pulled after a rain when the soil is loose. The entire root must be removed since broken fragments may resprout.

2. Biological Controls

None known.

3. Herbicidal Controls

Foliar Spray Method: This method should be considered for large thickets of *Paulownia* seedlings where risk to non-target species is minimal. Air temperature should be above 65°F to ensure absorption of herbicides. **Glyphosate:** Apply a 2% solution of glyphosate and water plus a

0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Glyphosate is a non-selective systemic herbicide that may kill non-target partially-sprayed plants. *Triclopyr*: Apply a 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around paulownia, triclopyr can be used without non-target damage.

Cut Stump Method: This control method should be considered when treating individual trees or where the presence of desirable species preclude foliar application. Stump treatments can be used as long as the ground is not frozen. *Glyphosate*: Horizontally cut stems at or near ground level. Immediately apply a 25% solution of glyphosate and water to the cut stump making sure to cover the outer 50% of the stump. *Triclopyr*: Horizontally cut stems at or near ground level. Immediately apply a 50% solution of triclopyr and water to the cut stump making sure to cover the outer 20% of the stump.

Basal Bark Method: This method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the tree to a height of 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.

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Pueraria lobata
(Kudzu)

This aggressive vine can grow 60 feet per year forming a continuous blanket of foliage. This massive covering often chokes out competing native vegetation that provides food and habitat for native animals. The result is a large-scale alteration of biotic communities. Kudzu is also a problem in forest agriculture and landscaping. It belongs to the Fabaceae (Pea or Bean) family.

Biology/Description

- Height:** Kudzu is a trailing or climbing semi-woody perennial vine reaching 32-100 feet in length.
- Roots:** Typically 3 feet but up to 6 feet in depth, capable of storing large amounts of starch/food. Roots are fleshy, up to 7 inches in diameter, and may weigh up to 400 pounds.
- Leaves:** Alternate and compound with leaflets up to 4 inches across, each leaflet entire or deeply 2-3 lobed and with hairy margins. Foliage drops after the first fall frost.
- Stem:** First year vines may reach ½ inch in diameter; old vines may reach a diameter of 4 inches.
- Flowers:** Kudzu plants do not usually flower until their third year. Flowers are purple, fragrant, about ½ inches long, produced in long racemes, and resemble pea flowers in shape. They are produced from July-October.
- Fruit:** Flowers are followed by flattened, 2 inch long, hairy pods which may contain 3-10 hard seeds.
- Habitat:** Kudzu grows well under a wide range of environmental conditions, although most growth is achieved where winters are mild (40-60 degrees F), summer temperatures rise above 80 degrees F, and rainfall abundant (40 inches or more). Kudzu can grow in nearly any type of soil (e.g., acid soils, lime soils, lowlands with high water tables, and over heavy subsoil), and where winter soil temperatures remain above -25 degrees F (which temperature kills roots). Forest edges or disturbed areas such as abandoned fields and roadsides are preferred habitats.
- Origin:** A native of Asia, Kudzu was introduced into the United States at the Philadelphia Centennial Exposition in 1876.
- Comments:** Kudzu is a perennial which rarely produces seeds in the United States. It generally spreads by means of stolon (runners) and rhizomes. In addition, any vine contacting the soil will produce roots at nodes; these roots enlarge, forming

new crowns. Vine cuttings and root divisions will also sprout. Vines are intolerant of shade and grow toward light. Large roots store water, allowing plants to survive in fairly dry climates. Growth is most rapid in acid to neutral soils (4.5 – 7.0). Exposure to –25 degrees F can kill roots.

Life History: Kudzu is a leguminous perennial actively growing from early summer (May) until the first frost. Sexual reproduction is rare. Kudzu establishes plants by forming roots at nodes where the vines come in contact with the soil. These roots enlarge to form new crowns. Vines grow rapidly- increases of 15 m (50 ft) in a single season are not uncommon. Roots can penetrate the soil to depths of 3 m (9 ft).

Management options

1. Mechanical Controls

Grubbing: This consists of mechanical removal and destruction of the entire plant, including the taproot. If all root tissue is removed, no re-growth can occur; repetition should not be necessary. Removed vegetation should be destroyed by burning, feeding to livestock, or by bagging and removing to a trash dumpster. Because many roots exceed 6 feet, elimination by this process is very difficult.

Cultivation: Cultivating or harrowing is a good method to use if used as a follow-up control after herbicidal controls are used.

Cutting: Vines (including runners) are chopped just above the ground level, and the pieces destroyed by burning or feeding to livestock. Early in the season, cutting is repeated at 2-week intervals, to weaken the crown and prevent resumption of photosynthesis. Later in the season, when the stored energy in the taproot has been reduced, the interval between cuttings can be extended. Cutting does not affect roots.

Burning: Burning destroys aboveground growth. Since kudzu vines usually will not burn during active growth (because of their high water content), vines may be flamed (a kerosene torch is played over the foliage, wilting the leaves, thus defoliating the plant) two or three days prior to burning. This procedure may be utilized to reduce the draping effect and foliage volume, but is ineffective in complete elimination. Winter burning of kudzu when the leaves are dead is also a good pre-treatment. It not only facilitates later spraying with herbicides, but also exposes the soil to freezing, which is detrimental to kudzu rhizomes. Cutting (especially during the growing season) can result in vigorous re-sprouts.

2. Biological controls

None known.

3. Herbicidal control

Foliar Applications: *Glyphosate:* Apply a 2% concentration of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all foliage. Do not apply so heavily that herbicide will

drip off leaves. Glyphosate is a non-selective systemic herbicide that may kill non-target partially-sprayed plants. Ambient air temperature should be above 65°F.

Triclopyr: Apply a 2% concentration of triclopyr and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. A 0.5% concentration of a non-ionic surfactant is recommended in order to penetrate leaf cuticle. Ambient air temperature should be above 65°F.

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Rosa multiflora

(Multiflora rose)

Multiflora rose was introduced more than 40 years ago for high quality wildlife cover, living farm fences, and windbreaks. In some states, multiflora rose was used as a crash barrier along highways. Multiflora rose spreads rapidly into adjacent fields and undisturbed areas, often forming monotypic thickets. Many states list it as a noxious weed. It belongs to the Rosaceae (Rose) family.

Biology/Description

- Height:** A perennial, thorny shrub which can reach a height of 4.6 m (15 feet). The first 1.5-3 m (5-10 feet) of the stem are typically erect, with the tips arching back to the ground.
- Leaves:** Pinnately compound leaves, usually divided into 7-9 toothed leaflets. Leaflets are oval and less than 4 cm (1.5 inches) long. Highly fringed, winged leaf appendages are present at base of leaf stalks.
- Thorns:** Thorns are curved, flattened, and broad-based.
- Flowers:** White to pinkish-white blooms which are 1.2-4 cm (3.4 to 1-1/2 inches) wide. Five sepals, lanceolate, sharp-tipped, petals 5, stamen and pistils numerous. Blooms in summer, May-July.
- Fruit:** Small, red, globular, fleshy, many-seeded hip formed in late summer. Becoming firm and remaining on plant into the winter months.
- Habitat:** Borders of fields and thin woodlands, forest openings, roadsides, fence rows, and pastures.
- Natural enemies:** Possible rose rosette disease.
- Comments:** Fruits are eaten by birds and animals, particularly in winter, seeds seem to germinate better after passing through a birds digestive system. *Rosa multiflora* reproduces by 1) seeds, 2) taking root where stems touch the ground (layering), and 3) sprouting from shallow roots. Seeds in the ground may remain viable for 10-20 years. In addition to choking out other vegetation, multiflora rose is an aggressive and successful competitor for nutrients.
- Life History:** Multiflora rose reproduces by seed, root sprouts, and layering (rooting from the tips of arching branches). Flowers emerge from May to July and the fruits (rose hips) develop in September through October. Its prolific seeds are eaten and spread by birds and other animals. Seeds may remain viable in the soil for 10-20

years. Seedlings develop within 60 days at soil temperatures above freezing. Plants grow slowly for the first one or two years followed by rapid expansion through layering and root sprouts.

Similar Species: The native rose that resembles multiflora rose is swamp rose (*Rosa palustris* Marsh.). Swamp rose is distinguished from multiflora rose by having a shorter overall height (2 m; 79 in), solitary flowers, and entire stipules.

Management Options

1. Mechanical Controls

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

2. Biological controls

Rose rosette disease: Rose rosette, an endemic disease in the midwestern states which is lethal to roses, shows excellent potential as a biological control for *Rosa multiflora*. The disease appears to be a virus which is spread by a wingless mite (*Phyllocoptes fructiphilus*). Once infected, most plants die within one or two years, with large plants surviving up to four years. Although multiflora rose seems by far to be the preferred host, there is concern over infection of native and ornamentally grown rose species. Current research indicates that commercially important relatives such as apples, plums, cherries, etc. are not susceptible to rose rosette disease. Until the cause is determined and some reliable protection is available for other rose species, the disease may not be accessible for use on Parkway incursions of *Rosa multiflora*.

Phytophagous wasp: An introduced European wasp, *Megastigmus aculeatus*, also has potential as an effective biological control of multiflora rose. Sources for obtaining the wasps for Parkway introductions are not available at this time.

3. Herbicidal controls

Foliar Spray Method: This method should be considered for large thickets of multi-flora rose where risk to non-target species is minimal. Air temperature should be above 65°F to ensure absorption of herbicides. **Glyphosate:** Apply a 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant thoroughly wetting all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Glyphosate is a non-selective systemic herbicide that may kill non-target partially-sprayed plants. **Triclopyr:** Apply a 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray-drift damage to non-target species. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around multiflora rose, triclopyr can be used without non-target damage.

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

Basal Bark Method: This method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the shrub to a height of 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.

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Rubus phoenicolasius

(Wineberry)

Wineberry is an aggressive plant which is adapted to a variety of growing conditions and habitats. It can form dense thickets which displace native species in fields, forests and riparian areas. It is capable of reproducing by seeds and root buds and cane layering. Wineberry can invade and eliminate native plants in very large areas. The name *Rubus phoenicolasius* translates as "blackberry with purple hairs."

Biology/Description

- Leaves: Leaves consist of three heart-shaped, serrated leaflets with purplish veins and are silvery white tomentose on the underside. Alternate, palmately compound, typically 3.
- Flower: Greenish with small white petals, small reddish hairs present, appears in May to June, not showy.
- Fruit: Juicy, red to orangish red, multiple of drupes, may have fine hairs. When picked they separate from the fleshy core forming a hollow shell. Ripen June to July.
- Twig/Bark: Arching "canes" covered in red gland tipped hairs, initially green but later turning red, canes root at tip.
- Form: Arching canes reach 4 to 6 feet high and often form thickets. The mature plant has long stems (canes) that are upright and arching and covered with distinctive glandular red hairs and small spines. The hairs give the canes a reddish color when seen from a distance. Under favorable conditions, canes may grow to a length of 9 feet.

Management Options

1. Mechanical Control

Hand-pulling or digging are difficult but acceptable methods of control, especially in small populations with few stems. These methods are impractical in large areas or in areas where the soil is dry or compact. Disturbance of the soil will contribute to germination and growth of new and additional plants. As with any invasive species, hand-grubbed vegetation must be properly disposed of to prevent recontamination or contamination of new areas.

2. Biological Control

No biological controls are indicated for wineberry.

3. Chemical Control

Although chemical controls are indicated in literature, no specific herbicides or applications rates are recommended.

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Spiraea japonica
(Japanese Spirea)

Japanese spiraea was introduced into the United States as an ornamental landscape plant and first cultivated in the northeastern states around 1870. Japanese spiraea tolerates a wide range of edaphic conditions and ideal habitats include successional fields, roadsides, forest edges and riparian areas. Once established, however, spiraea populations rapidly expand to invade canopy gaps and adjacent woodlands, forming dense stands which crowd out native species. It has been documented well into canopied areas previously undisturbed by non-native invasives. The small seeds are produced in large numbers and disperse through wind, water and disturbed soil.

Biology/Description

- Height:** Japanese spiraea is a small shrub with slender erect stems to 2 m (6.5 ft) tall.
- Stem:** Brown to reddish-brown stems are round and glabrous to densely pubescent on branchlets. Buds are very small, rounded to triangular and somewhat flattened.
- Leaves:** The leaves are alternate, lanceolate to lance-ovate, simply or doubly serrate, acute at base, 8-12 cm (3.0-4.5 in) long, 3-4 cm (1.2-1.6 in) wide, and glabrous.
- Flowers:** Inflorescence is a compound corymb with wide spreading branches. Flowers are pale to deep pink, 5 mm (0.2 in) wide, with stamens much longer than the 2-3 mm (0.07-0.11 in) petals. Blooms June-July.
- Fruit:** The 2.2-2.4 mm (0.09-0.1 in) long seeds are borne in a glabrous, smooth, and lustrous capsule. Blooms July-August.
- Origin:** Japanese spiraea is native to Japan and was first cultivated in 1870. Introduced as an ornamental landscape plant, spiraea spread from the northeast U.S. and is naturalized in much of the southeast and Midwest,

Similar Species: There are two native species of spiraea that are similar to Japanese spiraea: *S. virginiana* (Britt.) and *S. betulifolia* (Pallas). Both of these species are rare in Tennessee; *S. virginiana* is listed as a threatened species by the U.S. Fish and Wildlife Service. Japanese spiraea is distinguished by dense pubescence on the branchlets and inflorescence, lanceolate leaves, and pink flowers.

Management Options

1. Mechanical Control

While repeated mowing is effective as a management tool, the ability of the plant to produce flowers and seeds at lower heights on cut stems can result in the added dispersal of seed through the mowing action. Mowing will also not eradicate the species. Cutting and digging of the stems

is an effective control when labor forces are available and populations are small. Mechanical removal is difficult or impossible when the plant occurs in very rocky or dry soil. Even small pieces of root broken and left in the ground will resprout. As with any invasive species, hand-grubbed vegetation must be properly disposed of to prevent recontamination or contamination of new areas.

2. Biological Control

No biological controls are indicated for this species.

3. Chemical Control

Both triclopyr and glyphosate have proven effective on spirea when applied as a foliar spray and as a treatment on cut stems. Both are effective at low concentrations (2%) for foliar spray. Triclopyr has the advantage of being selective for broadleaf species, which is an advantage when non-target grasses are in proximity. When spirea grows in wet, saturated conditions, a glyphosate approved for use near water is required. Both chemicals are effective when sprayed on cut stems at a fairly low rate (25% recommended).

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Tussilago farfara
(Coltsfoot)

Coltsfoot is a perennial herb in the Asteraceae family. It is native to Europe and has a long history of being used as an expectorant. The name 'Tussilago' comes from the Latin 'tussis' which means cough. The name Coltsfoot refers to the horseshoe shaped leaves.

Height: Flowers grow to a height of 7.5 to 30.5 cm.

Leaves: The cordate (heart-shaped) leaves are slightly toothed, upright and the underside is whitish. They arise directly from the root with no main stem present. Individual leaves are 7.5 to 17.5 cm wide.

Flowers: The solitary flowers are dandelion-like and bright yellow in color. There are several scaly white flower stalks per plant. Flowers emerge before the leaves in early spring through June.

Seeds: The brown nutlets are attached to a pappus resembling the seeds of common dandelion.

Life History: Coltsfoot is a perennial with a multi-branched rhizome. In the early spring the flower stalks emerge before the leaves. Each stalk bears a solitary flower, which opens only on sunny days. The leaves appear after the flowers have matured; the flowers and leaves are usually not seen at the same time. The flowers and leaves arise directly from the rootstock. Coltsfoot reproduces both vegetatively and sexually. The roots can remain dormant underground for long periods of time. In some cases, coltsfoot has been known to reemerge after soil disturbance, and very small fragments of roots can produce new plants.

Origin: A native of Europe, this plant was probably brought to this country by early settlers for its medicinal properties. It has spread throughout the northeastern United States from Maine to North Carolina, west to Tennessee and north to Minnesota.

Similar Species: The ray-like flowers of Coltsfoot resemble dandelions (*Taraxacum officinale*). Dandelions differ by having a smooth flower stalk with milky white sap and long lobed leaves. The leaves of coltsfoot resemble many species including violets (*Viola* sp.), some forms of rattlesnake-root (*Prenanthes* sp.), and golden ragwort (*Senecio aureus*).

Habitat: Coltsfoot thrives in low-lying mesic areas including stream banks, moist field or pastures, roadsides, and disturbed areas. It can also be found in drier sites and in poor soils. It is intolerant of shade and is not commonly found in wooded areas, though it has been documented invading forests following fire.

Management Recommendations

1. Mechanical Control

Initial infestations may be controlled by hand pulling. It is critical that all of the underground portions of the plant are removed. Pulling when the ground is moist may make it easier to remove the entire plant. Residual roots left in the soil may resprout and possibly create several new plants. Hand pull before the plant has set seed to reduce the further spread.

2. Chemical Control

Foliar Spray: This method is effective on large populations or where mechanical control measures are not feasible or are impractical. Apply a 2% solution of glyphosate or triclopyr and water plus a non-ionic surfactant using a tank or backpack sprayer to thoroughly cover all leaves. Do not apply so heavily that herbicide drips off the leaf surface. Glyphosate is a non-selective herbicide requiring caution not to spray non-target species. Triclopyr is selective for broad leaf plants and is best used in areas where native grasses are present. Treatments should be done in the summer when the leaves of coltsfoot are fully developed. Refer to manufacturer's label for specific information and restrictions regarding use.

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Wisteria floribunda/sinensis

Wisteria

Chinese wisteria was brought to the U.S. from China in 1816 and Japanese wisteria was introduced from Japan around 1830. Both were brought in as ornamentals. They have been grown extensively in the southern U.S. as decorative additions to porches, gazebos, walls, and gardens. Most infestations in natural areas are a result of escapes from landscape plantings.

Biology/Description

Chinese and Japanese wisteria are exotic, showy, woody ornamental vines in the pea family, or Fabaceae.

- Height: These vigorous vines can climb trees, apparently limited only by the height of the tree, and have been observed to reach 65 feet. White-barked Japanese wisteria vines twine clockwise around the host plant and Chinese wisteria twines counter-clockwise.
- Leaves: The compound leaves, consisting of 7-13 (Chinese) or 13-19 (Japanese) smaller leaf units, called leaflets, are about 1 foot long and alternate along the stem.
- Flowers: Fragrant, violet to blue-violet flowers, ½ to 1 inch long, occur in showy, pendulous clusters that hang gracefully from the twining. Unlike American wisteria (*Wisteria frutescens*), native to the southeastern U.S., which flowers June through August, and produces a non-hairy seed pod 2-4 inches long, both exotic wisterias flower in the springtime (April-May) and produce a velvety seed pod.
- Fruits: The fuzzy brown seed pods are 4-6 inches long, narrowed toward the base, with constrictions between the seeds.
- Stems: Stems of the exotic wisterias can grow to 15 inches in diameter in older plants.
- Habitat: The ideal habitat for exotic wisterias is in full sun, but established vines will persist and reproduce in partial shade. Vines often climb surrounding vegetation and structures toward sunlight. Wisteria tolerates a variety of soil and moisture regimes but prefers loamy, deep, well drained soils. Infestations are commonly found along forest edges, roadsides, ditches, and rights-of-way.

Management Options

1. Mechanical Control

Cutting or digging of vines is feasible in small populations and in areas where the vine has not become established. These control methods can prevent seed production and preserve trees

which would otherwise be strangled. Retreatment will be necessary to take care of resprouts. Mechanical treatments should be started early in the growing season and continued throughout the season. These mechanical methods are valuable as initial treatments to large populations prior to herbicidal applications. As with any invasive species, hand-grubbed vegetation must be properly disposed of to prevent recontamination or contamination of new areas.

2. Biological Control

No biological controls are indicated for wisteria.

3. Chemical Control

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

Use foliar spray herbicide treatments to control large infestations of exotic wisterias. It may be necessary to precede foliar applications with stump treatments to reduce the risk of damaging non-target species. Apply a 2% concentration of glyphosate (e.g. Round Up) or triclopyr (e.g. Garlon) and water, plus a 0.5% non-ionic surfactant to thoroughly wet all foliage. Chlorpyralid (e.g. Transline) is effective at a concentration of 0.5% and is selective to plants in the aster, buckwheat, and pea families. Caution should be taken with chlorpyralid as groundwater pollution through leaching can be a problem with certain soil types. Do not apply spray so heavily that herbicide drips off the leaves. Glyphosate is a non-selective systemic herbicide that may kill non-target plants that are only partially contacted by spray. Triclopyr is selective to broadleaved species and is a better choice if native grasses are present. Ambient air temperature should be above 65°F for all foliar treatments.

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