FORESTRY MANAGEMENT AND INVASIVE SPECIES CONTROL PLAN

May 2024

Prepared for:

Municipality of Mt. Lebanon

MT. LEBANON
PENNSYLVANIA

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INTRODUCTION

The Mt. Lebanon Parks Master Plan, completed in 2022, recognized the importance of healthy park ecosystems for the safety and enjoyment of visitors. The Parks Master Plan recognized that threats such as climate change adaptation and invasive species were important potential threats to the parks. Therefore, they recommended as a Tier 1 Priority that the Municipality complete a Woodland Park Management Plan and an Invasive Plant Management Plan.

The Municipality thus engaged Oikos Ecology LLC to complete a Forestry Management and Invasive Species Control Plan. This report is organized in the following sections:

Part 1: Assessment and Recommendations – field assessment and generalized recommendations
Part 2: Management Plan – specific recommendations for management units in each park
Part 3: Implementation Plan – schedule of activities, budget, and potential contractors and funding

PART 1: Assessment and Recommendations

In spring 2023, ecologists from Oikos Ecology LLC began collecting data on invasive species presence in each of the ten conservation-focused parks owned by the Municipality. The assessment was conducted during the time when invasive shrub species like Amur honeysuckle, Chinese privet, and multiflora rose were leafed out but native species were not yet leafed out. This made identification and mapping of invasive shrubs more effective. Additionally, many invasive herbaceous species, including for example garlic mustard, poison hemlock, Japanese knotweed, and lesser celandine, were also evident at this time and they were also mapped. Data were supplemented with additional data collected through the summer.

In consultation with the Municipality, it was decided to focus subsequent assessments and recommendations on the three largest conservation parks – Bird, Twin Hills, and Robb Hollow. Thus, in summer 2023, Oikos Ecology LLC completed a forest canopy assessment of the three parks using two methods. The first established a set of 8 to 10 forest inventory points systematically within each park. Points were located in the field with a global positioning system (GPS). Around each survey point, a quantitative tree survey was conducted using a calibrated prism to select trees representing 10 square feet of basal area each. Each of these trees was located with the GPS, identified to species, and its diameter measured at breast height (DBH = 4.5 feet above ground). These results were tabulated for each park and provide indications of forest community composition, mean tree size, and variability across each park.

The second method of forest canopy assessment used aerial imagery collected with an unmanned aerial vehicle (UAV, aka “drone”). These images were assembled to provide a detailed, orthographically correct, color mosaic aerial image of each park. Additionally, we used photogrammetric methods to develop a three-dimensional model of the canopy surface of the parks, from which a canopy height model was developed by subtracting the ground surface elevation from the canopy surface elevation. The goal of this exercise was to help locate areas of sparse canopy, which could suggest areas to focus reforestation and invasive shrub management.

Finally, we collected information from Municipality staff and volunteers on locations of past and ongoing tree planting and invasive plant management projects. These were provided to the project team in the form of annotated maps, which we digitized so they could be displayed along with the other mapped data to suggest areas where new and follow-up management projects could be located.

FINDINGS

Each of Mt. Lebanon's three main conservation parks has a mixed land use history based on each being consolidated from multiple previous landowners (see Pittsburgh Historic Maps[1]). For example, Bird Park consisted of two main parcels in 1923, the eastern of which was forested continuously since at least 1939 and the western of which was open pasture in 1939 with scattered tree lines. This eastern portion of Bird Park then regenerated into the early-successional forest we see today. Robb Hollow Park consisted of at least five parcels in 1923. Most of these appeared to be regenerating forest or scrub in 1939, except the Robb Hollow creek area itself which was wooded. The neighborhood that the park surrounds is evident first in the 1957 imagery, and by then woods within the park area were expanding. Twin Hills Park consisted of two parcels in 1923. In 1939, the western of these was mostly pasture or fields and the eastern parcel was mixed pasture and woodland in the hollow. By 1967, the western parcel was still mostly open with woodlands around the edges but the western was mostly regenerating forest or scrub.

Invasive species

Across all parks, it quickly became apparent that invasive shrub species, especially Amur honeysuckle, winged euonymus (burning bush), and Chinese privet, are the primary factor threatening the parks (Figure 1). These invasive shrubs make many areas of the parks impenetrable, provide very little habitat value for native wildlife, and interfere with establishment and growth of tree regeneration and native flora. Areas with high densities of invasive shrubs are most prevalent in areas that had a longer history of open scrubby condition (evident from historic aerial imagery), whereas those with lower density of invasive shrubs appear to be those that were continuously forested or regeneratesd to forest more quickly.

Forest health

Forest composition in the three parks indicates a northern hardwoods forest community with elements of mixed oak. The forest composition is heavily influenced by the disturbed site histories, interference by invasive plant species, and high levels of deer browsing. I evaluated forestry point data for each park against a forestry stocking guide for northern hardwoods forests[2] (Figure 2). Stocking combines information on basal area, mean tree diameter[3], and density (number of trees per acre), to help inform management of forest stands. Fully stocked stands lie above the minimum stocking line in Figure 2 and are considered healthy (all else being equal) whereas under-stocked stands lie below this line and indicate a problem, usually with the conditions under which the stand regenerated, or due to disturbance. Over-stocked stands lie above the maximum stocking line and an are indication of an over-mature condition. This means there is no additional room for canopy tree growth. While it is important to recognize that the primary purpose of stocking guides is to guide forest management aimed at timber harvest, which is not a goal for the Municipality, they nevertheless provide a useful framework for understanding the condition of forests vis a vis opportunity for additional canopy growth or overly open conditions.

[1] https://www.arcgis.com/apps/View/index.html?appid=63f24d1466f24695bf9dfc5bf6828126

[2] Tubbs, C. H. (1977). Manager's handbook for northern hardwoods in the North Central States (Vol. 39). Department of Agriculture, Forest Service, North Central Forest Experiment Station, Forest Service.

[3] Basal area is the total cross-sectional area of tree trunks at breast height (4.5 ft) expressed as square feet per acre. Quadratic mean diameter is the diameter corresponding to a tree of average cross-sectional area at breast height.

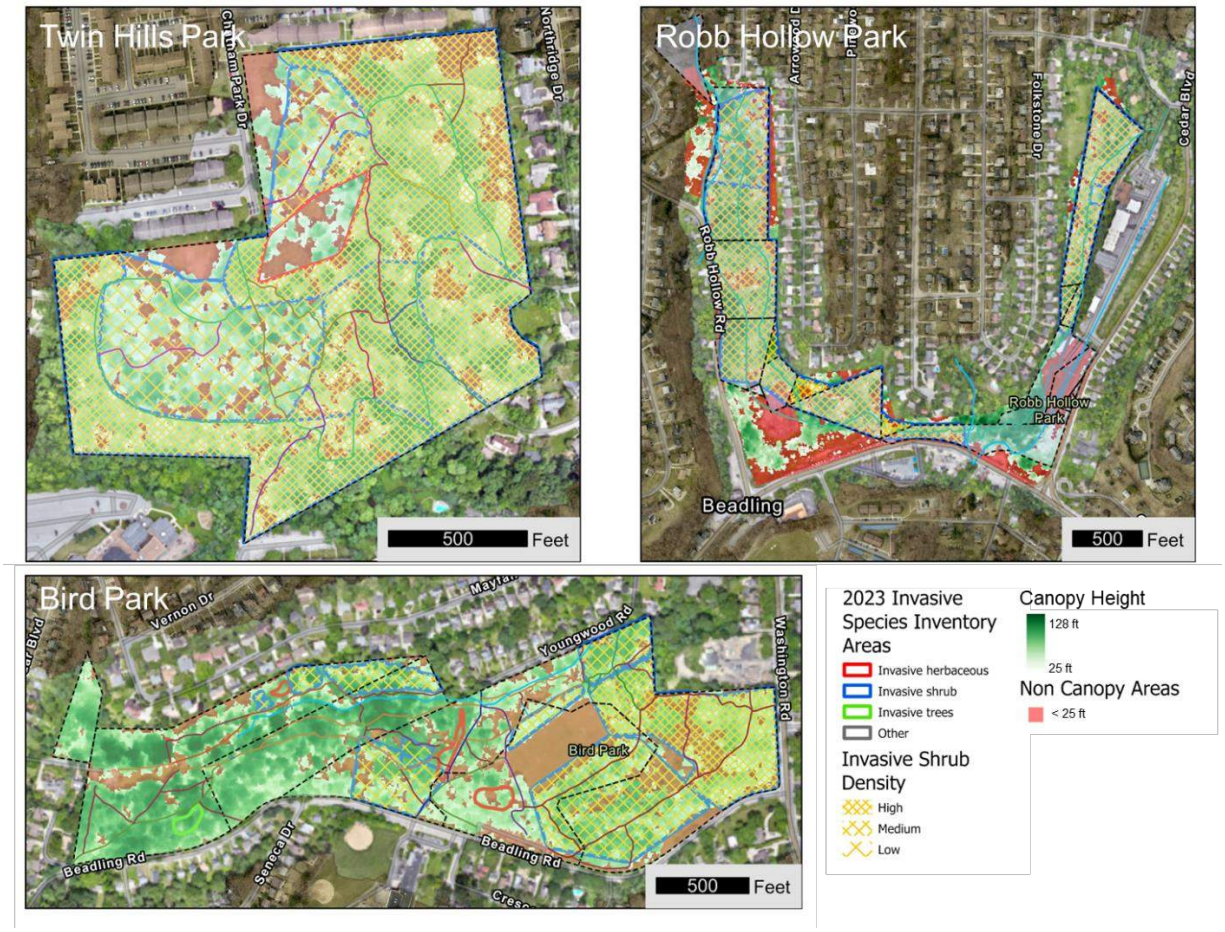


Figure 1. Invasive species prevalence in Twin Hills, Robb Hollow, and Bird Parks, Municipality of Mt. Lebanon.

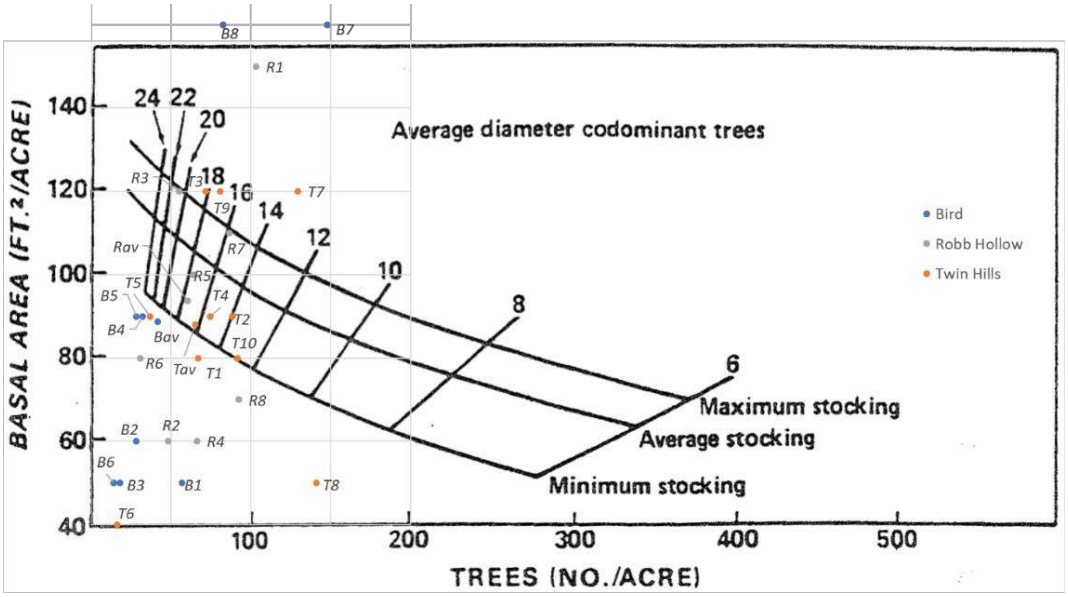


Figure 2. Stocking levels of each sample point superimposed on a stocking guide for norther hardwood forests. Points below the minimum stocking line are under-stocked and those above the maximum stocking line are over-stocked; those between these lines are fully stocked. Adapted from figure 6 in Tubbs (1977).

Bird Park – Fourteen tree species were observed across 8 tree assessment points in Bird Park (Table 1). Of these, the only invasive tree species were Norway maple and white mulberry, each comprising 1% of the sample. The dominant tree species across the park were black cherry and black locust; however, black locust trees were concentrated in the eastern half of the park. The average basal area across the park was 89 sq ft/ac. With quadratic mean tree diameter of 20 inches DBH, this is somewhat less than fully stocked (Figure 2), meaning trees on average are not fully utilizing the site. However, when looking at individual sample points, only points 1, 2, 3 and 6 were severely under stocked, and points 4 and 5 were somewhat understocked (Figure 2). The black locust-dominated areas (represented by points 7 and 8 in the southeastern portion of the park) are over-stocked (Table 1). Combined with their advanced age for a pioneer tree species, they are likely to die in a few years. Considering the dense understory of invasive shrubs and lack of existing understory trees to regenerate, these areas should be the subject of invasive species removal and tree planting.

For the canopy height model, we determined that 25 feet was the lower extent of forest canopy, meaning that areas with maximum height less than 25 feet were composed mostly of shrubs or herbaceous vegetation This 25-ft cutoff was remarkably consistent across the three parks. Figure 3a shows the canopy height model, with areas in red representing open canopy areas and green representing forest canopies of various heights. Overlaying the forestry assessment point locations with the canopy height model reveals that the under-stocked points were mostly located near areas of open canopy in the eastern half of the park. Point 6, in the western part of the park appears to have a tall canopy composed of a few very large trees.

The canopy height model also reveals that for the most part, areas of open canopy were also observed to have higher densities of invasive shrubs (Figure 3b). Whereas some of these areas have been subject to removal of invasive species in the past (Figure 3c), the current moderate to high density of remaining invasive shrubs indicates the need for follow-up treatment.

Table 1. Tree species composition from 8 survey points in Bird Park, summer 2023 (BA = basal area in sq ft/ac; QMD = quadratic mean diameter in inches).

	Bird Park 1		Bird Park 2		Bird Park 3		Bird Park 4		Bird Park 5		Bird park 6		Bird park 7		Bird park 8		Parkwide			
Tree species	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	N	%	BA	QMD
American Elm	10	15													10	24	2	3%	3	20
Bitternut Hickory									10	28							1	1%	1	28
Black Cherry	20	15	30	22	10	21	40	26	20	25			60	13	40	22	22	31%	28	20
Black Locust													90	16	100	18	19	27%	24	17
Black Maple					20	21	10	20	10	16							4	6%	5	19
Black Walnut					10	22	10	10			10	30					3	4%	4	22
Boxelder							10	9									1	1%	1	9
Hawthorn	10	6													10	6	2	3%	3	6
Northern Red Oak			10	24	10	28	10	35	10	37	30	27					7	10%	9	30
Norway Maple	10	12															1	1%	1	12
Pin Oak			10	17													1	1%	1	17
Red Maple			10	5			10	15									2	3%	3	11
Sugar Maple									40	20	10	11					5	7%	6	19
White Mulberry													10	5			1	1%	1	5
Plotwide BA/QMD	50	13	60	20	50	23	90	23	90	24	50	25	160	14	160	19	71		89	20

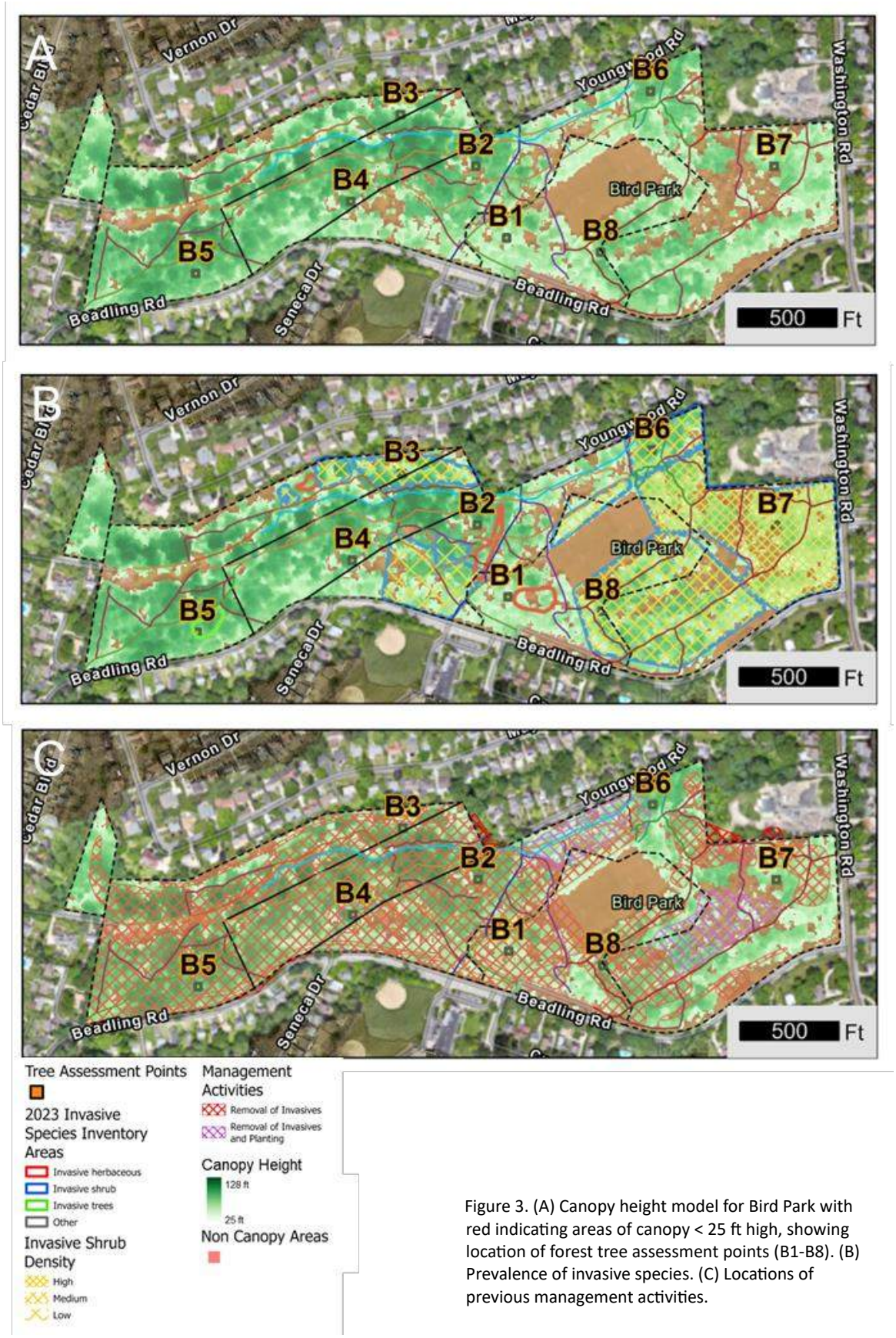


Figure 3. (A) Canopy height model for Bird Park with red indicating areas of canopy < 25 ft high, showing location of forest tree assessment points (B1-B8). (B) Prevalence of invasive species. (C) Locations of previous management activities.

Robb Hollow Park – Sixteen tree species were observed across 8 tree assessment points in Robb Hollow Park; none were invasive (Table 2). The dominant tree species across the park were black cherry and northern red oak; however, most of the northern red oak trees were from a single sample point (Robb Hollow 5). The average basal area across the park was 94 sq ft/ac. With quadratic mean tree diameter of 17 inches DBH, this is on the lower end of a fully stocked stand. Points 2 and 4 were severely under-stocked, and point 6 was somewhat understocked.

Figure 4a shows the canopy height model for Robb Hollow Park, with areas in red representing open canopy areas and green representing forest canopies of various heights. Overlaying the forestry assessment point locations with the canopy height model reveals that the under-stocked points were mostly located near areas of open canopy.

While there were areas of open canopy scattered across the park, the canopy height model does not show a strong correlation between open canopy and invasive species presence (Figure 4b). The only area without significant coverage of invasive shrubs was the southeastern corner of the park. Whereas some of these areas have been subject to removal of invasive species in the past (Figure 4c), the current moderate to high density of remaining invasive shrubs indicates the need for follow-up treatment.

Twin Hills Park – Because of its somewhat larger size and configuration, we surveyed 10 tree assessment points in Twin Hills Park. Despite the higher number of samples, Twin Hills had the lowest tree species richness, with just 7 species observed; none were invasive (Table 3, though Norway maples were observed near point T10 and tree of heaven near point T6). The dominant tree species across the park were black locust and black cherry, followed by American elm. Unlike with the other parks, Black locust was fairly evenly distributed across the park. The average basal area across the park was 88 sq ft/ac. With quadratic mean tree diameter of 16 inches DBH, this is on the lower end of a fully stocked stand. Points 6 and 8 were severely under-stocked and points 1 and 5 were slightly under-stocked.

Figure 5a shows the canopy height model, for Twin Hills Park with areas in red representing open canopy areas and green representing forest canopies of various heights. Overlaying the forestry assessment point locations with the canopy height model reveals that the under-stocked points were located near areas of open canopy.

Invasive shrub species were present at moderate to high density throughout the park, and areas of open canopy were scattered across the park as well. (Figure 45). The only area without significant coverage of invasive shrubs was the southwestern and northwestern corners of the park that had previously been managed (Figure 5c). The current low density of invasive shrubs in these areas indicates follow-up treatment can soon get these areas under control.

Figure 4. (A) Canopy height model for Robb Hollow Park with red indicating areas of canopy < 25 ft high, showing location of forest tree assessment points (R1-R8). (B) Prevalence of invasive species. (C) Locations of previous management activities.

Table 2. Tree species composition from 8 survey points in Robb Hollow Park, summer 2023 (BA = basal area in sq ft/ac; QMD = quadratic mean diameter in inc

	Robb Hollow 1		Robb Hollow 2		Robb Hollow 3		Robb Hollow 4		Robb Hollow 5		Robb Hollow 6		Robb Hollow 7		Robb Hollow 8		Parkwide			
Tree species	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	N	%	BA	QMD
American Beech													20	11			2	3%	3	11
American Elm							10	7					10	11			2	3%	3	9
Black Cherry	50	16	50	15			40	15			20	15	40	15	20	15	22	29%	28	15
Black Locust					10	12											1	1%	1	12
Black Maple	10	18			10	15											2	3%	3	16
Black Walnut					10	13											1	1%	1	13
Chinkapin Oak													10	20	10	17	2	3%	3	18
Eastern Hop Hornbeam													10	12			1	1%	1	12
Northern Red Oak					50	25			100	17							15	20%	19	20
Red Maple											20	28			40	8	6	8%	8	17
Sassafras											40	21					4	5%	5	21
Sugar Maple					30	12											3	4%	4	12
Tulip Poplar													20	19			2	3%	3	19
White Ash							10	7									1	1%	1	7
White Oak					10	27											1	1%	1	27
White Pine	90	16	10	18													10	13%	13	17
Plotwide BA/QMD	150	16	**60**	15	120	20	**60**	13	100	17	**80**	22	110	15	70	12	75		94	17

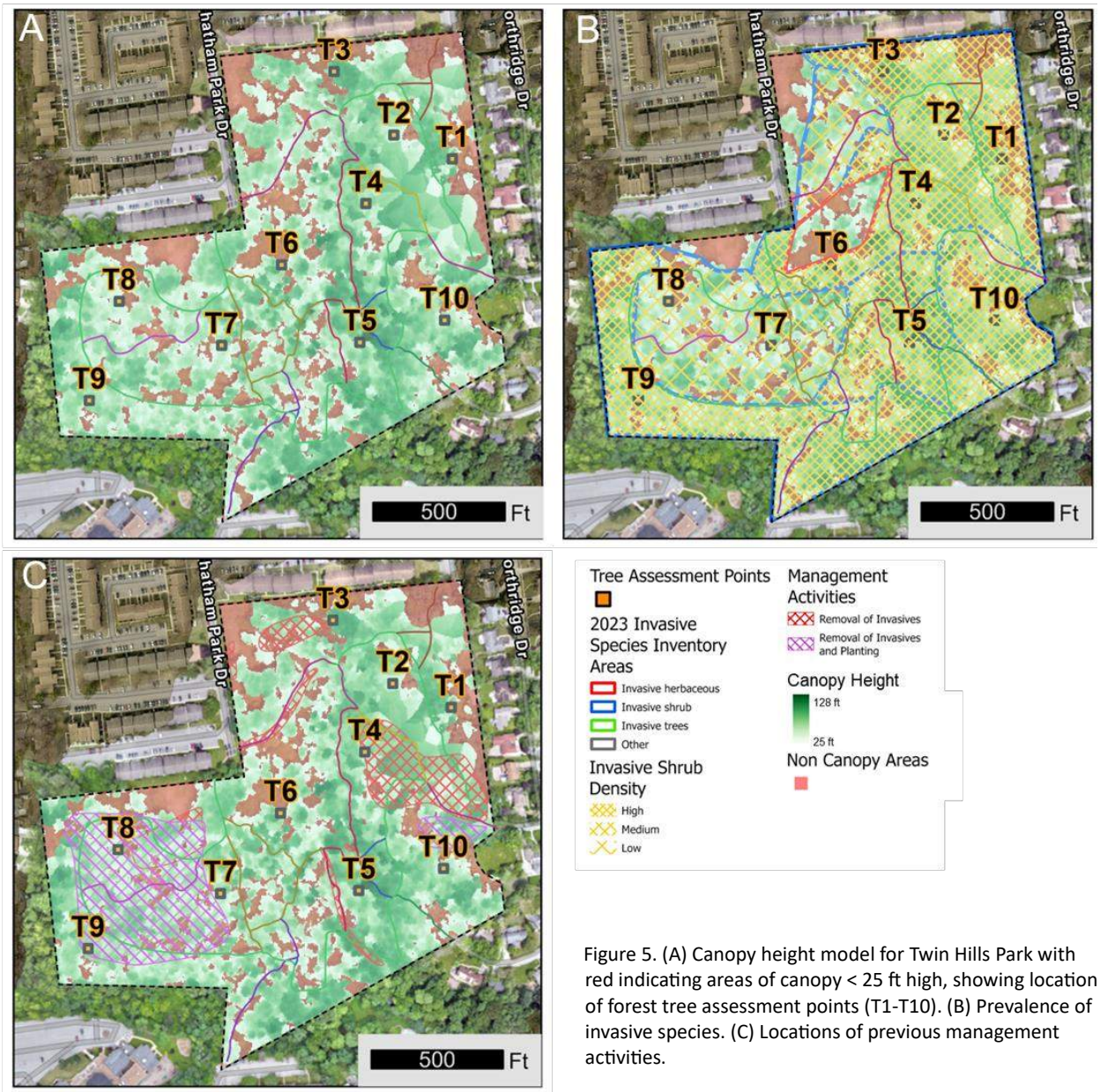


Figure 5. (A) Canopy height model for Twin Hills Park with red indicating areas of canopy < 25 ft high, showing location of forest tree assessment points (T1-T10). (B) Prevalence of invasive species. (C) Locations of previous management activities.

Table 3. Tree species composition from 8 survey points in Twin Hills Park, summer 2023 (BA = basal area in sq ft/ac; QMD = quadratic mean diameter in inches).

	Twin Hills 1		Twin Hills 2		Twin Hills 3		Twin Hills 4		Twin Hills 5		Twin Hills 6		Twin Hills 7		Twin Hills 8		Twin Hills 9		Twin Hills 10		Parkwide			
Tree species	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	BA	QMD	N	%	BA	QMD
American Elm	10	13					40	10	10	21	10	13	40	10	50	8	10	13	10	14	18	20%	18	11
Bitternut Hickory									10	18											1	1%	1	18
Black Cherry	30	13	60	12			20	15	30	30			20	8			80	17	60	12	30	34%	30	16
Black Locust	40	16	30	16	120	18	30	19			20	27	60	16			30	16	10	17	34	39%	34	18
Black Walnut											10	15									1	1%	1	15
Eastern Wahoo									10	7											1	1%	1	7
Sugar Maple									30	14											3	3%	3	14
Grand Total	80	15	90	14	120	18	90	15	90	21	40	21	120	13	50	8	120	16	80	13	88		88	16

Climate adaptability of tree species – I evaluated tree species observed in tree assessment point surveys for climate change adaptability using projections provided by the USDA Forest Service's Climate Change Tree Atlas (https://www.fs.usda.gov/nrs/atlas). The Atlas combines information on the preferred climate conditions of each species (based on extensive inventories across the US) with species characteristics like dispersal ability to assess the overall capability of the species to cope with the future climate conditions in an area. A synthesis of the results is provided in Table 4. Note that the most dominant tree species across the three parks, black cherry and black locust, are rated as performing poorly under future climate projections. However, most of the individual species are projected to perform well under future climate projections.

Table 4. Tree species present in Mt. Lebanon parks forest surveys that have been rated for climate adaptability in the Pittsburgh area (https://www.fs.usda.gov/nrs/atlas).

Common Name	Scientific Name	Climate capability*
Chinkapin oak	*Quercus muehlenbergii*	New Habitat
White oak	*Quercus alba*	Very Good
Boxelder	*Acer negundo*	Good/Very Good
Bitternut hickory	*Carya cordiformis*	Good/Very Good
Red maple	*Acer rubrum*	Good
Sugar maple	*Acer saccharum*	Good
Black walnut	*Juglans nigra*	Good
Northern red oak	*Quercus rubra*	Good
Yellow-poplar	*Liriodendron tulipifera*	Fair/Good
Eastern hophornbeam	*Ostrya virginiana*	Fair/Good
White ash	*Fraxinus americana*	Fair
Sassafras	*Sassafras albidum*	Fair
American beech	*Fagus grandifolia*	Poor/Fair
American elm	*Ulmus americana*	Poor/Fair
Black maple	*Acer nigrum*	Poor
Black cherry	*Prunus serotina*	Poor
Black locust	*Robinia pseudoacacia*	Poor
Eastern white pine	*Pinus strobus*	Very Poor
Pin oak	*Quercus palustris*	Very Poor

* Combination of Capability45 and Capability85 ratings, which rate species by their ability to survive and regenerate under lower and higher future climate scenarios, respectively. The Atlas did not provide projections for Norway maple or eastern wahoo due to limited data.

RECOMMENDATIONS

Invasive species management

Trees – Invasive trees were not observed to be a significant issue for Bird, Robb Hollow, and Twin Hills Parks. There is a small stand of Norway spruce in Bird Park that could be removed, but it is not high priority as Norway spruce tends not to spread. Other invasive tree species like Norway maple and tree of heaven were observed, but not in concentration. These can be selectively culled by hack-and-squirt herbicide treatment. Dead trees can be left standing for wildlife habitat if they don't pose a safety hazard.

Shrubs – While past efforts at invasive shrub removal have been successful at reducing shrub cover, in many areas it appears these effects were temporary due to their existing seed banks and the ability of all the major shrub species encountered to resprout from cut stumps. Therefore, it is recommended that all recently completed invasive shrub removal projects be followed up with annual monitoring and management consisting of follow-up cutting and spot herbicide application when resprouting shrubs are still small. A seed mix of native herbaceous species (adapted to partial sun) should be applied to each

shrub removal area to occupy the site and help prevent establishment of new invasive species' seedlings. Over time, this strategy will allow the native understory community to re-establish and promote growth of canopy trees via reduced competition for soil resources.

After current and recent shrub removal projects have been brought under reasonable control, additional shrub removal areas can be added, starting with the densest areas adjacent to areas under active management.

Woody vines – Woody vines, including both native and non-native species, can threaten survival and growth of existing and future canopy trees. However, woody vines were not observed to be a major problem in the three focal parks, apparently due to ongoing management by volunteers. It is recommended that inspection for and removal of woody vines continue in each of the parks on an ongoing basis. Woody vines should be cut at shoulder level and then at the ground. The cut stump can be treated with a concentrated herbicide solution.

Herbaceous plants – There were many invasive herbaceous plants observed in the parks, but for the most part, their presence was not deemed to be as big a threat as invasive shrubs. One significant patch of Japanese knotweed was observed in Twin Hills Park at the bottom of a ravine, accompanied by scattered tree of heaven. This area could be the target of invasive species removal. Additionally, poison hemlock appears to be spreading in sunnier areas. Isolated individuals can be cut below the root collar with a spade, which will kill them; extensive patches of seedlings can be sprayed. Other invasive herbs like garlic mustard and lesser celandine occurred throughout, but relative to the other species are less a threat.

Tree planting

Large areas of each of the parks are dominated by two species that are approaching the end of their life cycles and are not projected to fare well under future climate scenarios (black cherry and black locust). When seeking to establish a forest understory that will be able to regenerate into the canopy and thrive under our changing climate, it is important to consider species that are projected to perform well as well as ones that are suitable to the site and are less prone to disease or pests.

To generate a list of trees to consider for future plantings, I screened all tree species modelled by the USDA Forest Service Climate Change Tree Atlas for the Pittsburgh area against recommendations for the soil types that occur in each park[4]. I also considered species that currently exist in the parks, as well as pests and diseases and other factors. Species that currently occur in the parks or nearby, are projected to perform well under the future climate, are adapted to the parks' soils, and relatively free of pests and diseases make good candidates for planting. Table 5 summarizes this information with species in bold being recommended; other species in this list may be also be suitable. Table 6 summarizes trees that are modeled to perform poorly by the Climate Change Tree Atlas; they are thus *not* recommended for future plantings.

[4] Web Soil Survey available at https://websoilsurvey.nrcs.usda.gov/, Forestland Productivity analysis.

Table 5. Tree species that are rated by USDA Forest Service Climate Atlas climate capability to perform **well** in the Pittsburgh Region (combined projections under two emissions scenarios; https://www.fs.usda.gov/nrs/atlas), recommendations from the NRCS Soil Survey for soils that occur in each park (corresponding to recent past climate conditions), and notes on pest/disease risk. Species in bold are recommended for planting combining these factors, availability, and professional experience, and include some (below horizontal line at bottom) that are rated to perform poorly by the climate atlas, but can be successful under certain conditions (see notes).

		Present	Climate	Soil Report			
Common Name	**Scientific Name**	**in survey**	**Capability**	**B**	**RH**	**TH**	**Notes**
Florida maple	*Acer barbatum*		New Habitat				
Black hickory	*Carya texana*		New Habitat				
Sugarberry	*Celtis laevigata*		New Habitat				
Eastern redbud	***Cercis canadensis***		**New Habitat**				
Common persimmon	***Diospyros virginiana***		**New Habitat**				
Eastern redcedar	*Juniperus virginiana*		New Habitat				
Sourwood	*Oxydendrum arboreum*		New Habitat				
Shortleaf pine	***Pinus echinata***		**New Habitat**	**x**	**x**	**x**	
Loblolly pine	*Pinus taeda*		New Habitat				
Virginia pine	***Pinus virginiana***		**New Habitat**	**x**	**x**		
Southern red oak	*Quercus falcata*		New Habitat				1
Bluejack oak	*Quercus incana*		New Habitat				1
Blackjack oak	*Quercus marilandica*		New Habitat				1
Chinkapin oak	***Quercus muehlenbergii***	**x**	**New Habitat**				**1**
Post oak	*Quercus stellata*		New Habitat				1
Gum bumelia	*Sideroxylon lanuginosum*		New Habitat				
Eastern hemlock	***Tsuga canadensis***		**New Habitat**				**2**
Winged elm	*Ulmus alata*		New Habitat				
White oak	***Quercus alba***	**x**	**Very Good**	**x**	**x**	**x**	**1**
Black oak	***Quercus velutina***		**Very Good**	**x**	**x**	**x**	**1**
Boxelder	*Acer negundo*	x	Good/V. Good				
Bitternut hickory	***Carya cordiformis***	**x**	**Good/V. Good**				
Red maple	*Acer rubrum*	x	Good	x			
Sugar maple	***Acer saccharum***	**x**	**Good**	**x**	**x**	**x**	
Mockernut hickory	*Carya alba*		Good				
Pignut hickory	*Carya glabra*		Good				
Shagbark hickory	***Carya ovata***		**Good**				
Hackberry	***Celtis occidentalis***		**Good**				
Green ash	*Fraxinus pennsylvanica*		Good		x		2
Black walnut	***Juglans nigra***	**x**	**Good**	**x**	**x**	**x**	**3**
Sweetgum	*Liquidambar styraciflua*		Good				
Blackgum	*Nyssa sylvatica*		Good				
Chestnut oak	*Quercus prinus*		Good	x	x		1
Northern red oak	***Quercus rubra***	**x**	**Good**	**x**	**x**	**x**	**1**
Yellow-poplar	***Liriodendron tulipifera***	**x**	**Fair/Good**	**x**	**x**	**x**	
Eastern hophornbeam	***Ostrya virginiana***	**x**	**Fair/Good**				
Flowering dogwood	*Cornus florida*		Fair				
White ash	*Fraxinus americana*	x	Fair	x	x	x	2
Honeylocust	*Gleditsia triacanthos*		Fair				
Sassafras	*Sassafras albidum*	x	Fair				
Serviceberry	***Amelanchier spp.***		**V. Poor/Poor**				**4**
American holly	***Ilex opaca***		**Lost**				**4**
Pawpaw	***Asimina triloba***		**V. Poor**				**4**
Sycamore	***Platanus occidentalis***		**Poor/Fair**	**x**			**4**
Scarlet oak	***Quercus coccinea***		**Poor**	**x**	**x**		**1, 4**

Notes: 1 = Disperse oaks to limit disease risk of disease spread; 2 = Pest/disease prone (manageable for limited plantings of hemlock but not for ashes); 3 = Allelopathic but some species are compatible with it. 4 = Capability was modeled as low due to current rarity and/or limited dispersal ability to colonize new habitat – if planted, it is modeled to do well.

Table 6. Tree species that are rated by USDA Forest Service Climate Atlas climate capability to perform **poorly** in the Pittsburgh Region (combined projections under two emissions scenarios; https://www.fs.usda.gov/nrs/atlas) and recommendations from the NRCS Soil Survey for soils that occur in each park (corresponding to recent past climate conditions). None of these species are recommended to be planted.

		Present	Climate	Soil Report			
Common Name	**Scientific Name**	**in survey**	**Capability**	**B**	**RH**	**TH**	**Notes**
Silver maple	*Acer saccharinum*		Poor/Fair				
American beech	*Fagus grandifolia*	x	Poor/Fair				2
Osage-orange	*Maclura pomifera*		Poor/Fair				
Red mulberry	*Morus rubra*		Poor/Fair				
American elm	*Ulmus americana*	x	Poor/Fair				
Slippery elm	*Ulmus rubra*		Poor/Fair				
Black maple	*Acer nigrum*	x	Poor				
Eastern cottonwood	*Populus deltoides*		Poor				
Black cherry	*Prunus serotina*	x	Poor	x	x	x	
Black locust	*Robinia pseudoacacia*	x	Poor				
American hornbeam	*Carpinus caroliniana*		V. Poor/Poor				
American basswood	*Tilia americana*		V. Poor/Poor				
Striped maple	*Acer pensylvanicum*		Very Poor				
Sweet birch	*Betula lenta*		Very Poor				
Cucumber magnolia	*Magnolia acuminata*		Very Poor				
Eastern white pine	*Pinus strobus*	x	Very Poor	x	x	x	
Shingle oak	*Quercus imbricaria*		Very Poor				1
Pin oak	*Quercus palustris*	x	Very Poor	x			1
Black willow	*Salix nigra*		Very Poor				
Yellow birch	*Betula alleghaniensis*		Lost/V. Poor				
Red pine	*Pinus resinosa*		Lost	x	x		
Bigtooth aspen	*Populus grandidentata*		Lost				
Quaking aspen	*Populus tremuloides*		Lost				
Pin cherry	*Prunus pensylvanica*		Lost				

Notes: 1 = Prone to disease spread; 2 = Pest/disease prone.

PART 2: Management Plan

INTRODUCTION

The purpose of the management plan is to translate the generalized recommendation presented in Part 1 into a series of tasks that should be completed both overall as a park system and within each park. These include a schedule of routine activities that should be accomplished, such as removal of identified invasive species when encountered so as to prevent outbreaks, as well as major projects such as removal of already-established populations of invasive species and recommended re-vegetation to avoid re-infestation. A draft of the management plan was reviewed with Municipality staff and stakeholders to receive feedback on the recommendations. This feedback was incorporated into the final version presented here.

GOALS AND OBJECTIVES

The goal of the management plan is to provide guidance to Mt. Lebanon Municipality on sustainable management for long-term forest health its three large conservation parks (Bird, Robb Hollow, and Twin Hills).

The objectives are to:

1. Provide recommendations on forest rehabilitation projects in defined areas to:
    a. Manage invasive plant species, focusing on shrubs
    b. Re-establish a healthy native tree, shrub, and herbaceous plant community through planting and seeding
2. Provide recommendations on system-wide routine monitoring and maintenance (adaptive management) to help keep invasive plant species from becoming infestations or reinfesting treated areas.

RECOMMENDATIONS

Park System-wide Recommendations

There are four over-arching recommendations to improve the condition and long-term sustainability of the Mount Lebanon park system. These include:

1. **Park boundary demarcation**: For the most part, boundaries of all the Municipality's parks are not well marked, leading to encroachment by adjoining landowners in many locations, including dumping of yard waste and other material. Therefore, it is recommended that for at least the three focal parks, a boundary survey be conducted and two-sided boundary markers be installed around the perimeter of each park. Where dumping is observed, adjoining landowners should instructed to stop and notified of relevant penalties for continuing.

2. **Increase deer harvesting quotas**: Protecting plantings from deer browsing is expensive, unsightly, requires a lot of upkeep, and only partially effective. It is therefore recommended that the Municipality, in consultation with their contractor (Suburban Wildlife Management Solutions), take the necessary measures to increase the number of deer harvested each year to further reduce their negative effects on vegetation.

3. **Invasive plant species ordinance**: Implementing an invasive species ordinance that prohibits the planting of known invasive species would help control their spread at the community level. The

PA Department of Conservation and Natural Resources (DCNR) maintains a list of invasive plant species ranked by risk level (attached)[1]. It is recommended to prohibit all species on the list regardless of risk level (including "watch list" species).

4. **Restore park vegetation**: All of the conservation parks visited are infested with invasive plant species to varying degrees, threatening the long-term sustainability of forests and other plant communities in the parks. Invasive species prevalence and lack of tree regeneration and desirable understory plants are exacerbated by the two other main issues identified above. In consultation with the Municipality, it was decided to focus specific management recommendations on the three large conservation parks. These recommendations are elaborated below and in the following sections. It is recommended that a management plan be developed for the remaining parks after substantial progress on the current management plan has been made. Additionally, it is recommended that an education program be installed (including for example signs and links to web sites) about the vegetation management program, including information about invasive species.

Individual Park Management Units

Following from the generalized recommendations presented in Part 1, each of the three focal parks was revisited in February 2024 to define specific Management Units (MU) for which specific objectives and recommendations are further detailed in the following sections. Following the period of active management projects like invasive species treatment and planting, it is essential that the prescribed Monitoring and Adaptive Management Plan be implemented. This will ensure that any issues like new invasive species or tree mortality are detected early and can be addressed in the most cost effective manner possible.

For many of the MUs, tree, shrub, and herbaceous planting/seeding is recommended. I simplified the tree species selection based on recommendations from Table 5 in Part 1, based primarily on availability and keeping to species with more general planting requirements. For shrubs, I made a selection of native shrubs, most of which provide human and wildlife food uses, as well as flowers. For herbaceous seeding, I discussed the goals of the project with Ernst Conservation Seeds, who recommended their Partially Shaded Area Roadside Mix ERNMX-140 as a general mix that would do well against invasive species in partially shaded areas.

As most of the recommended projects involve extensive invasive shrub removal, hundreds of trees and shrubs to be planted, and acres of herbaceous seeding, hiring an experienced contractor is recommended. Prior to commencing work, the selected contractor should review the project area with the ecologist to verify area boundaries, species to be targeted, species to be protected, potential locations of brush piles, proposed alternative methods or substitutions, etc.

Some projects involve small-scale invasive species removal, monitoring, and adaptive management; these projects can engage volunteers.

[1] Also available at: https://elibrary.dcnr.pa.gov/GetDocument?docId=2700788&DocName=dcnr_20033786.pdf

MANAGEMENT UNIT DESCRIPTIONS & RECOMMENDATIONS

MT. LEBANON PENNSYLVANIA

Oikos Ecology LLC

CIVIC MAPPER

N

Bird Park Management Units

0 500 1,000 Feet

MU B1 – Riparian restoration project 2.1 acres

Objectives

This area is intended as a reference for good management of the Mt Lebanon parks. Encourage successful growth and establishment of restoration plantings in the area and maintain the area free of invasive plant species. Conserve and protect the existing sassafras grove, due to threat of laurel wilt disease.

Current Conditions

This MU consists of a sparsely canopied forest in the riparian area of a small stream. A vegetation restoration project is being implemented (invasive shrub removal and tree planting).

Management Activities

Invasive species management

Continue removal of invasive shrubs and other invasive species to the northern edge of the park. Apply concentrated triclopyr and glyphosate solution to cut stumps. For any shrub stumps that have already been cut but not treated with herbicide, treat re-sprouts with a foliar application of triclopyr and glyphosate in summer. See Exotic Shrubs fact sheet (attached).

Tree and shrub planting

Continue planting trees and shrubs per the area's restoration plan, including areas that are included in this MU boundary but not already treated (around the edges of completed area).

Deer protection

Tree and shrub plantings must be protected from deer browsing. The primary method employed in this area is small fenced areas around clusters of plantings. Where feasible, this method can be continued in other areas to be planted. For sloped areas, individual tree cages can be used, or it may be more manageable to fence an entire hillside, for example along the road or edge of the ball field.

Seeding

After invasive species removal, hand broadcast a mix of 20 lb/acre (54 lb total) of the specified seed mix (see attached) with 30 lb/acre (81 lb total) of cover crop (grain oats or rye, depending on season, see seed mix sheet) and 1 lb kitty litter per lb of seed (135 lb total) as a carrier as follows for each area. The carrier helps evenly distribute the seed across the area and helps you see what areas have been seeded. Work seed into the leaf litter with a rake. Lightly mulch with half an inch (182 cu yd) or less of grass clippings, straw, or compost. If using baled straw, one bale = one cubic yard once uncompressed. Assuming the entire MU has not yet been seeded, the following quantities should be applied (if a smaller area needs to be seeded, adjust accordingly):

Monitoring and adaptive management

After invasive species control, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

MU B2 –Follow-up shrub control in planting areas **3.4 acres** (B2a = 1.1 ac, B2b = 2.3 ac)

Objectives

Encourage successful growth and establishment of restoration plantings in the area and maintain the area free of invasive plant species. Maintain a healthy meadow community as a transition until canopy closure.

Current Conditions

These two areas (B2a and B2b) consist of openings in the forest that have been subject to invasive shrub removal and replanting with native trees and shrubs. However, invasive shrubs, especially Amur honeysuckle and Chinese privet, are re-sprouting from cut stumps.

Management Activities

Invasive species management

Shrub re-sprouts, which are still relatively small, should be treated with a foliar application of triclopyr and glyphosate. See Exotic Shrubs fact sheet (attached).

Monitoring and adaptive management

After invasive species control, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

MU B3 –Forest restoration – eastern Bird Park 12.8 acres

Objectives

Remove invasive shrub understory and replace with native forest trees, shrubs, and herbaceous plants. Establish and maintain a healthy meadow community as a transition until canopy closure.

Current Conditions

Other than MUs 1 and 2, the remainder Bird Park east of the ball field is heavily infested with invasive shrubs, mainly Amur honeysuckle and Chinese privet. Some of this area was apparently previously subject to invasive shrub management several years ago, but they have resprouted. In other areas, honeysuckle bushes are larger (several inches in diameter) and have not been treated, excepting some smaller patches within that have been cleared and replanted with trees in tree shelter tubes.

Management Activities

Invasive plant management

1. There are many large downed trees scattered throughout the area. These will impede access by a forestry mulcher and should be cut into manageable logs and stacked to create habitat brush piles (see specifications, attached)
2. Throughout most of the area, use a forestry mulcher to cut invasive shrubs to ground level. Care should be taken to avoid damaging existing desirable vegetation, especially understory trees and native shrubs. These can flagged in advance so they are more easily avoided.
3. Approximately 6-8 weeks following forestry mulching, apply a foliar herbicide mixture of glyphosate and triclopyr to resprouting targeted shrub species (see Exotic Shrubs fact sheet).
4. In areas that are inaccessible due to topography or obstacles, invasive shrubs can be cut using hand tools such as loppers and chainsaws.
5. Stumps from hand-cut stems should immediately be treated with concentrated mixture of glyphosate and triclopyr (see Exotic Shrubs fact sheet).

Tree and shrub planting

It is important to replace removed invasive species with a desirable plant community, to help prevent invasive species from re-invading and establish the desired forest community.

Tree density in this area is highly variable and many areas are insufficiently stocked, especially around sample point B6 (Figure 2 and 4C in Part 1). Even in areas with high tree density (like points B7 and B8), tree regeneration is lacking. Therefore, accounting for existing trees, planting native trees and shrubs is recommended at 200 trees/acre and 50 shrubs per acre.

Species of different shade tolerances should be planted in areas corresponding to their tolerance, and a mix of canopy and understory trees should be used. Species recommendations and quantities following these principles are provided in the following table. Trees should be planted approximately 10 ft apart, including between other planted and existing trees. Shrubs should be planted interspersed among the trees or in sunny clumps, following recommendations in the table for each species.

Recommended tree and shrub species for planting in MU B3 (12.9 acres) at 200 trees per acre. Quantities of each species may be redistributed based on availability, maintaining relative distribution in strata and shade tolerance categories. Alternative species may be suitable (see Table 5 in Part 1).

Common Name	Scientific Name	Stratum	Quantity	Shade tolerance	Notes
Sugar maple	*Acer saccharum*	Canopy tree	387	Tolerant	
Bitternut hickory	*Carya cordiformis*	Canopy tree	129	Intolerant	
Shagbark hickory	*Carya ovata*	Canopy tree	129	Mid-tolerant	
Hackberry	*Celtis occidentalis*	Canopy tree	129	Mid-tolerant	
Yellow-poplar	*Liriodendron tulipifera*	Canopy tree	129	Intolerant	
Shortleaf pine	*Pinus echinata*	Canopy tree	129	Intolerant	
White oak	*Quercus alba*	Canopy tree	258	Mid-tolerant	1
Chinkapin oak	*Quercus muehlenbergii*	Canopy tree	129	Mid-tolerant	1
Northern red oak	*Quercus rubra*	Canopy tree	258	Mid-tolerant	1
Eastern hemlock	*Tsuga canadensis*	Canopy tree	129	Tolerant	2
Serviceberry	*Amelanchier spp.*	Understory tree	129	Tolerant	
Pawpaw	*Asimina triloba*	Understory tree	129	Tolerant	
Eastern redbud	*Cercis canadensis*	Understory tree	129	Mid-tolerant	
Common persimmon	*Diospyros virginiana*	Understory tree	129	Tolerant	
American holly	*Ilex opaca*	Understory tree	129	Mid-tolerant	
Eastern hophornbeam	*Ostrya virginiana*	Understory tree	129	Tolerant	
Red chokeberry	*Aronia arbutifolia*	Shrub (clumped)	65	Intolerant	5
Black chokeberry	*Aronia malanocarpa*	Shrub (clumped)	65	Intolerant	5
Black raspberry	*Rubus occidentalis*	Shrub (clumped)	65	Intolerant	5
Purple-flowered thimbleberry	*Rubus odoratum*	Shrub (clumped)	65	Intolerant	5
American hazelnut	*Corylus americana*	Shrub (scattered)	65	Tolerant	5
American witchhazel	*Hamamelis virginiana*	Shrub (scattered)	65	Tolerant	4
Spicebush	*Lindera benzoin*	Shrub (scattered)	65	Tolerant	4
American black currant	*Ribes americanum*	Shrub (scattered)	65	Tolerant	4
Appalachian gooseberry	*Ribes rotundifolium*	Shrub (scattered)	65	Mid-tolerant	4
Blackhaw	*Viburnum prunifolium*	Shrub (scattered)	65	Mid-tolerant	4

Notes: 1 = Avoid planting dense clusters of oaks to limit risk of disease spread; 2 = Pest/disease prone (manageable for limited plantings); 3 = Allelopathic but some species are compatible with it. 4 = Disperse throughout planting area; plant in 4-ft-tall cages. 5 = Plant 4-6 ft apart in clumps in sunny areas; install 8-ft-tall fence around entire clump if clump is over 10 ft diameter; otherwise install a cluster of clumps inside 4-ft-tall, 4-ft-diameter welded wire cages with T-post supports.

Deer protection

Tree and shrub plantings must be protected from deer browsing. Options include 8-ft fencing, welded wire individual tree cages, or plastic tree shelters (tubes). While a fence would be the most cost-effective solution due to the low edge to area ratio, stakeholder consensus was that a fence would be too disruptive to park uses. Therefore, the cost estimate in Part 3 includes a combination of tree shelters in sunny areas and cages in more shaded areas and for shrubs. Clusters of the indicated shrubs can be fenced temporarily until well established.

Seeding

After invasive species removal, broadcast a mix of 20 lb/acre of the specified seed mix (258 lb total; see attached seed mix specifications) with 30 lb/acre of cover crop (grain oats or rye, 387 lb total). Seeding may occur in fall, winter, or spring.

Monitoring and adaptive management

After invasive species control and planting, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

MU B4 –Forest restoration – Sycamore Trail 5.3 acres

Objectives

Remove invasive shrubs, vines, and groundcover and replace with native forest trees, shrubs, and herbaceous plants. Establish and maintain a healthy meadow community as a transition until canopy closure.

Current Conditions

North of Sycamore Trail, there are several somewhat contiguous patches of invasive shrubs (Chinese privet, Amur honeysuckle, winged euonymus/burning bush, viburnum), English Ivy (primarily on the ground), and Japanese pachysandra. These are growing among scattered native trees and shrubs. The area of invasive species is approximately 1.5 acres within the 2.2-acre MU.

Management Activities

Invasive plant management

Cut invasive shrubs using hand tools such as loppers and chainsaws. Stumps from cut stems should immediately be treated with concentrated mixture of glyphosate and triclopyr (see Exotic Shrubs fact sheet).

For Japanese pachysandra, apply glyphosate solution (1-2%) in fall when temperatures are 40 F or warmer.

For English ivy, if growing on trees, cut at head height and then at the ground. Apply concentrated mix of glyphosate and triclopyr (see English Ivy fact sheet). If growing on the ground, apply a foliar herbicide spray of glyphosate and triclopyr (see Exotic Woody Vines fact sheet).

Tree and shrub planting

It is important to replace removed invasive species with a desirable plant community, to help prevent invasive species from re-invading and establish the desired forest community.

Tree density in this MU is rather sparse so planting native trees and shrubs is recommended at 200 trees/acre and 50 shrubs per acre.

Species of different shade tolerances should be planted in areas corresponding to their tolerance, and a mix of canopy and understory trees should be used. Species recommendations and quantities following these principles are provided in the following table. Spacing for trees should be approximately 10 ft on center, including between other planted and existing trees. Shrubs should be planted interspersed among the trees or in sunny clumps, following recommendations in the table for each species.

Deer protection

Tree and shrub plantings must be protected from deer browsing. Options include 8-ft fencing, welded wire individual tree cages, or plastic tree shelters (tubes). Due to the high edge-to-area ratio of this MU, I recommend a combination of tree shelters in sunny areas and cages in more shaded areas and for shrubs. Clusters of the indicated shrubs can be fenced temporarily until well established.

Recommended tree and shrub species for planting in MU B4 (1.5 acres) at 200 trees per acre. Quantities of each species may be redistributed based on availability, maintaining relative distribution in strata and shade tolerance categories. Alternative species may be suitable (see Table 5 in Part 1).

Common Name	Scientific Name	Stratum	Quantity	Shade tolerance	Notes
Sugar maple	*Acer saccharum*	Canopy tree	45	Tolerant	
Bitternut hickory	*Carya cordiformis*	Canopy tree	15	Intolerant	
Shagbark hickory	*Carya ovata*	Canopy tree	15	Mid-tolerant	
Hackberry	*Celtis occidentalis*	Canopy tree	15	Mid-tolerant	
Yellow-poplar	*Liriodendron tulipifera*	Canopy tree	15	Intolerant	
Shortleaf pine	*Pinus echinata*	Canopy tree	15	Intolerant	
White oak	*Quercus alba*	Canopy tree	30	Mid-tolerant	1
Chinkapin oak	*Quercus muehlenbergii*	Canopy tree	15	Mid-tolerant	1
Northern red oak	*Quercus rubra*	Canopy tree	30	Mid-tolerant	1
Eastern hemlock	*Tsuga canadensis*	Canopy tree	15	Tolerant	2
Serviceberry	*Amelanchier spp.*	Understory tree	15	Tolerant	
Pawpaw	*Asimina triloba*	Understory tree	15	Tolerant	
Eastern redbud	*Cercis canadensis*	Understory tree	15	Mid-tolerant	
Common persimmon	*Diospyros virginiana*	Understory tree	15	Tolerant	
American holly	*Ilex opaca*	Understory tree	15	Mid-tolerant	
Eastern hophornbeam	*Ostrya virginiana*	Understory tree	15	Tolerant	
Red chokeberry	*Aronia arbutifolia*	Shrub (clumped)	8	Intolerant	5
Black chokeberry	*Aronia malanocarpa*	Shrub (clumped)	8	Intolerant	5
Black raspberry	*Rubus occidentalis*	Shrub (clumped)	8	Intolerant	5
Purple-flowered thimbleberry	*Rubus odoratum*	Shrub (clumped)	8	Intolerant	5
American hazelnut	*Corylus americana*	Shrub (scattered)	8	Tolerant	5
American witchhazel	*Hamamelis virginiana*	Shrub (scattered)	8	Tolerant	4
Spicebush	*Lindera benzoin*	Shrub (scattered)	8	Tolerant	4
American black currant	*Ribes americanum*	Shrub (scattered)	8	Tolerant	4
Appalachian gooseberry	*Ribes rotundifolium*	Shrub (scattered)	8	Mid-tolerant	4
Blackhaw	*Viburnum prunifolium*	Shrub (scattered)	8	Mid-tolerant	4

Notes: 1 = Avoid planting dense clusters of oaks to limit risk of disease spread; 2 = Pest/disease prone (manageable for limited plantings); 3 = Allelopathic but some species are compatible with it. 4 = Disperse throughout planting area; plant in 4-ft-tall cages. 5 = Plant 4-6 ft apart in clumps in sunny areas; install 8-ft-tall fence around entire clump if clump is over 10 ft diameter; otherwise install a cluster of clumps inside 4-ft-tall, 4-ft-diameter welded wire cages with T-post supports.

Seeding

After invasive species removal, broadcast a mix of 20 lb/acre (30 lb total) of the specified seed mix (see attached) with 30 lb/acre (45 lb total) of cover crop (grain oats or rye, depending on season, see seed mix sheet) and kitty litter as a carrier (1 lb per lb seed, or 75 lb total) as follows for each area. The carrier helps evenly distribute the seed across the area and helps you see what areas have been seeded. Work seed into the leaf litter with a rake. Lightly mulch with half an inch (101 yd) or less of grass clippings, straw, or compost. If using baled straw, one bale = one cubic yard once uncompressed.

Monitoring and adaptive management

After invasive species control and planting, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

MU B5 – Western Bird Park 16.2 acres

Objectives

Monitor and maintain existing plantings and maintain the area free of invasive plant species.

Current Conditions

This MU consists mostly of closed canopy forest in good condition. The area has been subject to periodic invasive shrub species management and scattered tree plantings. Other than the areas called out in separate MUs, these are largely successful. There are scattered patches of invasive herbaceous species like lesser celandine, garlic mustard, and Japanese pachysandra

Management Activities

Invasive plant management

Hand pull garlic mustard (0.27 acre, plus some in the patch of lesser celandine) in spring, before seeds set. Pulled plants can be piled to compost on site.

For lesser celandine control (0.20 acre), apply glyphosate solution (1-2%) in late winter-early spring (March through May) when temperatures are 40 F or warmer. Follow label instructions.

Seeding

It is important to replace removed invasive species with a desirable plant community, to help prevent invasive species from re-invading. After invasive species removal, broadcast a mix of 20 lb/acre of the specified seed mix (see attached) with 30 lb/acre of cover crop (grain oats or rye, depending on season, see seed mix sheet) and kitty litter as a carrier as follows for each area. The carrier helps evenly distribute the seed across the area and helps you see what areas have been seeded. Work seed into the leaf litter with a rake. Lightly mulch with half an inch or less of grass clippings, straw, or compost. If using baled straw, figure one bale = one cubic yard once uncompressed.

Patch	Area	Seed mix (20 lb/ac)	Cover crop (30 lb/ac)	Carrier (1 lb/lb seed)	Mulch (cu yd)
Garlic mustard	0.27 ac	5.4	8.1	13.5	18
Lesser celandine	0.20 ac	4.0	6.0	10.0	13

Monitoring and adaptive management

After invasive species control and planting, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

Robb Hollow Park Management Units

MT. LEBANON PENNSYLVANIA

Oikos Ecology LLC

CIVIC MAPPER

ROBB HOLLOW PARK FOREST MANAGEMENT PROJECTS

MU R1 – Northwest Robb Hollow Park 7.7 acres

Objectives

Remove invasive shrub understory and replace with native forest trees, shrubs, and herbaceous plants.

Current Conditions

Black cherry and red maple dominated forest with patchy Amur honeysuckle, Chinese privet, and some desirable beech and other tree regeneration. Volunteer records and presence of cut stumps evidence that much of the unit was previously managed to cut invasive shrubs, but they have resprouted. A creek runs down roughly the middle of the MU. The west side of the creek is very steep and uneven, with scattered tree of heaven and a dense understory of Amur honeysuckle, Chinese privet, multiflora rose. Oriental bittersweet and Japanese honeysuckle threaten several trees. There is a patch of Japanese stiltgrass in the southwest corner of the area, near the creek.

Invasive plant management

1. Throughout most of the area, use a forestry mulcher to cut invasive shrubs to ground level. Care should be taken to avoid damaging existing desirable vegetation, especially understory trees and native shrubs. These can flagged in advance so they are more easily avoided.
2. Approximately 6-8 weeks following forestry mulching, apply a foliar herbicide mixture of glyphosate and triclopyr to resprouting targeted shrub species (see Exotic Shrubs fact sheet).
3. In areas that are inaccessible due to topography or obstacles, invasive shrubs can be cut using hand tools such as loppers and chainsaws.
4. Stumps from hand-cut stems should immediately be treated with concentrated mixture of glyphosate and triclopyr (see Exotic Shrubs fact sheet).
5. Cut vines at shoulder level and at ground (window cut). Stumps should immediately be treated with concentrated mixture of glyphosate and triclopyr. Treat resprouts with a foliar spray of glyphosate and triclopyr (see Exotic Woody Vines fact sheet).
6. During winter, it is relatively easy to locate tree of heaven by bark and presence of seed clusters. These should be flagged and then treated using the hack and squirt method (see Tree of Heaven fact sheet) during the growing season. Priority should be placed on killing female trees to eliminate the source of seed.
7. For Japanese stiltgrass, after plants are well established but before flower stalks develop, hand pull or use a string trimmer to cut to ground level (see Japanese Stiltgrass fact sheet). Sow the area with the indicated seed mix.

Tree and shrub planting

It is important to replace removed invasive species with a desirable plant community, to help prevent invasive species from re-invading and establish the desired forest community.

Tree density in this MU is moderate so planting native trees and shrubs is recommended at 200 trees/acre and 50 shrubs per acre.

Species of different shade tolerances should be planted in areas corresponding to their tolerance, and a mix of canopy and understory trees should be used. Species recommendations and quantities following

these principles are provided in the following table. Spacing for trees should be approximately 10 ft on center, including between other planted and existing trees. Shrubs should be planted interspersed among the trees or in sunny clumps, following recommendations in the table for each species.

Recommended tree and shrub species for planting in MU R1 (5.3 acres) at 200 trees per acre. Quantities of each species may be redistributed based on availability, maintaining relative distribution in strata and shade tolerance categories. Alternative species may be suitable (see Table 5 in Part 1).

Common Name	Scientific Name	Stratum	Quantity	Shade tolerance	Notes
Sugar maple	*Acer saccharum*	Canopy tree	159	Tolerant	
Bitternut hickory	*Carya cordiformis*	Canopy tree	53	Intolerant	
Shagbark hickory	*Carya ovata*	Canopy tree	53	Mid-tolerant	
Hackberry	*Celtis occidentalis*	Canopy tree	53	Mid-tolerant	
Yellow-poplar	*Liriodendron tulipifera*	Canopy tree	53	Intolerant	
Shortleaf pine	*Pinus echinata*	Canopy tree	53	Intolerant	
White oak	*Quercus alba*	Canopy tree	106	Mid-tolerant	1
Chinkapin oak	*Quercus muehlenbergii*	Canopy tree	53	Mid-tolerant	1
Northern red oak	*Quercus rubra*	Canopy tree	106	Mid-tolerant	1
Eastern hemlock	*Tsuga canadensis*	Canopy tree	53	Tolerant	2
Serviceberry	*Amelanchier spp.*	Understory tree	53	Tolerant	
Pawpaw	*Asimina triloba*	Understory tree	53	Tolerant	
Eastern redbud	*Cercis canadensis*	Understory tree	53	Mid-tolerant	
Common persimmon	*Diospyros virginiana*	Understory tree	53	Tolerant	
American holly	*Ilex opaca*	Understory tree	53	Mid-tolerant	
Eastern hophornbeam	*Ostrya virginiana*	Understory tree	53	Tolerant	
Red chokeberry	*Aronia arbutifolia*	Shrub (clumped)	27	Intolerant	5
Black chokeberry	*Aronia malanocarpa*	Shrub (clumped)	27	Intolerant	5
Black raspberry	*Rubus occidentalis*	Shrub (clumped)	27	Intolerant	5
Purple-flowered thimbleberry	*Rubus odoratum*	Shrub (clumped)	27	Intolerant	5
American hazelnut	*Corylus americana*	Shrub (scattered)	27	Tolerant	5
American witchhazel	*Hamamelis virginiana*	Shrub (scattered)	27	Tolerant	4
Spicebush	*Lindera benzoin*	Shrub (scattered)	27	Tolerant	4
American black currant	*Ribes americanum*	Shrub (scattered)	27	Tolerant	4
Appalachian gooseberry	*Ribes rotundifolium*	Shrub (scattered)	27	Mid-tolerant	4
Blackhaw	*Viburnum prunifolium*	Shrub (scattered)	27	Mid-tolerant	4

Notes: 1 = Avoid planting dense clusters of oaks to limit risk of disease spread; 2 = Pest/disease prone (manageable for limited plantings); 3 = Allelopathic but some species are compatible with it. 4 = Disperse throughout planting area; plant in 4-ft-tall cages. 5 = Plant 4-6 ft apart in clumps in sunny areas; install 8-ft-tall fence around entire clump if clump is over 10 ft diameter; otherwise install a cluster of clumps inside 4-ft-tall, 4-ft-diameter welded wire cages with T-post supports.

Deer protection

Tree and shrub plantings must be protected from deer browsing. Options include 8-ft fencing, welded wire individual tree cages, or plastic tree shelters (tubes). Due to the high edge-to-area ratio of this MU, tree tubes are more cost-effective solution than fencing, but fencing would be more cost-effective than individual tree cages. On the other hand, there is only one trail that would require gates, and fencing would help establish the park boundary, especially in the disjunct northwestern section of this MU.

Seeding

After invasive species removal, broadcast a mix of 20 lb/acre of the specified seed mix (105 lb total; see attached seed mix specifications) with 30 lb/acre of cover crop (grain oats or rye, 158 lb total). Seeding may occur in fall, winter, or spring.

Monitoring and adaptive management

After invasive species control and planting, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

MU R2 – Southwest Robb Hollow Park **17.0 acres** (excluding 1-acre leaf composting area)

Objectives

Remove invasive shrub understory and replace with native forest trees, shrubs, and herbaceous plants.

Current Conditions

Black cherry, red oak, and red maple dominated forest with dense Amur honeysuckle and Chinese privet. There is some limited tree regeneration. As evidenced from volunteer records and presence of cut stumps, much of this area was previously managed to cut invasive shrubs, but they have resprouted.

Management Activities

Invasive plant management

1. Throughout most of the area, use a forestry mulcher to cut invasive shrubs to ground level. Care should be taken to avoid damaging existing desirable vegetation, especially understory trees and native shrubs. These can flagged in advance so they are more easily avoided.
2. Approximately 6-8 weeks following forestry mulching, apply a foliar herbicide mixture of glyphosate and triclopyr to resprouting targeted shrub species (see Exotic Shrubs fact sheet).
3. In areas that are inaccessible due to topography or obstacles, invasive shrubs can be cut using hand tools such as loppers and chainsaws.
4. Stumps from hand-cut stems should immediately be treated with concentrated mixture of glyphosate and triclopyr (see Exotic Shrubs fact sheet).

Tree and shrub planting

It is important to replace removed invasive species with a desirable plant community, to help prevent invasive species from re-invading and establish the desired forest community.

Tree density in this MU is moderate so planting native trees and shrubs is recommended at 200 trees/acre and 50 shrubs per acre.

Species of different shade tolerances should be planted in areas corresponding to their tolerance, and a mix of canopy and understory trees should be used. Species recommendations and quantities following these principles are provided in the following table. Spacing for trees should be approximately 10 ft on center, including between other planted and existing trees. Shrubs should be planted interspersed among the trees following recommendations in the table.

Deer protection

Tree and shrub plantings must be protected from deer browsing. Options include 8-ft fencing, welded wire individual tree cages, or plastic tree shelters (tubes). The moderate edge-to-area ratio of this MU, few trail entrances, and need for a vehicle entrance to the leaf composting area (via a deer grate) make tree tubes and deer fencing of the entire MU approximately equal in cost. Individual wire tree cages would be about twice as expensive. Due to reported problems with tree tubes in shaded areas, a combination of tree shelters in sunny areas and cages in more shaded areas and for shrubs and be used. Clusters of the indicated shrubs can be fenced temporarily until well established.

Seeding

After invasive species removal, broadcast a mix of 20 lb/acre of the specified seed mix (338 lb total; see attached seed mix specifications) with 30 lb/acre of cover crop (grain oats or rye, 507 lb total). Seeding may occur in fall, winter, or spring.

Monitoring and adaptive management

After invasive species control and planting, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

Recommended tree and shrub species for planting in MU R2 (16.9 acres) at 200 trees per acre. Quantities of each species may be redistributed based on availability, maintaining relative distribution in strata and shade tolerance categories. Alternative species may be suitable (see Table 5 in Part 1).

Common Name	Scientific Name	Stratum	Quantity	Shade tolerance	Notes
Sugar maple	*Acer saccharum*	Canopy tree	507	Tolerant	
Bitternut hickory	*Carya cordiformis*	Canopy tree	169	Intolerant	
Shagbark hickory	*Carya ovata*	Canopy tree	169	Mid-tolerant	
Hackberry	*Celtis occidentalis*	Canopy tree	169	Mid-tolerant	
Yellow-poplar	*Liriodendron tulipifera*	Canopy tree	169	Intolerant	
Shortleaf pine	*Pinus echinata*	Canopy tree	169	Intolerant	
White oak	*Quercus alba*	Canopy tree	338	Mid-tolerant	1
Chinkapin oak	*Quercus muehlenbergii*	Canopy tree	169	Mid-tolerant	1
Northern red oak	*Quercus rubra*	Canopy tree	338	Mid-tolerant	1
Eastern hemlock	*Tsuga canadensis*	Canopy tree	169	Tolerant	2
Serviceberry	*Amelanchier spp.*	Understory tree	169	Tolerant	
Pawpaw	*Asimina triloba*	Understory tree	169	Tolerant	
Eastern redbud	*Cercis canadensis*	Understory tree	169	Mid-tolerant	
Common persimmon	*Diospyros virginiana*	Understory tree	169	Tolerant	
American holly	*Ilex opaca*	Understory tree	169	Mid-tolerant	
Eastern hophornbeam	*Ostrya virginiana*	Understory tree	169	Tolerant	
Red chokeberry	*Aronia arbutifolia*	Shrub (clumped)	85	Intolerant	5
Black chokeberry	*Aronia malanocarpa*	Shrub (clumped)	85	Intolerant	5
Black raspberry	*Rubus occidentalis*	Shrub (clumped)	85	Intolerant	5
Purple-flowered thimbleberry	*Rubus odoratum*	Shrub (clumped)	85	Intolerant	5
American hazelnut	*Corylus americana*	Shrub (scattered)	85	Tolerant	5
American witchhazel	*Hamamelis virginiana*	Shrub (scattered)	85	Tolerant	4
Spicebush	*Lindera benzoin*	Shrub (scattered)	85	Tolerant	4
American black currant	*Ribes americanum*	Shrub (scattered)	85	Tolerant	4
Appalachian gooseberry	*Ribes rotundifolium*	Shrub (scattered)	85	Mid-tolerant	4
Blackhaw	*Viburnum prunifolium*	Shrub (scattered)	85	Mid-tolerant	4

Notes: 1 = Avoid planting dense clusters of oaks to limit risk of disease spread; 2 = Pest/disease prone (manageable for limited plantings); 3 = Allelopathic but some species are compatible with it. 4 = Disperse throughout planting area; plant in 4-ft-tall cages. 5 = Plant 4-6 ft apart in clumps in sunny areas; install 8-ft-tall fence around entire clump if clump is over 10 ft diameter; otherwise install a cluster of clumps inside 4-ft-tall, 4-ft-diameter welded wire cages with T-post supports.

MU R3 – Southeast Robb Hollow Park 5.7 acres

Objectives

Monitor and maintain the area free of invasive plant species.

Current Conditions

Good quality forest dominated by sugar maple and northern red oak as well as an open area with a managed meadow. The southeast portion along the road is a public works staging area.

Management Activities

Monitoring and adaptive management

Because this area is in good condition, the main activity for this MU is to implement a monitoring and adaptive management plan (Monitoring and Adaptive Management Plan section). The disturbed area around the staging area needs particular attention to keep invasive species at bay.

MU R4 – Northeast Robb Hollow Park 4.8 acres

Objectives

Remove invasive shrub understory and replace with native forest trees, shrubs, and herbaceous plants.

Current Conditions

Black cherry dominated forest with white pine area around sample point R1. dense understory of Amur honeysuckle and Chinese privet. As evidenced from volunteer records and presence of cut stumps, much of this area was previously managed to cut invasive shrubs, but they have resprouted.

Management Activities

Invasive plant management

1. There are many large downed trees scattered throughout the area. These will impede access by a forestry mulcher and should be cut into manageable logs and stacked to create habitat brush piles (see attached)
2. Throughout much of the area, use a forestry mulcher to cut invasive shrubs to ground level. Care should be taken to avoid damaging existing desirable vegetation, especially understory trees and native shrubs. These can flagged in advance so they are more easily avoided.
3. Approximately 6-8 weeks following forestry mulching, apply a foliar herbicide mixture of glyphosate and triclopyr to resprouting targeted shrub species (see Exotic Shrubs fact sheet).
4. Many areas are too steep or inaccessible to a forestry mulcher due to topography or obstacles; in these areas invasive shrubs can be cut using hand tools such as loppers and chainsaws.
5. Stumps from hand-cut stems should immediately be treated with concentrated mixture of glyphosate and triclopyr (see Exotic Shrubs fact sheet).

Tree and shrub planting

It is important to replace removed invasive species with a desirable plant community, to help prevent invasive species from re-invading and establish the desired forest community.

Tree density in this MU is moderate so planting native trees and shrubs is recommended at 200 trees/acre and 50 shrubs per acre.

Species of different shade tolerances should be planted in areas corresponding to their tolerance, and a mix of canopy and understory trees should be used. Species recommendations and quantities following these principles are provided in the following table. Spacing for trees should be approximately 10 ft on center, including between other planted and existing trees. Shrubs should be planted interspersed among the trees following recommendations in the table.

Deer protection

Tree and shrub plantings must be protected from deer browsing. Options include 8-ft fencing, welded wire individual tree cages, or plastic tree shelters (tubes). The high edge-to-area ratio of this would make tree tubes more cost-effective than deer fencing of the entire MU. Individual wire tree cages would be more expensive than fencing. Due to reported problems with tree tubes in shaded areas, a combination of tree shelters in sunny areas and cages in more shaded areas and for shrubs and be used. Clusters of the indicated shrubs can be fenced temporarily until well established.

Seeding

After invasive species removal, apply a mix of 20 lb/acre of the specified seed mix (94 lb total; see attached seed mix specifications) with 30 lb/acre of cover crop (grain oats or rye, 141 lb total). Seeding may occur in fall, winter, or spring.

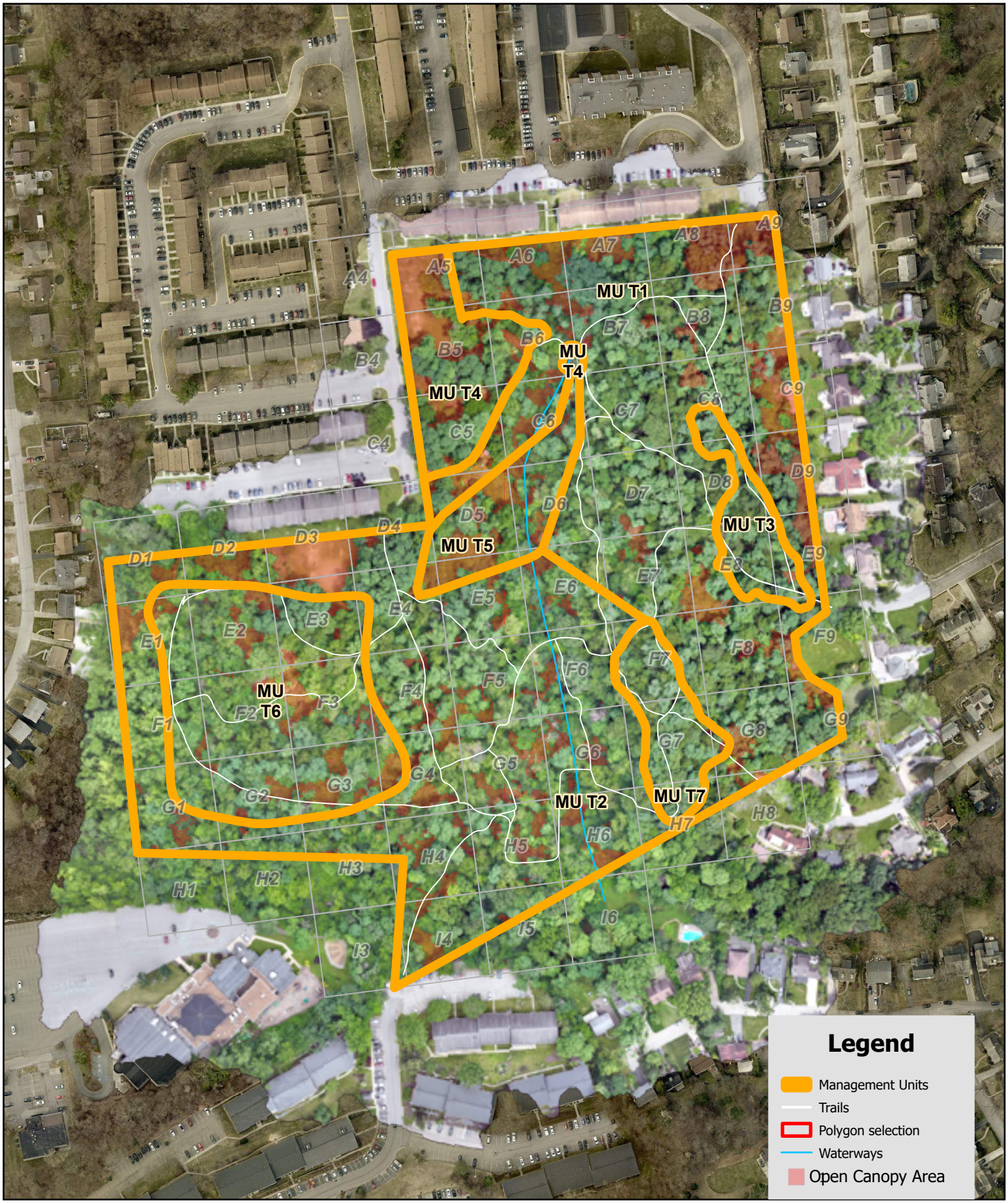
Recommended tree and shrub species for planting in MU R4 (4.7 acres) at 200 trees per acre. Quantities of each species may be redistributed based on availability, maintaining relative distribution in strata and shade tolerance categories. Alternative species may be suitable (see Table 5 in Part 1).

Common Name	Scientific Name	Stratum	Quantity	Shade tolerance	Notes
Sugar maple	*Acer saccharum*	Canopy tree	141	Tolerant	
Bitternut hickory	*Carya cordiformis*	Canopy tree	47	Intolerant	
Shagbark hickory	*Carya ovata*	Canopy tree	47	Mid-tolerant	
Hackberry	*Celtis occidentalis*	Canopy tree	47	Mid-tolerant	
Yellow-poplar	*Liriodendron tulipifera*	Canopy tree	47	Intolerant	
Shortleaf pine	*Pinus echinata*	Canopy tree	47	Intolerant	
White oak	*Quercus alba*	Canopy tree	94	Mid-tolerant	1
Chinkapin oak	*Quercus muehlenbergii*	Canopy tree	47	Mid-tolerant	1
Northern red oak	*Quercus rubra*	Canopy tree	94	Mid-tolerant	1
Eastern hemlock	*Tsuga canadensis*	Canopy tree	47	Tolerant	2
Serviceberry	*Amelanchier spp.*	Understory tree	47	Tolerant	
Pawpaw	*Asimina triloba*	Understory tree	47	Tolerant	
Eastern redbud	*Cercis canadensis*	Understory tree	47	Mid-tolerant	
Common persimmon	*Diospyros virginiana*	Understory tree	47	Tolerant	
American holly	*Ilex opaca*	Understory tree	47	Mid-tolerant	
Eastern hophornbeam	*Ostrya virginiana*	Understory tree	47	Tolerant	
Red chokeberry	*Aronia arbutifolia*	Shrub (clumped)	24	Intolerant	5
Black chokeberry	*Aronia malanocarpa*	Shrub (clumped)	24	Intolerant	5
Black raspberry	*Rubus occidentalis*	Shrub (clumped)	24	Intolerant	5
Purple-flowered thimbleberry	*Rubus odoratum*	Shrub (clumped)	24	Intolerant	5
American hazelnut	*Corylus americana*	Shrub (scattered)	24	Tolerant	5
American witchhazel	*Hamamelis virginiana*	Shrub (scattered)	24	Tolerant	4
Spicebush	*Lindera benzoin*	Shrub (scattered)	24	Tolerant	4
American black currant	*Ribes americanum*	Shrub (scattered)	24	Tolerant	4
Appalachian gooseberry	*Ribes rotundifolium*	Shrub (scattered)	24	Mid-tolerant	4
Blackhaw	*Viburnum prunifolium*	Shrub (scattered)	24	Mid-tolerant	4

Notes: 1 = Avoid planting dense clusters of oaks to limit risk of disease spread; 2 = Pest/disease prone (manageable for limited plantings); 3 = Allelopathic but some species are compatible with it. 4 = Disperse throughout planting area; plant in 4-ft-tall cages. 5 = Plant 4-6 ft apart in clumps in sunny areas; install 8-ft-tall fence around entire clump if clump is over 10 ft diameter; otherwise install a cluster of clumps inside 4-ft-tall, 4-ft-diameter welded wire cages with T-post supports.

Monitoring and adaptive management

After invasive species control and planting, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).



MT. LEBANON PENNSYLVANIA

Oikos Ecology LLC

CIVIC MAPPER

Twin Hills Park Management Units

0 250 500 Feet

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TWIN HILLS PARK FOREST MANAGEMENT PROJECTS

MU T1 – Forest restoration Twin Hills east 9.1 acres

Objectives

Remove invasive shrub understory and replace with native forest trees, shrubs, and herbaceous plants.

Current Conditions

Black cherry and black locust dominated forest with a dense understory of Amur honeysuckle and Chinese privet. There are occasional desirable trees in the understory, such as hawthorns and native tree regeneration.

Management Activities

Note: MU T1 and MU T2 are similar and have the same management needs. They are broken out into separately in case the Municipality wishes to commence management of the two MUs at different times.

Invasive plant management

1. Due to relatively high density of overstory and desirable understory trees, hand cutting (using loppers or chainsaws) of invasive shrubs is recommend.
2. Cut slash into manageable pieces and pile to create habitat brush piles (see attachment).
3. Stumps from stems cut with hand tools should immediately be treated with concentrated glyphosate and triclopyr solution (see Exotic Shrubs fact sheet).
4. During winter, it is relatively easy to locate tree of heaven by bark and presence of seed clusters. These should be flagged and then treated using the hack and squirt method (see Tree of Heaven fact sheet) during the growing season. Priority should be placed on killing female trees to eliminate the source of seed.

Tree and shrub planting

It is important to replace removed invasive species with a desirable plant community, to help prevent invasive species from re-invading and establish the desired forest community.

Tree density in this MU is relatively high so planting native trees and shrubs is recommended at 150 trees/acre and 37.5 shrubs per acre.

Species of different shade tolerances should be planted in areas corresponding to their tolerance, and a mix of canopy and understory trees should be used. Species recommendations and quantities following these principles are provided in the following table. Spacing for trees should be approximately 10 ft on center, including between other planted and existing trees. Shrubs should be planted interspersed among the trees following recommendations in the table.

Deer protection

Tree and shrub plantings must be protected from deer browsing. Options include 8-ft fencing, welded wire individual tree cages, or plastic tree shelters (tubes). The park's regular shape and relatively few entrances make a whole-park deer exclusion fence the most cost effective and holistic solution.

Seeding

After invasive species removal, broadcast a mix of 20 lb/acre of the specified seed mix (183 lb total; see a attached seed mix specifications) with 30 lb/acre of cover crop (grain oats or rye, 274 lb total). Seeding may occur in fall, winter, or spring.

Monitoring and adaptive management

After invasive species control and planting, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

Recommended tree and shrub species for planting in MU T1 (9.1 acres) at 150 trees per acre. Quantities of each species may be redistributed based on availability, maintaining relative distribution in strata and shade tolerance categories. Alternative species may be suitable (see Table 5 in Part 1).

Common Name	Scientific Name	Stratum	Quantity	Shade tolerance	Notes
Sugar maple	*Acer saccharum*	Canopy tree	205	Tolerant	
Bitternut hickory	*Carya cordiformis*	Canopy tree	68	Intolerant	
Shagbark hickory	*Carya ovata*	Canopy tree	68	Mid-tolerant	
Hackberry	*Celtis occidentalis*	Canopy tree	68	Mid-tolerant	
Yellow-poplar	*Liriodendron tulipifera*	Canopy tree	68	Intolerant	
Shortleaf pine	*Pinus echinata*	Canopy tree	68	Intolerant	
White oak	*Quercus alba*	Canopy tree	137	Mid-tolerant	1
Chinkapin oak	*Quercus muehlenbergii*	Canopy tree	68	Mid-tolerant	1
Northern red oak	*Quercus rubra*	Canopy tree	137	Mid-tolerant	1
Eastern hemlock	*Tsuga canadensis*	Canopy tree	68	Tolerant	2
Serviceberry	*Amelanchier spp.*	Understory tree	68	Tolerant	
Pawpaw	*Asimina triloba*	Understory tree	68	Tolerant	
Eastern redbud	*Cercis canadensis*	Understory tree	68	Mid-tolerant	
Common persimmon	*Diospyros virginiana*	Understory tree	68	Tolerant	
American holly	*Ilex opaca*	Understory tree	68	Mid-tolerant	
Eastern hophornbeam	*Ostrya virginiana*	Understory tree	68	Tolerant	
Red chokeberry	*Aronia arbutifolia*	Shrub (clumped)	34	Intolerant	5
Black chokeberry	*Aronia malanocarpa*	Shrub (clumped)	34	Intolerant	5
Black raspberry	*Rubus occidentalis*	Shrub (clumped)	34	Intolerant	5
Purple-flowered thimbleberry	*Rubus odoratum*	Shrub (clumped)	34	Intolerant	5
American hazelnut	*Corylus americana*	Shrub (scattered)	34	Tolerant	5
American witchhazel	*Hamamelis virginiana*	Shrub (scattered)	34	Tolerant	4
Spicebush	*Lindera benzoin*	Shrub (scattered)	34	Tolerant	4
American black currant	*Ribes americanum*	Shrub (scattered)	34	Tolerant	4
Appalachian gooseberry	*Ribes rotundifolium*	Shrub (scattered)	34	Mid-tolerant	4
Blackhaw	*Viburnum prunifolium*	Shrub (scattered)	34	Mid-tolerant	4

Notes: 1 = Avoid planting dense clusters of oaks to limit risk of disease spread; 2 = Pest/disease prone (manageable for limited plantings); 3 = Allelopathic but some species are compatible with it. 4 = Disperse throughout planting area; plant in 4-ft-tall cages. 5 = Plant 4-6 ft apart in clumps in sunny areas; install 8-ft-tall fence around entire clump if clump is over 10 ft diameter; otherwise install a cluster of clumps inside 4-ft-tall, 4-ft-diameter welded wire cages with T-post supports.

MU T2 – Forest restoration Twin Hills east 9.2 acres

Objectives

Remove invasive shrub understory and replace with native forest trees, shrubs, and herbaceous plants.

Current Conditions

Black cherry and black locust dominated forest with a dense understory of Amur honeysuckle and Chinese privet. There are scattered clusters of tree of heaven. There are occasional desirable trees in the understory, such as hawthorns and native tree regeneration. Lawn area near apartments is used as a cricket pitch. Knotweed patch in SW corner.

Management Activities

Note: MU T1 and MU T2 are similar and have the same management needs. They are broken out into separately in case the Municipality wishes to commence management of the two MUs at different times.

Invasive plant management

1. Due to relatively high density of overstory and desirable understory trees, hand cutting (using loppers or chainsaws) of invasive shrubs is recommend.
2. Cut slash into manageable pieces and pile to create habitat brush piles (see attachment).
3. Stumps from stems cut with hand tools should immediately be treated with concentrated glyphosate and triclopyr solution (see Exotic Shrubs fact sheet).
4. During winter, it is relatively easy to locate tree of heaven by bark and presence of seed clusters. These should be flagged and then treated using the hack and squirt method (see Tree of Heaven fact sheet) during the growing season. Priority should be placed on killing female trees to eliminate the source of seed.

Tree and shrub planting

It is important to replace removed invasive species with a desirable plant community, to help prevent invasive species from re-invading and establish the desired forest community.

Tree density in this MU is relatively high so planting native trees and shrubs is recommended at 150 trees/acre and 37.5 shrubs per acre.

Species of different shade tolerances should be planted in areas corresponding to their tolerance, and a mix of canopy and understory trees should be used. Species recommendations and quantities following these principles are provided in the following table. Spacing for trees should be approximately 10 ft on center, including between other planted and existing trees. Shrubs should be planted interspersed among the trees following recommendations in the table.

Deer protection

Tree and shrub plantings must be protected from deer browsing. Options include 8-ft fencing, welded wire individual tree cages, or plastic tree shelters (tubes). The park's regular shape and relatively few entrances make a whole-park deer exclusion fence the most cost effective and holistic solution.

Seeding

After invasive species removal, broadcast a mix of 20 lb/acre of the specified seed mix (185 lb total; see attach seed mix specifications) with 30 lb/acre of cover crop (grain oats or rye, 277 lb total). Seeding may occur in fall, winter, or spring.

Monitoring and adaptive management

After invasive species control and planting, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

Recommended tree and shrub species for planting in MU T2 (9.2 acres) at 150 trees per acre. Quantities of each species may be redistributed based on availability, maintaining relative distribution in strata and shade tolerance categories. Alternative species may be suitable (see Table 5 in Part 1).

Common Name	Scientific Name	Stratum	Quantity	Shade tolerance	Notes
Sugar maple	*Acer saccharum*	Canopy tree	207	Tolerant	
Bitternut hickory	*Carya cordiformis*	Canopy tree	69	Intolerant	
Shagbark hickory	*Carya ovata*	Canopy tree	69	Mid-tolerant	
Hackberry	*Celtis occidentalis*	Canopy tree	69	Mid-tolerant	
Yellow-poplar	*Liriodendron tulipifera*	Canopy tree	69	Intolerant	
Shortleaf pine	*Pinus echinata*	Canopy tree	69	Intolerant	
White oak	*Quercus alba*	Canopy tree	138	Mid-tolerant	1
Chinkapin oak	*Quercus muehlenbergii*	Canopy tree	69	Mid-tolerant	1
Northern red oak	*Quercus rubra*	Canopy tree	138	Mid-tolerant	1
Eastern hemlock	*Tsuga canadensis*	Canopy tree	69	Tolerant	2
Serviceberry	*Amelanchier spp.*	Understory tree	69	Tolerant	
Pawpaw	*Asimina triloba*	Understory tree	69	Tolerant	
Eastern redbud	*Cercis canadensis*	Understory tree	69	Mid-tolerant	
Common persimmon	*Diospyros virginiana*	Understory tree	69	Tolerant	
American holly	*Ilex opaca*	Understory tree	69	Mid-tolerant	
Eastern hophornbeam	*Ostrya virginiana*	Understory tree	69	Tolerant	
Red chokeberry	*Aronia arbutifolia*	Shrub (clumped)	35	Intolerant	5
Black chokeberry	*Aronia malanocarpa*	Shrub (clumped)	35	Intolerant	5
Black raspberry	*Rubus occidentalis*	Shrub (clumped)	35	Intolerant	5
Purple-flowered thimbleberry	*Rubus odoratum*	Shrub (clumped)	35	Intolerant	5
American hazelnut	*Corylus americana*	Shrub (scattered)	35	Tolerant	5
American witchhazel	*Hamamelis virginiana*	Shrub (scattered)	35	Tolerant	4
Spicebush	*Lindera benzoin*	Shrub (scattered)	35	Tolerant	4
American black currant	*Ribes americanum*	Shrub (scattered)	35	Tolerant	4
Appalachian gooseberry	*Ribes rotundifolium*	Shrub (scattered)	35	Mid-tolerant	4
Blackhaw	*Viburnum prunifolium*	Shrub (scattered)	35	Mid-tolerant	4

Notes: 1 = Avoid planting dense clusters of oaks to limit risk of disease spread; 2 = Pest/disease prone (manageable for limited plantings); 3 = Allelopathic but some species are compatible with it. 4 = Disperse throughout planting area; plant in 4-ft-tall cages. 5 = Plant 4-6 ft apart in clumps in sunny areas; install 8-ft-tall fence around entire clump if clump is over 10 ft diameter; otherwise install a cluster of clumps inside 4-ft-tall, 4-ft-diameter welded wire cages with T-post supports.

MU T3 – East Twin Hills forest restoration project **0.7 acre**

Objectives

Encourage successful growth and establishment of restoration plantings in the area and maintain the area free of invasive plant species.

Current Conditions

This MU consists of a somewhat sparsely canopied area where invasive shrub management and tree planting were recently completed.

Management Activities

Because invasive species removals and restoration plantings have already been completed, the main activity for this MU is to implement a monitoring and adaptive management plan (Monitoring and Adaptive Management Plan section).

MU T4 – Northwest Twin Hills forest restoration project 1.5 acres

Objectives

Encourage successful growth and establishment of restoration plantings in the area and maintain the area free of invasive plant species.

Current Conditions

This MU consists of a somewhat sparsely canopied area where invasive shrub management and tree planting were recently completed. There is a low density of Amur honeysuckle re-sprouts and poison hemlock.

Management Activities

Invasive species management

Poison hemlock and honeysuckle re-sprouts, which are still relatively small, should be treated with a foliar application of triclopyr and glyphosate. It is important to treat poison hemlock before seed set. See Exotic Biennials and Exotic Shrubs fact sheets (attached).

Monitoring and adaptive management

After invasive species control, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

MU T5 – Japanese knotweed and tree of heaven opening 1.1 acres

Objectives

Remove invasive species and replant with native small trees, shrubs, and herbaceous species to preserve views from the overlook.

Current Conditions

An open-canopied ravine with scattered tree of heaven and Japanese knotweed near the bottom.

Management Activities

Invasive species management

1. Tree of heaven: Treat using the hack and squirt method (see Tree of Heaven fact sheet)
2. Japanese knotweed: The strategy for knotweed is to wear it down over time by repeated cutting and then kill the depleted plant with herbicide (see Japanese Knotweed fact sheet).
    a. Cut knotweed to the ground in June
    b. At least eight weeks later, cut it again (or spray with 5-8% foliar application of glyphosate)
    c. Before the first frost, spray resprouted plants with 5-8% foliar application of glyphosate.
    d. Repeat the following year for any surviving plants.

Recommended tree and shrub species for planting in MU T5 (1 acre) at 100 understory trees per acre and 100 shrubs per acre. Quantities of each species may be redistributed based on availability, maintaining relative distribution in strata and shade tolerance categories. Alternative species may be suitable (see Table 5 in Part 1).

Common Name	Scientific Name	Stratum	Quantity	Shade tolerance	Notes
Serviceberry	*Amelanchier spp.*	Understory tree	25	Tolerant	
Pawpaw	*Asimina triloba*	Understory tree	25	Tolerant	
Eastern redbud	*Cercis canadensis*	Understory tree	25	Mid-tolerant	
Common persimmon	*Diospyros virginiana*	Understory tree	25	Tolerant	
Red chokeberry	*Aronia arbutifolia*	Shrub (clumped)	10	Intolerant	2
Black chokeberry	*Aronia malanocarpa*	Shrub (clumped)	10	Intolerant	2
Black raspberry	*Rubus occidentalis*	Shrub (clumped)	25	Intolerant	2
Purple-flowered thimbleberry	*Rubus odoratum*	Shrub (clumped)	25	Intolerant	2
American hazelnut	*Corylus americana*	Shrub (scattered)	10	Tolerant	2
American witchhazel	*Hamamelis virginiana*	Shrub (scattered)	10	Tolerant	1
Blackhaw	*Viburnum prunifolium*	Shrub (scattered)	10	Mid-tolerant	1

Notes: 1 = Disperse throughout planting area; plant in 4-ft-tall cages. 2 = Plant 4-6 ft apart in clumps in sunny areas; install 8-ft-tall fence around entire clump if clump is over 10 ft diameter; otherwise install a cluster of clumps inside 4-ft-tall, 4-ft-diameter welded wire cages with T-post supports. Cages or fencing can be omitted if there is a larger deer fence surrounding the area.

Tree and shrub planting

It is important to replace removed invasive species with a desirable plant community, to help prevent invasive species from re-invading and establish the desired forest community.

To maintain open views from the observation blind above, a subset of understory trees and shrubs have been selected. See the table, above.

Deer protection

Tree and shrub plantings must be protected from deer browsing. Options include 8-ft fencing, welded wire individual tree cages, or plastic tree shelters (tubes). The park's regular shape and relatively few entrances make a whole-park deer exclusion fence the most cost effective and holistic solution.

Seeding

After invasive species removal, hand broadcast a mix of 20 lb/acre (20 lb total) of the specified seed mix (see attached) with 30 lb/acre (30 lb total) of cover crop (grain oats or rye, depending on season, see seed mix sheet) and 1 lb kitty litter per lb of seed (50 lb total) as a carrier as follows for each area. The carrier helps evenly distribute the seed across the area and helps you see what areas have been seeded. Work seed into the leaf litter with a rake. Lightly mulch with half an inch (66 cu yd) or less of grass clippings, straw, or compost. If using baled straw, one bale = one cubic yard once uncompressed. Assuming the entire MU has not yet been seeded, the following quantities should be applied (if a smaller area needs to be seeded, adjust accordingly):

Monitoring and adaptive management

After invasive species control, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

MU T6 – Southwest Twin Hills forest restoration project 3.7 acres

Objectives

Encourage successful growth and establishment of restoration plantings in the area and maintain the area free of invasive plant species.

Current Conditions

This MU consists of a somewhat sparsely canopied area where invasive shrub management and tree planting were recently completed. There is a low density of Amur honeysuckle and dense patches of wineberry.

Management Activities

Invasive species management

Wineberry and honeysuckle re-sprouts, which are still relatively small, should be treated with a foliar application of triclopyr and glyphosate. See Exotic Biennials and Exotic Shrubs fact sheets (attached).

Monitoring and adaptive management

After invasive species control, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

MU T7 – Barren understory 0.9 acre

Objectives

Create more vertical habitat structure through planting understory trees and shrubs.

Current Conditions

Closed canopy forest with many downed logs and almost no understory woody vegetation. There is no evidence of past shrub removal though there are a few scattered trees planted within plastic tree shelters. Stakeholders report an adjacent homeowner has spread salt on the ground in this area to suppress weeds.

Management Activities

Conduct a soil test of a composite soil sample throughout the area to assess presence of excess salt or other harmful chemicals. Follow recommendations in the soil report for soil remediation if necessary. The soil report may recommend fertilization, but this is not usually necessary for the intended use. If reports of salt application are confirmed and the offending homeowner can be identified, Municipality personnel should contact them to instruct them to stop the activity.

Tree and shrub planting

As the area is closed canopy, a selection of shade-tolerant trees and shrubs has been recommended at 100 trees per acre and 100 shrubs per acre (see table).

Recommended tree and shrub species for planting in MU T5 (0.9 acres) at 100 trees per acre and 50 shrubs per acre. Quantities of each species may be redistributed based on availability, maintaining relative distribution in strata and shade tolerance categories. Alternative species may be suitable (see Table 5 in Part 1).

Common Name	Scientific Name	Stratum	Quantity	Shade tolerance	Notes
Sugar maple	*Acer saccharum*	Canopy tree	27	Tolerant	
Eastern hemlock	*Tsuga canadensis*	Canopy tree	9	Tolerant	1
Serviceberry	*Amelanchier spp.*	Understory tree	18	Tolerant	
Pawpaw	*Asimina triloba*	Understory tree	18	Tolerant	
Common persimmon	*Diospyros virginiana*	Understory tree	18	Tolerant	
American hazelnut	*Corylus americana*	Shrub (scattered)	11	Tolerant	3
American witchhazel	*Hamamelis virginiana*	Shrub (scattered)	11	Tolerant	2
Spicebush	*Lindera benzoin*	Shrub (scattered)	11	Tolerant	2
American black currant	*Ribes americanum*	Shrub (scattered)	11	Tolerant	2

Notes: 1 = Pest/disease prone (manageable for limited plantings); 2 = Disperse throughout planting area; plant in 4-ft-tall cages. 3 = Plant 4-6 ft apart in clumps in sunny areas; install 8-ft-tall fence around entire clump if clump is over 10 ft diameter; otherwise install a cluster of clumps inside 4-ft-tall, 4-ft-diameter welded wire cages with T-post supports. Cages or fencing can be omitted if there is a larger deer fence surrounding the area.

Deer protection

Tree and shrub plantings must be protected from deer browsing. Options include 8-ft fencing, welded wire individual tree cages, or plastic tree shelters (tubes). The park's regular shape and relatively few entrances make a whole-park deer exclusion fence the most cost effective and holistic solution.

Monitoring and adaptive management

After invasive species control, the monitoring and adaptive management plan for this area should be implemented (Monitoring and Adaptive Management Plan section).

MONITORING AND ADAPTIVE MANAGEMENT PLAN

A monitoring and adaptive management plan should be implemented in all management units after the applicable invasive species control and planting activities have been performed. The purpose of monitoring is to determine the success of the prescribed activities and detect potential problems that may arise. The purpose of adaptive management is to adjust the management plan as needed to take appropriate corrective actions when problems are still small and easiest to deal with.

At least twice a year (spring and fall) for five years:

1. Conduct a meander survey to assess effectiveness of control of invasive species and growth and survival of planted trees, shrubs, and herbaceous plants. Note that additional invasive species may arrive and should also be controlled. DCNR maintains a list of invasive plant species as well as their relative threat to native communities (attached[2]). Invasive species should be treated soon after they are discovered, before they start to spread. Effective control measures for various species can be obtained from Penn State Extension.[3]
2. Inspect deer protection (tubes, fences, cages). The person assigned to monitor the deer protection should come equipped with necessary tools and supplies to address fence issues, such as saws and loppers to cut and remove fallen branches, as well as zip ties or wire to repair wholes or re-attach fencing to posts. Once per year, during the dormant season, tree tubes should be lifted off their plants and dead leaves and other debris removed. If the protected tree is missing or dead, the tree tube can be removed. Proper function of access gates should also be assessed.
3. Assess growth and survival of planted and naturally occurring vegetation. If naturally occurring (volunteer) trees and shrubs are identified, install deer protection cage or tree guard around each.
4. If more than a few of the trees/shrubs that were planted (more than 5%) are noted during meander surveys, a more quantitative survey may be conducted to determine if follow-up planting may be indicated.
5. At the end of five years, there should be at least 300 surviving trees per acre in the restoration area and a diversity of surviving shrubs. Desirable volunteer trees and shrubs can be counted toward this total. As the canopy closes and starts to exclude light from the understory, some trees and shrubs will be crowded out. This is normal.
6. After 5 years, or if tree growth is sufficient so that at least 300 trees per acre are above browse height for deer and sufficiently large in diameter to withstand buck rubbing, deer protection may be removed. Alternatively, some areas may be selected to be permanently fenced and appropriate forest understory plants be introduced over time, which would otherwise be browsed out by deer.
7. Note any other problematic issues or opportunities that may warrant action, blow downs, undesirable uses such as dumping, new invasive species occurrence, pests, etc.

After five years, monitoring may be reduced to once per year. It is important to regularly monitor all areas to detect and plan for any changes that may intervention (such as blow downs, undesirable uses such as dumping, new invasive species occurrence, pests, etc.).

[2] Also available at https://elibrary.dcnr.pa.gov/GetDocument?docId=2700788&DocName=dcnr_20033786.pdf
[3] https://www.dcnr.pa.gov/Conservation/WildPlants/InvasivePlants/InvasivePlantFactSheets/Pages/default.aspx and https://extension.psu.edu/forests-and-wildlife/forest-management/invasive-and-competing-plants

ATTACHMENTS

FORESTRY & INVASIVE SPECIES MANAGEMENT PLAN – SPECIFICATIONS

Site Preparation, Clearing, and Invasive Species Removal

Prior to invasive species treatment, the contractor shall walk through the sites with the ecologist to review species to be removed, locations, and methods.

Invasive and Undesired Tree Removal

The contractor shall walk through the site with the ecologist to identify and mark invasive trees to be removed, as well as other trees that may be leaning or otherwise desired to be cut. Marked trees shall be treated with hack-and-squirt or similar methods to kill while standing. Trees shall not be cut without treating with herbicide first to prevent re-sprouting. After at least two weeks, marked trees < 10 inches DBH are to be cut down. Cut logs are to be used as the foundation for wildlife habitat brush piles. Branches in excess of that needed for brush piles are to be chipped and spread on site or used for mulch in plantings (see below). Trees ≥ 10 inches DBH shall remain standing to provide snag habitat, unless they are deemed a safety hazard, in which case they shall be used for brush piles, left on the ground to provide habitat, or removed from site. Placement of logs and brush piles shall be made in consultation with the ecologist.

Invasive shrub removal:

Invasive shrubs shall be removed within the designated areas as indicated on the plans. Most areas will require a combination of forestry mulcher and hand tools (chainsaws, loppers, etc.) to remove invasive shrubs. When using a forestry mulcher, resprouting invasive shrubs shall be treated with foliar herbicide. When using hand tools, shrubs shall be cut at ground level and cut stumps shall be treated with herbicide. Cut branches shall be stacked to create habitat brush piles or if in excess they may be chipped and scattered on site or used as mulch for plantings (see below).

Invasive vine removal:

Invasive vines, poison ivy, and grape vines are not prevalent but any that are encountered during invasive tree and shrub removal should be cut and treated with herbicide. Vines shall be cut at ground and head height and stumps treated with herbicide. Do not try to pull vines out of tree canopies as this can damage the trees. Vines to be treated include oriental bittersweet, grape, Japanese honeysuckle, and poison ivy. Woody vines that may remain (due to low risk of affecting trees) include greenbriar and Virginia creeper.

Wildlife Habitat Brush Piles

Brush piles shall be placed on relatively flat, sunny areas, using cut logs and branches from invasive trees and shrubs. Potential locations of brush piles shall be reviewed with the ecologist.

See the following guidance on constructing brush piles to benefit wildlife habitat:

https://efotg.sc.egov.usda.gov/references/public/MN/jobsheet_15_wildlife_brushpiles_649.pdf

https://efotg.sc.egov.usda.gov/references/Delete/2005-1-22/314bpjsDRAFT.pdf

Briefly, brush piles start with two layers of logs in a criss-crossing or log cabin pattern. Large logs go on bottom. Working up, smaller branches are layered on top, with the largest branches on the bottom.

Invasive herbaceous species

Follow guidance from PA DNCR/Penns State Extension or other reputable sources for control methods for specific species. Review preferred methods with ecologist before proceeding.

Deer Protection Fence

Installation of deer protection fencing must be completed prior to or within two weeks of planting. Deer must be driven out of enclosed area once installation is completed.

Acceptable Product

Sturdy woven wire or welded wire metal fence at least 8 ft tall with mesh size no greater than 8 inches, installed on metal or treated wood poles. See example photos below.

Example deer fence with wooden poles

Example corner brace

Corner brace with access gate

Alternative suitable product includes for example: https://www.deerbusters.com/fixed-knot-fence/

Installation Requirements

Fence posts should be spaced according to manufacturer's instructions, but no more than 20 ft apart. The fence must be installed with minimal disturbance to existing trees. The fence should be installed after invasive tree and shrub removal. Fence to be installed such that there are no gaps where deer can crawl through, either on the sides or ground. Fence must be tied into existing walls, railing, etc on each end. The fence must be installed flush to the ground. There must be no gaps greater than 4 inches between the bottom of the fence and the ground. All gaps must be filled with soil or stone (e.g. size 4 rip rap or larger). The bottom of the fence must be rigid or buried 4-6" into the ground. Corners and gates to be appropriately braced.

Preinstallation Conference.

The contractor shall review the placement and termination of all deer protection fencing in the field with the ecologist and owner. Written authorization from the ecologist is required before proceeding with installation.

Substitutions

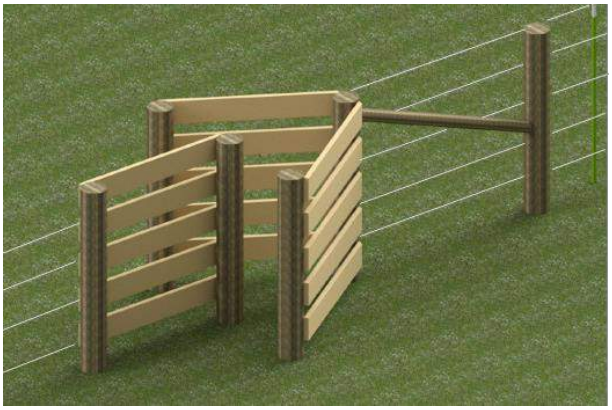
Substitutions must be reviewed with the ecologist and owner. Written approval is required for all substitutions.

Deer Protection Access Gates

Access gates shall be provided in locations as specified in specific RFPs. Gates shall be wide enough to allow maintenance vehicles and equipment to enter. Typically 7 ft wide and 8 ft tall. Gates should be locked except when needed for maintenance, to prevent visitors from leaving them open. The following images illustrate the design of these offset escape stiles:

Deer Protection Pedestrian Access

Pedestrian access shall be provided by "livestock exclusion escape" that create a 2-ft-wide zigzag gateless entry point, such that people can enter but deer cannot. Locations to be indicated in specific RFPs.



Deer Protection Grating

Deer protection grating shall be indicated where vehicle and/or pedestrian access is desired without a gate or escape style. Locations shall be indicated in specific RFPs.

Installation of deer protection grating must be completed prior to or within two weeks of planting

Acceptable products

Deer excluding grating must prevent deer from crossing over, around, or on the grating. It must be at least 20' long in the direction of vehicle/pedestrian travel and there shall be no point less than 20' long that deer may jump across by going around the sides of the grating. Sides of grating must be blocked by 8' tall fencing, 8' tall access gates, or walls at least 8' high. For further details, see: Peterson et al (2003) Wildlife Society Bulletin 31:1198-1204, https://www.jstor.org/stable/3784467.

Grating must have a gap size of 2-2.5 inches. Grating must be round or angled on the top or flat but less than ¼ inch wide. Acceptable products include examples on http://www.easthamptonfenceny.com/driveway-grates/ with the square grating being ideal.

Bridge decking may be acceptable: https://gratingpacific.com/product/bridge-decking/

For vehicle grates only, examples include: https://www.wellscroft.com/shop-products-accessories/heavy-duty-gates-hardware/deer-grates

https://www.deerbusters.com/gates/deer-crossing-guards/14dx-12w-deer-fence-driveway-crossing-guard/

Grate material must be galvanized or weathering (COR-TEN) steel. Vehicle grates may be concrete as in https://www.deerbusters.com/gates/deer-crossing-guards/14dx-12w-deer-fence-driveway-crossing-guard/

Vehicle grating must be rated for vehicular traffic including cars, trucks, and delivery vehicles.

Additional possible products:

https://www.bzwiremesh.com/steel-bar-grating/steel-bar-grating.html

https://www.holemetals.com/product/floor-mesh-steel/

https://www.metalsdepot.com/stainless-steel-products/stainless-bar-grating

http://www.brown-campbell.com/products/info?page=bar-grating&cmsID=bar-grating-terminology

Pedestrian grating must be able to be walked across by a person wearing regular shoes, or using a wheelchair.

Installation requirements

Grating should be installed approximately 2" above the ground, either set into existing pavement by excavating a sufficient amount of asphalt or by installing supports and an asphalt or concrete ramp to allow smooth driving or walking onto the grate. Sufficient gaps, grooves, or spacing under the grate and through the ramps should be provided to allow drainage. Grates must be at least partially removable for maintenance (such as removing debris).

Field measurements and submittals.

The contractor shall field measure to determine final grade dimensions and prepare shop drawings, including installation details. Shop drawings shall be submitted to the ecologist and owner for review. Installation of deer grating may not proceed until shop drawings are approved by the ecologist and owner.

Substitutions

Substitutions must be reviewed with the ecologist and owner. Written approval is required for all substitutions.

Deer & Rabbit Protection Tubes / Cages

Deer and rabbit protection tubes and cages shall be installed at the time of planting.

Acceptable product

Tall tubes: 60" high plastic tubing such as Tubex or similar.

Short tubes: 15-24: high plastic tubing such as Tubex shrub tubes.

Cages: 2x4" welded wire fencing, constructed in a cylinder 1-ft in diameter. For shrubs these must be 18-24" tall. For trees, at least 48" tall.

Stakes: 60” tall oak, fiberglass, or galvanized conduit stakes. For short tubes, shorter stakes may be used.

Alternative for rabbit protection inside deer-enclosed areas: instead of short tubes, within fenced areas, clusters of trees and shrubs may be protected from rabbits by using short fencing. Fenced areas can be informed by existing area boundaries such as walls, sidewalks, or extents of shrub planting clusters. In such cases, the fence shall be metal with a 1-inch mesh size, such as coated chicken wire or welded wire “rabbit fence”. If this substitution is desired, the contractor shall discuss construction details with the ecologist before construction.

Installation requirements

Tubing is to be installed over the planted tree/shrub seedling. It is to be secured to a stake driven into the ground at least one foot deep, using zip ties that are capable of being opened so tubes can be periodically removed for maintenance. Tubing must be installed flush to the ground. On slopes, soil should be placed around the base to close large gaps to discourage mice from inhabiting the tube.

Cages should be installed with two stakes on opposite sides of the cage, secured with zip ties or wire.

Planting & Seeding

All deer fencing and grating shall be installed before planting begins.

Pre-installation conference with the ecologist and owner is required before planting.

All planting shall occur in the following windows:

April 15 to June 15

September 15 to October 31

Order of Planting. Plants shall be installed in the following sequence:

1. 1” caliper trees
2. 3” potted trees
3. Shrubs
4. Seeding (if hydroseeding, avoid spraying installed trees, shrubs, or plugs).

All planting work shall be done by hand.

Tree and Shrub planting

Trees and shrubs must be procured from nurseries using genetic stock that originates no more than 100 miles north or south or 300 miles east or west of the project location.

Plant material shall be provided in the quantities, sizes, genus, and species specified and comply with ANSI Z60.1. Wild types (not cultivars) shall be used where possible. If wild type is not available, substitution with cultivars shall be permitted upon prior written approval of the ecologist. In no circumstances shall any plants of a given species be of all the same cultivar. If cultivars are used, a minimum of 3 cultivars within each species shall be used and when planted, cultivars should be mixed throughout the designated area to avoid uniform clumps of a given species and cultivar. All substitutions of wild types must be approved by the ecologist and the owner in advance. To receive substitution approval, the contractor must submit proof that wild types were not available from the Tree Pittsburgh Heritage Nursery and at least 2 other native plant nurseries within the distances specified above.

Lay out tree and shrub locations and review with ecologist and owner prior to installation. To protect existing trees and soil during installation, all excavations shall be done by hand. At the time of planting, verify that the root flare is visible at the top of the rootball according to ANSI Z60. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break. Remove only dead, dying, or broken branches. Do not prune to shape. Do not apply pruning paint to wounds.

Tree Maintenance & Warranties

For the first two years after planting, trees and shrubs should be watered if, between May and September, the National Drought Mitigation Center's rating for southwestern Pennsylvania reaches D0 or higher.

The contractor shall warranty 1" and 2" trees for 2 years.

Seeding

Seeding may be applied with a hydroseeder or broadcast and mulched. Seeding must occur at an appropriate time of year for good germination success. Seeded areas should be mowed and or raked prior to seeding to provide sufficient soil-seed contact. Raked material may be placed back on the site after seeding to provide mulch. The seed mix shall be as follows:

- 20 lb/acre of the specified ERNMX-140 Partiall Shaded Area Roadside Mix (or equal)
- 30 lb/acre of cover crop (grain oats or rye, depending on season, see seed mix sheet)
- Lightly mulch with half an inch (182 cu yd) or less of grass clippings, straw, or compost, or hydromulch.

Ernst Conservation Seeds
8884 Mercer Pike
Meadville, PA 16335
(800) 873-3321 Fax (814) 336-5191
www.ernstseed.com

Date: February 12, 2024

Partially Shaded Area Roadside Mix - ERNMX-140

	Botanical Name	Common Name	Price/Lb
49.40 %	*Schizachyrium scoparium, Fort Indiantown Gap-PA Ecotype*	Little Bluestem, Fort Indiantown Gap-PA Ecotype	14.60
18.50 %	*Elymus virginicus, Madison-NY Ecotype*	Virginia Wildrye, Madison-NY Ecotype	10.45
9.50 %	*Echinacea purpurea*	Purple Coneflower	43.20
6.50 %	*Elymus hystrix, PA Ecotype*	Bottlebrush Grass, PA Ecotype	33.14
3.00 %	*Rudbeckia hirta*	Blackeyed Susan	31.20
2.00 %	*Chamaecrista fasciculata, PA Ecotype*	Partridge Pea, PA Ecotype	12.00
1.80 %	*Heliopsis helianthoides, PA Ecotype*	Oxeye Sunflower, PA Ecotype	33.60
1.00 %	*Penstemon digitalis*	Tall White Beardtongue	168.00
1.00 %	*Zizia aurea, PA Ecotype*	Golden Alexanders, PA Ecotype	72.00
0.70 %	*Liatris spicata*	Marsh Blazing Star	252.00
0.60 %	*Aster macrophyllus, PA Ecotype*	Bigleaf Aster, PA Ecotype	336.00
0.60 %	*Baptisia australis, Southern WV Ecotype*	Blue False Indigo, Southern WV Ecotype	96.00
0.50 %	*Anemone canadensis, PA Ecotype*	Canadian Anemone, PA Ecotype	456.00
0.50 %	*Gaura biennis*	Biennial Beeblossom	151.20
0.50 %	*Lespedeza capitata, RI Ecotype*	Roundhead Lespedeza, RI Ecotype	115.20
0.50 %	*Rudbeckia triloba, WV Ecotype*	Browneyed Susan, WV Ecotype	57.60
0.40 %	*Asclepias tuberosa, PA Ecotype*	Butterfly Milkweed, PA Ecotype	312.00
0.40 %	*Aster pilosus, PA Ecotype*	Heath Aster, PA Ecotype	264.00
0.30 %	*Asclepias syriaca, PA Ecotype*	Common Milkweed, PA Ecotype	96.00
0.30 %	*Monarda fistulosa*	Wild Bergamot	96.00
0.30 %	*Pycnanthemum incanum, MD Ecotype*	Hoary Mountainmint, MD Ecotype	432.00
0.30 %	*Solidago bicolor, PA Ecotype*	White Goldenrod, PA Ecotype	240.00
0.30 %	*Solidago nemoralis, PA Ecotype*	Gray Goldenrod, PA Ecotype	264.00
0.30 %	*Tradescantia ohiensis, PA Ecotype*	Ohio Spiderwort, PA Ecotype	252.00
0.20 %	*Aquilegia canadensis*	Eastern Columbine	384.00
0.20 %	*Aster prenanthoides, PA Ecotype*	Zigzag Aster, PA Ecotype	432.00
0.20 %	*Solidago juncea, PA Ecotype*	Early Goldenrod, PA Ecotype	336.00
0.10 %	*Penstemon hirsutus*	Hairy Beardtongue	480.00
0.10 %	*Penstemon laevigatus, PA Ecotype*	Appalachian Beardtongue, PA Ecotype	336.00

100.00 % **Mix Price/Lb Bulk: $37.40**

Seeding Rate: 20 lbs/acre with 30 lbs/acre of a cover crop. For a cover crop use either grain oats (1 Jan to 31 Jul) or grain rye (1 Aug to 31 Dec).

Grasses & Grass-like Species - Herbaceous Perennial; Herbaceous Flowering Species - Herbaceous Perennial; Pollinator Favorites; Woodland Openings

The native grasses and forbs are ideal for roadside areas and woodland margins. Mix formulations are subject to change without notice depending on the availability of existing and new products. While the formula may change, the guiding philosophy and function of the mix will not.

Price quotes guaranteed for 30 days.
All prices are FOB Meadville, PA.
Please check our web site at www.ernstseed.com
for current pricing when placing orders.

NRCS Natural Resources Conservation Service

Early Successional Habitat Development/Management

Brush Piles for Wildlife

Conservation Practice WV Job Sheet Code 647

Definition

The creation of artificial early successional habitat and supplemental cover for wildlife.

Purpose

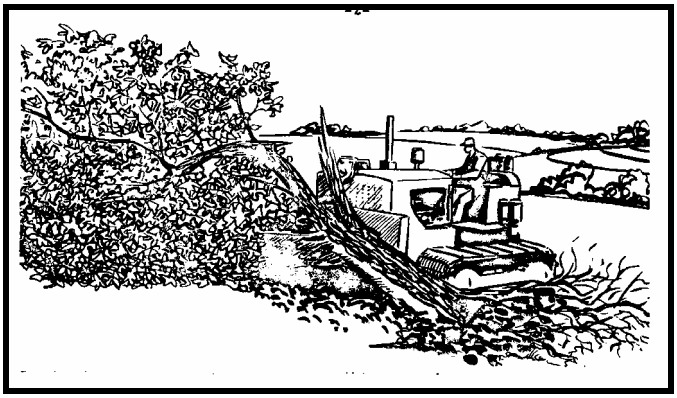
The purpose of this practice is to provide habitat for those species of wildlife that benefit from early successional vegetation or the creation of brush and woody cover. This practice is normally established concurrently with other practices as part of a wildlife resource management system.

Conditions Where Practice Applies

This job sheet pertains to the creation and establishment of brush piles for wildlife. Brush piles may be constructed as supplemental habitat where the establishment of woody shrubby thickets is not practical; or temporary habitat until permanent shrubby vegetation may become established.

Preservation and maintenance of nesting and escape cover is an important element of habitat management. Preserving any existing hedgerows, dense grasslands, low-growing shrub and briar thickets, field borders and brushy cover along open field habitat is essential for an area to support small game and mammal population. Disturbances to these areas such as mowing, disking or clearing of vegetation within these habitats should be kept to a minimum where wildlife is the primary concern. Where possible, allow vegetation to grow freely and avoid agricultural activities during the peak nesting season (February to September). Occasional mowing, disking, and burning are beneficial management practices as they promote regeneration of succulent grasses and other preferred forage vegetation. However, such disturbance should be conducted on a rotational basis and be implemented outside the nesting season when possible.

When natural cover is limited in wildlife habitat, brush piles may be provided. If possible, brush piles should be a by-product of other land management activities, rather than a specific practice. Timber harvest, timber stand improvements, pasture or cropland clearing, and firewood cutting all provide woody limbs suitable for brush piles.



Brush piles are frequently constructed as a byproduct of other land management activities.

In addition to the existing vegetation, brush piles can also improve and supplement an area's habitat composition by providing nesting and escape cover especially for rabbits and small mammals.

Construction

Brush piles are constructed by piling brush and loose branches on top of a base frame comprised of larger logs or tree trunks (See Figure 1).

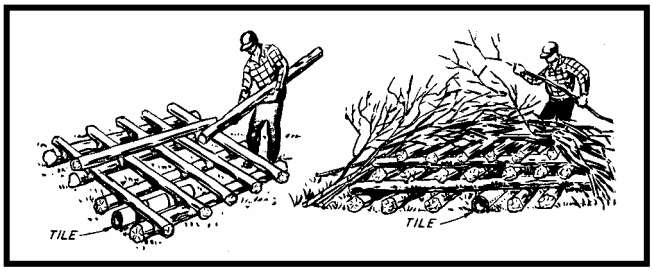


Figure 1 – Brush Pile Construction

The base of the pile is constructed by stacking logs perpendicular to and on top of one another to create a sturdy crisscross log cabin-like structure with a height of 12 to 20 inches. Some of the base logs can be as close as 3 inches apart. Old and discarded fence posts serve as good base materials. The largest diameter boughs should be on the bottom. Cinder blocks, stumps, rocks or similar materials can be used to elevate the base up to eight inches off the ground to prevent the acceleration of weather rot and enable larger mammals like cottontails to enter the pile. The crown is constructed by piling loose branches on top of the base to create a tangled pile of brush.

A four-foot long piece of drainage tile or PVC pipe may be placed under the base to enable cottontails or other small mammals to easily enter the pile. The diameter of the tile or pipe should not exceed six inches (6") to preclude foxes and other predators from entering the pile.

Size

Brush piles can be constructed of various sizes according to the habitats in which they are placed. However, piles 12 to 18 feet in diameter and three to six feet in height are best in order to enable multiple individuals and species to occupy a single pile. Smaller brush piles are acceptable when moderate use is expected. Small brush piles can always be enlarged later as use increases.

Placement

Properly locating brush piles within an area is important. They should allow relatively safe access to food sources and permit wildlife to forage over a larger area. Brush piles should be placed at intervals near feeding areas, along field borders and within idle fields or abandoned areas.

Avoid the bottoms of drainages and low spots where standing water might render the brush pile useless.

Well constructed brush piles can have a life span of as much as 10 years, and proper placement can promote use by eastern cottontails as well as many different species of songbirds, insects, and other animals.

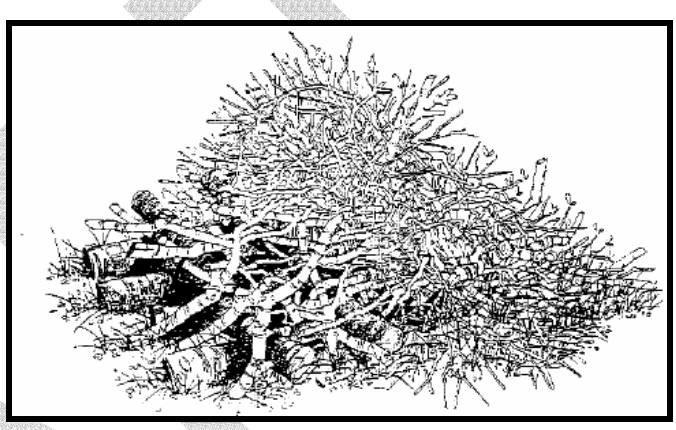


Illustration of a properly constructed brush pile.

Brush piles should be placed along hedgerows, briar thickets, windbreaks, and within dense grasslands when additional brushy cover is nearby. Improper placement of a brush pile (e.g., isolated and distant from tall grass and other forms of escape cover) can potentially create a "predator trap" for cottontails and other prey species due to increased access by predators. Brush piles help to establish a balance between predator and prey species within an area, but improper placement can cause a brush pile project to be counterproductive.

Lands managed for timber can benefit rabbits, small mammals and birds when slash from harvested trees is left as brush piles. Tree tops and branches assembled into windrow piles following harvest or the creation of forest openings can provide excellent cottontail cover for several years.

Windrowed piles should to the extent possible be constructed in the same manner as standard brush piles with the log cabin-like base and loose material piled as the canopy.

Living Brush Piles/Green-Tree Cuts

A simple, convenient brush pile needed in field borders, woodland edges, and odd areas may be created by cutting a larger diameter wolf or edge tree and leaving it where it falls. This will allow vines, weeds, and briar tangles to grow up in and around the felled crown and create cover and shelter for a variety of animals. Quail, rabbits, and many species of songbirds will make use of this type of cover.

Another method of creation is know as the "Living" brush pile. Evergreen trees such as Eastern red cedar, American holly or even deciduous trees may be used. Choose wide-crowned trees that are 6 to 8 feet tall.

In the spring of the year, make a cut in the tree with a hand or chainsaw 3-4 feet above the ground opposite the intended location of the pile. Cut deep enough so that you can push the top over, leaving a connecting strip of bark and wood (hinge) to nourish the tree. Use a stake or stone to tie the top of the tree to the ground.

Select trees with grape or honeysuckle vines nearby that will grow and cover the pile. If the trees are cut to fall in a crisscross pattern over each other, a living brush pile is created.

This figure illustrates green tree cuts (living brush piles) where the stem is partially cut, allowing additional growth and surrounding vegetation to create a brush pile.

Brush piles of this type are loosely formed and do not give the best protection from severe weather. They can be made more dense by using the bases of the cut trees as foundations and piling dead limbs and brush over them. Old piles may need to be reworked every 5 or 6 years.

Operation and Maintenance

When properly constructed brush piles may last for as long as 10 years with very little maintenance. The lifespan of brush piles depend on factors such as climate, composition and species of the brush used and the method and type of construction.

Periodic monitoring of brush piles to determine the amount of use and production should be performed at least annually during nesting seasons of small mammals such as rabbits (February – September).

Additional boughs, branches, and fine brush may need to be added to the structure each year to maintain the desired density.

If PVC pipe, tiles or similar devices are installed as escape routes in brush piles, periodically check these structures for obstructions that may inhibit wildlife use.

Wildlife Brush Piles (649)

Biology Job Sheet #15

Natural Resources Conservation Service (NRCS) - Minnesota **August 2014**

Landowner: _____

WHAT IS A WILDLIFE BRUSH PILE?

The term "brush pile" describes a mound or heap of woody vegetative material constructed to furnish additional wildlife cover. Brush piles can be fashioned in many different ways to meet various cover needs for particular wildlife species.

Loosely formed brush piles can provide nesting habitat, resting areas, concealment, and protection from predators. Brush piles that are relatively open at ground level, but tightly compacted above, can provide good protective cover against harsh weather conditions. Densely packed piles of logs, rocks, or boulders can provide den sites for additional wildlife species such as reptiles.

Constructing brush piles on your land can provide cover for ground-nesting birds, many songbirds, rabbits, and other small mammals. Landowners should determine what cover types are needed and specifically design brush piles to meet those needs.

PLANNING CONSIDERATIONS

- Place brush piles near wildlife food sources. Good locations include: along forest roads and edges; in woodland openings; along field edges and corners; and beside streams and wetlands. Isolated piles are not as beneficial, nor as likely to be used.
- Brush piles can be developed in woodland habitats with the material left from timber harvesting, woodland edge development, forest stand improvement, forest opening development, or firewood cutting.
- Several strategically placed medium-size piles, roughly 10 feet in diameter and six (6) feet high, are better than one large one.
- Plant native vines such as Bittersweet, Wild Grape, or Virginia Creeper as an attractive cover for the brush pile; border with wildflowers; or screen with shrubs. Shrubs can provide additional food and cover.
- Keep brush piles away from houses and lawns to avoid problems with nuisance wildlife.
- Brush piles are flammable. Keep them away from buildings.

Consider requesting technical assistance from an Minnesota Department of Natural Resources (MDNR), U.S. Fish and Wildlife Service, or NRCS biologist.

BRUSH PILES AS NESTING, RESTING AND ESCAPE COVER

Predators such as owls, hawks, foxes, coyotes, and domestic pets, can significantly impact wildlife populations including rabbits and quail when thick, brushy cover is lacking or not well distributed. The well-planned creation and placement of brush piles can often supplement naturally occurring escape cover for these and other wildlife species.

A loosely formed brush pile will encourage plant growth by allowing sunlight penetration. The tangled network of dead branches will eventually be intertwined by a thin to moderately dense stand of grasses and forbs. The end result is excellent resting and escape cover.

These same types of brush piles may also be used as nesting sites by songbirds such as the White-throated Sparrow, Song Sparrow, Fox Sparrow, and Brown Thrasher.

The key to forming this type of habitat is to lightly pile branches in such a fashion so that plenty of sunlight reaches the ground. The branches can be sparingly piled in a teepee-type fashion or laid against an elevated object, such as a tree stump or fallen log.

Discarded Christmas trees (without the tinsel!) can be used in a similar manner. The resulting combination of overhead woody cover mixed with a grass and forb groundcover provides a secure hiding and resting site.

An old, discarded section of woven wire fencing, rolled up to an inner diameter of 1½ to 2 feet and laid on its side, will also afford rabbits considerable protection from predators and at the same time allow grasses and forbs to grow up through the openings. Brush piles fashioned in this way take on the characteristics that rabbits find attractive.

Another alternative is to elevate a discarded wooden pallet approximately eight (8) to 12 inches above ground. Sunlight penetrating through the slats will allow grasses and forbs to grow and provide additional cover.

Living Shelters

A brush pile will last longer if constructed of living materials. In addition to providing cover and protection, living brush piles made from partially cut hardwood trees can supply buds, twigs, leaves, and seeds for animals to eat. Red cedar or locust trees can be used as well.

To make a living brush pile, find several (three to five) small hardwood saplings (4 to 8 inches in diameter) located within a few feet from one another. Cut each tree halfway through the trunk about 12 to 18 inches above the ground. Place the cuts on the outside, away from the other trees in the group. Fold the treetop over towards the other trees in the group so it rests on the ground or on top of the other half-cut trees. Since the tree is not cut all the way through, the tree will stay alive for some time. Pile limbs and brush to reduce any large entrances, particularly near the folded trunks. Avoid covering the tops of the cut trees so they will continue to grow.

Placement

Rabbits and quail rarely stray far from good protective cover. This often limits the use of large open spaces that might otherwise serve as important nesting and feeding habitat. By placing brush piles along the edge or scattered throughout large open areas, rabbits and quail are more likely to utilize all available habitat.

General Recommendations

- Good locations to place brush piles include:
  - ✔ Adjacent to edges of gullies, woodlands, and pastures or hay fields
  - ✔ Within shrub thickets, fencerows or shelterbelts
  - ✔ In field corners or other odd areas
- For edge habitats, such as along woodland, fence rows, or gullies, one (1) brush pile every 200 to 300 feet will provide adequate cover and travel lanes between food sources.
- In abandoned fields and other early successional habitat, create at least two (2) piles per acre.
- On properties with little natural cover, create three (3) or four (4) brush piles per acre.
- Avoid the bottoms of drainage ways and low spots where standing water or flooding will reduce the usefulness of brush pile for upland wildlife species.

BRUSH PILES FOR HARSH WEATHER COVER

Brush piles can help ground dwelling wildlife escape the effects of harsh weather (bitterly cold or extremely hot), snow, and ice. A well-constructed, properly maintained, brush pile can supplement natural cover for 10 to 15 years.

Generally, brush piles of this type should range between 10 to 15 feet in diameter, and 5 to 8 feet in height. The most common design is built using logs (arranged in a tic-tac-toe pattern) for the foundation and covered with brush. Start with the largest material on the bottom to provide hiding space under the pile. Shallow depressions can also be dug before beginning the brush pile to provide more space.

Foundation

Use the largest available materials when constructing the foundation. Logs at least six (6) to 10 inches in diameter and 10 to 15 feet in length are recommended. The larger materials at the bottom keep the smaller limbs off the ground, helping to prevent decay.

Start construction by laying logs parallel and six (6) to 12 inches apart. Next, place a second layer of logs on top of, and perpendicular to, the first layer (again about six (6) to 12 inches apart - see Figure 1). Large, flat rocks can be substituted for the second layer of logs. Repeat this process one or two more times to complete the final tiers. The intent is to make a pyramid-type structure that has a hollow core. Note that old and discarded fence posts can also serve this purpose.

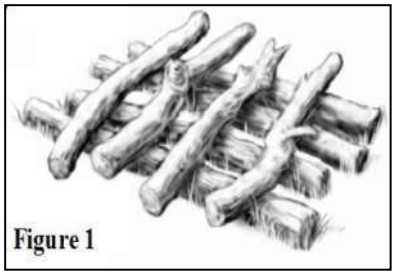


Figure 1

Many other options for building brush pile foundations are possible depending upon the materials available:

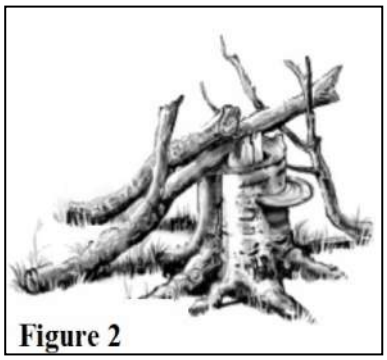


Figure 2

A tree stump that is still in place can create an adequate foundation.

Place several logs (6 to 10 inches in diameter and 5 to 6 feet long) on top of the stump so that the logs are radiating out from the center (see Figure 2).

Discarded wooden pallets can also make a suitable base. Pallets should be arranged in four (4) to six (6) layers (and elevated from the ground using concrete blocks, stones, etc., if available) to form the foundation. Consider utilizing six (6) to eight (8) inch diameter old clay tiles to create small wildlife tunnels within the foundation.

Small rock piles can be substituted as foundation material. Create rock piles approximately 12 inches apart with each pile about 10 inches high and 12 inches across. Stagger the piles so that they are capable of supporting the next layer of limbs (see Figure 3).

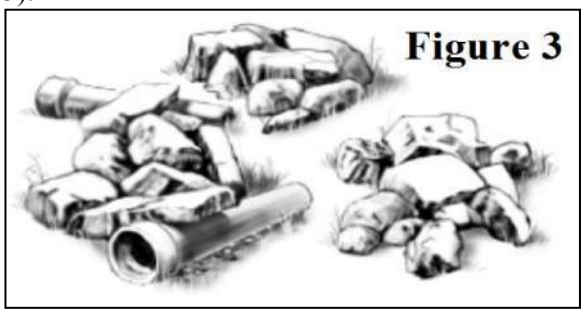


Figure 3

Brush Covering

Once completed, cover the foundation with larger branches and limbs, placing the smallest stock on top. The cover can consist of small limbs, saplings, old Christmas trees, stumps, or loose brush. Use leaves or pine boughs as a cap if available.

Ideally, the foundation should be covered with two (2) to four (4) feet of brush. Larger brush piles provide more security for wildlife and will receive more use than smaller piles. Leave six (6) to 12 inch openings in the sides at several places for easy wildlife access. Add to the brush pile as new brushy material is available. The older brush will settle as it decays, and new cover must be added as time passes.

When properly constructed, harsh weather brush piles will contain an easily accessible labyrinth of tunnels and cavities at ground level and at the same time provide good overhead shelter from harsh weather. Once again, brush piles should be established throughout the management area to meet wildlife needs.

OTHER CONSTRUCTION OPTIONS

A simple pile of logs, wood slabs, large rocks or boulders can be very attractive to amphibians, reptiles and small mammals, especially when located near or within woodland habitats. Piles of rotting logs or wood slabs not only provide shelter and produce an abundance of food items, but also maintain the moist conditions required by woodland amphibians.

Rock Piles

Amphibians and reptiles such as frogs, lizards, salamanders and snakes will benefit from rock piles. Besides providing shelter and basking areas, the rocks absorb heat during the day and radiate warmth at night.

Rock piles should start with the largest rocks (or boulders) on the bottom of the stack to create hiding places between rocks. Broken slabs of concrete can also be used for the foundation by arranging them loosely to form tunnels and cavities. Digging depressions under large flat rocks can create temporary pools for breeding frogs and salamanders (see Figure 4).

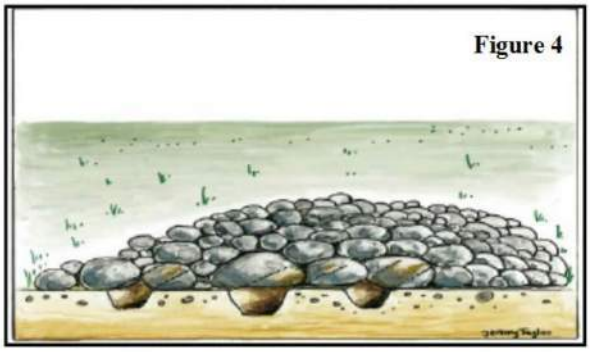


Figure 4

General Recommendations

- Build a mound of rocks and stones of different shapes and sizes, arranging the rock pile in a way that creates openings for shelter.
- Place pieces of chimney tile, old clay field tile or lengths of pipe at the base for entrances and tunnels.
- Add flat rocks on top for amphibians and reptiles.

OPERATION AND MAINTENANCE

Do not use materials that contain toxic substances (i.e. pressure treated lumber/posts, creosote railroad ties, lead painted surfaces, tires, etc.). These substances can cause wildlife mortality either through contact, consumption, or inhalation.

Brush piles are not permanent structures. Rot and decay are a normal process of brush piles. As brush piles rot, more insects are attracted, providing additional food for birds and other wildlife. The piles should be inspected yearly to see if the state of decay is such that additional brush is needed, or if a new brush pile should be constructed.

Site-specific recommendations are listed on the front page of this document. See the Minnesota Electronic Field Office Technical Guide Standard (645) *Upland Wildlife Habitat/Management* for additional wildlife guidance.

REFERENCES

Wildlife Management for Missouri Landowners (3rd Ed)

Outdoor California, CA Department of Fish & Game.

Invasive Plants in Pennsylvania

English ivy

Hedera helix

Chuck Bargeron, Univ. of Georgia

Background:

English ivy was probably first introduced into the United States by early European settlers for ornamental purposes. It continues to be a popular groundcover and vine due to its fast-growing, evergreen, pest-free and cold-hardy nature.

Range:

English ivy is native to Europe, western Asia and northern Africa. In the United States, it is now established mainly in the east, south and along the West Coast.

Description:

English ivy is an evergreen climbing vine with waxy, dark green leaves and conspicuous white veins. It attaches to surfaces by aerial rootlets. In sufficient light, terminal clusters of yellow-green flowers are produced in the fall. The black-purple fruits persist through the winter if not eaten by wildlife.

Forest & Kim Starr, Starr Environmental

Habitat:

This invasive vine infests woodlands, forest edges, fields, hedgerows and coastal areas; however, it does not grow well in extremely wet locations. It tolerates a wide range of soil pH, but prefers slightly acid soils. It is often associated with habitat disturbances and old home sites.

Biology and Spread:

Frugivorous birds are important seed dispersers of English ivy, transporting the vine to new areas over long distances. This vine also spreads through vegetative growth and can form new plants via broken pieces of stem that manage to root in the soil.

Ecological Threat:

Both a climbing vine and a groundcover, English ivy impacts all structural levels of ecosystems. As it climbs trees in search of light, it kills branches by covering leaves and preventing photosynthesis. Its sheer weight makes trees susceptible to blow-over during inclement weather. On the ground, it forms dense monocultures that exclude native plants. English ivy is also a reservoir for Bacterial Leaf Scorch (*Xylella fastidiosa*), a threat to native trees.

David J. Moorhead, Univ. of Georgia

How to Control this Species:

Physical

Vines growing as a ground-cover can be pulled by hand, but not without difficulty. Another option is mulching, where the infestation is smothered under several inches of biodegradable plant material, such as wood chips. The mulch needs to stay in place for at least two growing seasons. Climbing vines may be severed near the ground in order to kill upper portions. Damage to the host tree's bark should be minimized if possible. Rooted portions of climbing vines should be pulled or treated with herbicide.

Chemical

A 25 percent solution of triclopyr or glyphosate mixed in water can be applied to freshly cut stumps. Products like Brush-B-Gone®, Brush Killer®, and Roundup Pro® Concentrate are effective. Alternatively, a 20 percent solution of triclopyr ester (Garlon® 4) mixed in basal oil may be applied to intact vine stems. Garlon 4 may also be applied to wet leaves. Herbicide applications can be made at any time of the year as long as temperatures are above 60° Fahrenheit and rain is not expected within 24 hours. Garlon 4 is very toxic to aquatic life and should not be used near water sources.

Look-A-Likes:

English ivy is sometimes confused with eastern poison-ivy (*Toxicodendron radicans*), especially in the winter, because both are robust vines with obvious aerial rootlets.


Poison-ivy

Charles T. Bryson, USDA ARS

Exotic Biennials

Description

- Refer to the DCNR Invasive Plants pages under 'Herbs'- (http://www.dcnr.state.pa.us/forestry/plants/invasiveplants/index.htm), for information on seven biennial species, including garlic mustard (*Alliaria petiolata*), chervil (*Anthriscus sylvestris*), musk thistle (*Carduus nutans*), bull thistle (*Cirsium vulgare*), poison hemlock (*Conium maculatum*), dame's rocket (*Hesperis matronalis*). wild parsnip (*Pastinaca sativa*)
- Other problem biennials include common teasel (*Dipsacus fullonum*), plumeless thistle (*Carduus acanthoides*), and common burdock (*Arctium minus*).
- Biennial life span is two growing seasons. They germinate, and grow vegetatively as a rosette in year one, overwinter, then 'bolt' and flower, produce seed, and die in year two.
- They aren't just weedy - poison hemlock is deadly toxic to humans and livestock, and wild parsnip sap causes sunlight-induced blisters in sensitive individuals.
- Bull and musk thistles are Noxious Weed in PA.

Management Keys

There are a number of exotic biennials, and they vary somewhat in their flowering times and response to certain herbicides. These guidelines offer techniques and timings that should be effective against any biennial species you need to manage.

Long Term Goals

Biennials reproduce only by seed, and there is variability between species in how long their seed persists in the soil. The primary objective is to treat biennials early in their life cycle as selectively as practical, which increases the window of opportunity for desirable species to fill in, dominate the site, and limit the reinfestation by biennials. What complicates this is that many biennials can germinate throughout the growing season – eliminating one growth flush may just invite another. Leave as much desirable vegetation in place as practical.

Mechanical Control Methods

Biennials are taprooted, and unlike certain perennials, they generally do not regenerate from root fragments. Mechanical operations that completely remove shoot tissue will prevent regrowth.

Garlic mustard (*Alliaria petiolata*) is an example of a biennial that can be hand-pulled. When the plants bolt and are preparing to flower in the early spring, they are relatively easy to pull. This is one species that volunteers can effectively control. Each plant flowers over a period of weeks, and there will be variability of flower timing within a stand. Therefore, it is best to bag and remove the pulled plants from the site, as even early pulling episodes probably include plants that have viable seed.

For other species you can control isolated plants by shearing the root below the soil surface and removing the shoot and top of the root. This is labor intensive, and would only be suitable where plant numbers are low and the soil is moist or friable enough to penetrate with a shovel.

Controlling Biennials with Herbicides

Although biennials arise from seed, we don't rely on premergence herbicides as a control method. This is partly because we are typically devoting attention to the overwintered rosettes in the spring, rather than the next generation. Another factor that works against preemergent herbicide applications being a primary tool is the length of the germination window for many biennials. They are opportunistic species that can germinate throughout the growing season, whenever conditions are suitable.

Postemergence applications are the primary tool to control most biennial species. It is best to treat the rosette stage, as they are easier to selectively target with a spray application than taller, bolted plants. The window to treat rosettes is almost a year long. You can treat rosettes as soon as you recognize them after germination, and because they do not go dormant, you can treat even through the winter months as long as the temperature of the plant crown is above freezing.

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A selective mix useful for treating biennials is *triclopyr* ('Triclopyr 3') plus *2,4-D* ('DMA 4 IVM'). This combination does not injure grasses, or most grass-like plants (sedges, rushes, etc.), and both ingredients have aquatic labeling. Therefore, you can preserve desirable grasses, and work near water with a mix that poses less risk to non-target organisms. This mix is useful for most broadleaved plants, but will be weak against a lot of woody species.

If you are going to target other species while treating biennials, use *glyphosate* ('Rodeo') plus *triclopyr* ('Triclopyr 3'). This mixture will be effective against almost any species you encounter, whether grass, forb, or woody. The application rate described in Table 1 is higher than needed to control biennial rosettes. To retain the ability to control difficult species and apply an appropriate dose to less resilient targets, make your mix more dilute than normal. For example, instead of a carrier volume of 20 gallons/acre, mix in 40 gallons/acre, but apply the same as you would for the 20 gallon/acre mix. Then, you are applying a half-rate to the biennials, and when you encounter a more difficult species, apply the mix heavier to increase the dosage. In this manner, you can use one mix, treat many species, and dose each only as needed.

Figure 1. The management calendar for biennials emphasizes treatment before seed set. The rosette stage represents a year-long window for herbicide treatment. The table shows extended ranges because it addresses many species.

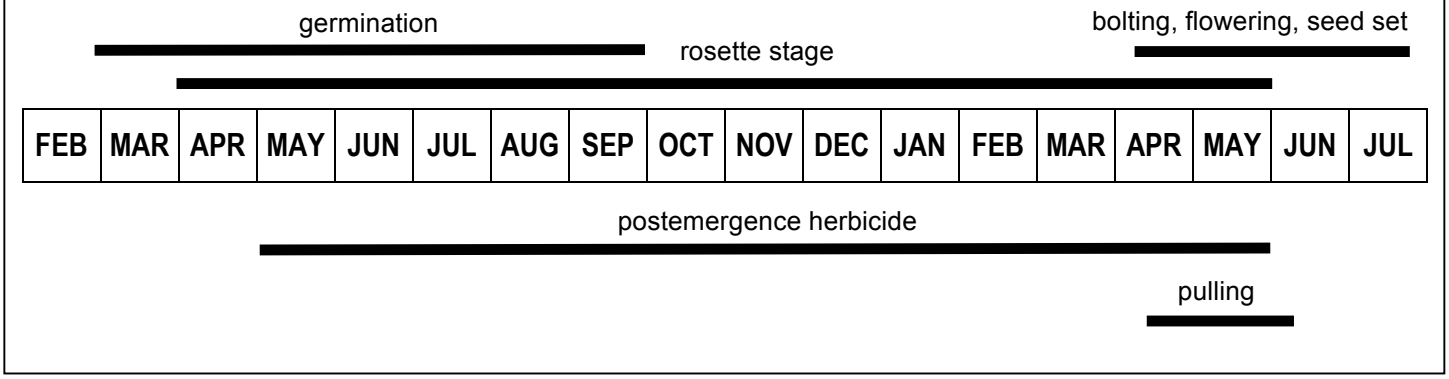

Table 1. Prescriptions for controlling invasive biennials emphasizes treatment before seed set, and when using herbicides, treat reproductive growth in the second season when it is easier to treat the low growing rosettes.

Timing	Treatment	Product Rate	Comments
Year 2: April to June	pulling	n/a	Garllc mustard is unique in that it pulls easily. Pull bolted plants from the pre-bloom to pre-seed shatter stage. Plants should be bagged and destroyed. This is a useful activity for volunteers.
Before seed set	root shearing	n/a	Most biennials have a distinct taproot. Individual plants can be controlled by cutting the root below the crown with a sharp digging tool and pulling the top.
Rosette stage	*Selective Postemergence* 'Triclopyr 3' plus 'DMA 4 IVM'	43 oz/ac plus 68 oz/acre	Postemergence applications of *triclopyr* ('Triclopyr 3') plus *2,4-D* ('DMA 4 IVM') are useful when targets plants are growing among desirable grasses or other grass-like plants. This is a broad spectrum combination that is aquatic-labeled and has little soil activity. This mix would be effective against most herbaceous species. Use an aquatic-labeled surfactant such as 'Alligare 90'. If you plan on treating woody vegetation as well during the operation, the 'Rodeo' plus 'Triclopyr 3' combination described below would be a better choice.
Rosette stage	*Non-selective Postemergence:* 'Rodeo' plus 'Triclopyr 3'	96 oz/ac + 64 oz/ac	This is a non-selective combination that would be effective when there is no advantage to using the selective mixture described above, or when you are also treating invasive grasses or woody species. An additional benefit is this mix will effectively control most any species you encounter during the operation. *Glyphosate* ('Rodeo') has been shown to be effective even in the dormant season, as long as the temperatures are above freezing. Use an aquatic-labeled surfactant such as 'Alligare 90'.

Exotic Woody Vines

Description

- Refer to the DCNR Invasive Plants pages under 'Vines'- (http://www.dcnr.state.pa.us/forestry/plants/invasiveplants/index.htm), for information on invasive woody vines including five-leaved akebia (*Akebia quinata*), porcelainberry (*Ampelopsis brevipedunculata*), Oriental bittersweet (*Celastrus orbiculatus*), Japanese honeysuckle (*Lonicera japonica*), kudzu (*Pueraria montana*), and Chinese wisteria (*Wisteria sinensis*).
- Exotic vines grow more aggressively than native vines such as grape (*Vitis* spp.) Virginia creeper (*Parthenocissus quinquefolia)*, or poison ivy (*Toxicodendron radicans)*, and do not provide the same habitat value.
- Invasive woody vines exert mechanical stress on their 'host' trees through extra weight, and some species spiral around the tree and can girdle them by strangulation.
- Woody vines behave as suckering species, and produce many stems from their root system.

Management Keys

Ultimately, you need to control the roots to be successful, but you often need to first control the aerial stems before you can address the root system.

Long Term Goals

You need to kill the root system of the vine. However, the root system may be supporting dozens of stems, and many of these stems may be very small, or wrapped around a desirable tree, making them impractical to treat. Often, the most practical approach is going to be to cut the existing stems, force the roots to send up new shoots, and foliar treat this regrowth.

Mechanical Control Methods

On well-developed vines, most of the leaf area is out of reach for herbicide application. Cutting the vines kills the portion hanging in the trees, and forces the roots to generate new growth. The cutting can be done any time, and is a very useful activity for volunteers seeking to assist with invasive species efforts. Use the 'window-cut' method, where the vines are cut at the ground and high as practical above ground. This ensures all the vines are located and cut, clears the site a ground level to facilitate a follow-up spray, and reduces 'Tarzan' ropes. Do not pull the cut vines from trees and shrubs. It will shed its leaves and dry, so that the weight will not longer be a significant issue. Additionally, it is quite likely you will damage the tree while trying to pull down the vines, and you may pull branches onto yourself.

Cutting alone will only be effective if it is continued until the roots are exhausted. This will take multiple cuts over multiple seasons, and it is likely that a cutting will be overlooked, and the vines will recover.

Stem Herbicide Treatments

Ideally, all herbicide treatments to vines would be later in the growing season to enhance translocation to the root system. However, treating all the vines on a well-developed infestation with stem treatment is challenging, or not practical at all if the vines are wrapped around desirable trees. Treating stumps after cutting, or stems – either intact or with hatchet cuts to expose the vascular tissue – will likely reduce the amount of regrowth you have to treat. However, it will not eliminate it. It may be less work to simply cut all the vines and wait to foliar treat the regrowth.

If you use an oil-soluble product such as 'Pathfinder II' (*triclopyr)*, do not get the spray on the bark of desirable trees and shrubs. The water-soluble form of *triclopyr* ('Triclopyr 3') reduces the risk of bark penetration. Using concentrated *triclopyr* mixtures around the base of desirable trees poses a potential risk of injury through root pick-up. Using *glyphosate* ('Rodeo') reduces this risk of injury because it has no soil activity.

Foliar Herbicide Treatments

The most practical method to injure the root system of invasive vines is to treat the regrowth with a foliar application after cutting the vines. Ideally, this should be done after the regrowth has had at least six weeks to grow. If you treat too soon, the new foliage will still be using all the energy it derives from photosynthesis to produce more foliage, and the herbicide will not get

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to the roots. The challenge will be treating the new vines before they get a chance to intermingle with the foliage of desirable plants. In this scenario, either treat the foliage and be prepared to spray again; or cut again, and treat the new regrowth after six weeks.

Use a mix of *glyphosate* ('Rodeo') and *triclopyr* ('Triclopyr 3'), with an aquatic surfactant (e.g. 'Alligare 90'). This mix will not only suppress the vine regrowth, but also give you the latitude to treat any other invasive species you encounter during the operation.

Well-developed vines will require ongoing monitoring to ensure you achieve complete control.

Figure 1. The management calendar for woody vines emphasizes injuring the root system with late-season herbicide applications, but this may need to follow a cutting of the existing vines to force new regrowth. The ranges for growth characteristics are wide because several species are considered.

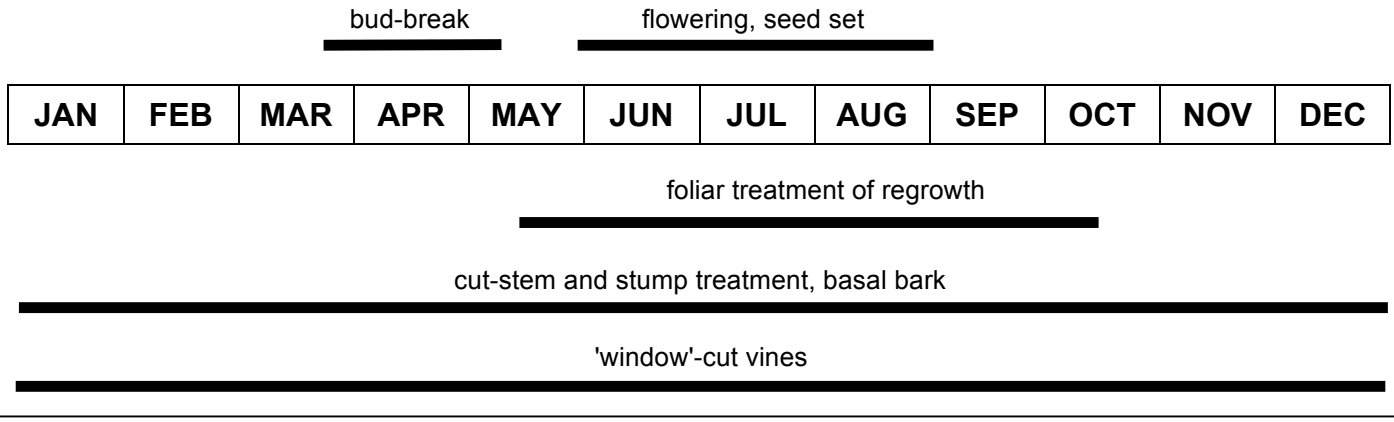

Table 1. Prescriptions for controlling invasive woody vines emphasize removing the aerial growth to facilitate a foliar treatment to injure the root system.

Timing	Treatment	Product Rate	Comments
Any time	'window' cut	n/a	'Window' cut means cutting the vine at the ground, and also a few feet in the air. The advantages are it eliminates missing vines during cutting, and it clears the ground level zone so that the regrowth can be sprayed more easily. DO NOT PULL THE CUT VINES FROM TREES.
Any time	*Stump or Stem Treatment:* 'Pathfinder II'	RTU	Treating the stumps after cutting or treating intact stems (basal bark) with 'Pathfinder II' (*triclopyr)* will reduce the number of stems that regrow. The question becomes, is it more efficient to treat twice – at cutting time and on the regrowth – or just once by only treating the reqrowth. Vine diameter makes a difference, as fewer, larger vines are easier to treat than many small-diameter vines. Additionally, 'Pathfinder II' should not be used in settings where you get spray solution on the stems of desirable plants. *Triclopyr* can cause injury through root pick-up to desirable plants, so avoid treating if there are a lot of stumps under the dripline of desirable trees.
Any time	*Stump or Stem Treatment:* 'Triclopyr 3' or 'Rodeo'	Apply either undiluted or mixed 1:1 with water	Treating stumps after cutting or treating fresh cuts on larger stems with water soluble formulations of *triclopyr* ('Triclopyr 3') or *glyphosate* ('Rodeo') will reduce resprouting, but not eliminate it. Therefore, you still need to treat the regrowth. These water-soluble forms are less likely to penetrate bark of desirable trees. If stumps are close to desirable trees, *glyphosate* poses less risk, as it has no soil activity.
mid-May to October	*Foliar Herbicide* 'Rodeo' plus 'Triclopyr 3'	96 oz/ac + 64 oz/ac	Apply this treatment to regrowth after enough foliage is present for a practical treatment. Waiting six weeks is desirable to ensure translocation to the roots, but rapidly growing shoots should be treated before they start vining around desirable trees and shrubs. Use aquatic-labeled surfactant such as 'Alligare 90'.

PennState College of Agricultural Sciences

Wildland Weed Management
plantscience.psu.edu/wildland

Invasive Plant Species Management **1**

Japanese knotweed (Fallopia japonica)

Description

- Refer to the DCNR Invasive Plants webpage, and the knotweed factsheet which describes Japanese knotweed and giant knotweed (*Fallopia sachalinense*).
- Herbaceous, rhizomatous, perennial dicot.
- The true identity of knotweed can be obscure – there is Japanese, giant, and a hybrid.
- Grows in tall (6 to 10-plus feet), dense stands that exclude almost all other vegetation.
- Native to East Asia, imported as an ornamental in the late-1800's.
- Grows almost anywhere, from acidic spoil in full sun to fertile, partly-shaded alluvial soils along rivers and streams.

Management Keys

The primary objective in controlling Japanese knotweed is eliminating the underground rhizome system. Rhizomes are creeping underground stems that give rise to new stems and roots. As long as you are willing to invest the effort and follow a few key timing guidelines, it can be successfully suppressed.

Be Persistent

There are two phases of invasive species management – control and maintenance. The control phase for knotweed takes two seasons, and would ideally include two herbicide applications the first season and a rigorous follow-up treatment the second year.

After your control efforts have nearly eliminated the knotweed, you need to periodically monitor the sites and treat any new growth to prevent re-infestation.

Target the Rhizomes – Timing is Key

To control knotweed, you have to injure the rhizomes. This is most effectively done with systemic herbicides applied later in the growing season (Figure 1). This is when the foliage is sending sugars produced through photosynthesis to the roots and rhizomes. Systemic herbicides move in the same direction through the plant as the sugars.

Applications made too early in the season or too soon after cutting do not translocate to the rhizomes, and only injure the shoots.

June Cutting Can Help

Cutting alone is not an effective suppression approach. However, cutting prior to an herbicide application can be very helpful. If you cut in June, and wait eight weeks after cutting to treat, you will find that the knotweed regrowth is much shorter than when it was cut. Typically, knotweed regrows 2- to 5-ft tall. This cutting also reduces rhizome growth as the plant has to expend its energy to regrow a canopy instead of expanding its network of rhizomes.

When knotweed is growing near water, cutting is useful because it is easier to treat the shorter regrowth without getting spray solution into the water.

If the knotweed is not near water, you have to decide if cutting the knotweed is a good use of your finite time and effort. Treating intact knotweed towering over your head is a lot like work, but cutting may be even more work. As long as you are able to effectively spray all the foliage in a patch, cutting is not critical.

Wait after Cutting to Treat

Wait eight weeks after cutting before applying herbicide. If you apply too soon after cutting, the plant is still directing its energy to new leaf growth and the herbicide will not be translocated to the rhizomes.

Recommended Herbicides

We recommend the herbicide *glyphosate*, a non-selective herbicide available as aquatic-labeled products for use in or near water. The *glyphosate* products typically available on the PA state contract include 'Rodeo', 'Aqauaneat', or 'Glyphomate 41'.

Glyphosate has several advantages:

- it is effective
- it has low toxicity to non-target organisms
- it is available in aquatic-labeled formulations
- it has no soil activity
- it is relatively inexpensive.

The herbicide *imazapyr* (e.g. 'Polaris', 'Habitat') is also effective against knotweed, but has considerable soil activity and can injure nearby trees through root

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absorption. Broadleaf herbicides such as *triclopyr* or *2,4-D* provide significant foliar injury, but limited effect on the rhizome system.

Mixing *glyphosate* with other herbicides makes sense if knotweed is not your only target during spray operations. Combinations with *triclopyr* or *imazapyr* provide a broader species spectrum and do not reduce activity against knotweed.

After the Knotweed

If you remove the knotweed while it is a small patch, you probably will not need to reseed or replant the site.

When a knotweed infestation is well established, you may need to suppress the vegetation that follows as well, and establish desirable plants in that space.

If you are planning on replanting the area, BE PATIENT. If you plant before the knotweed is completely suppressed, it will be much harder to manage the recurring knotweed without injuring the desirable plants you have established.

Suppress knotweed for at least two seasons before investing time and money into replanting the site. You can seed a cover crop such as oats, rye grain, or annual ryegrass if you need temporary cover to prevent erosion.

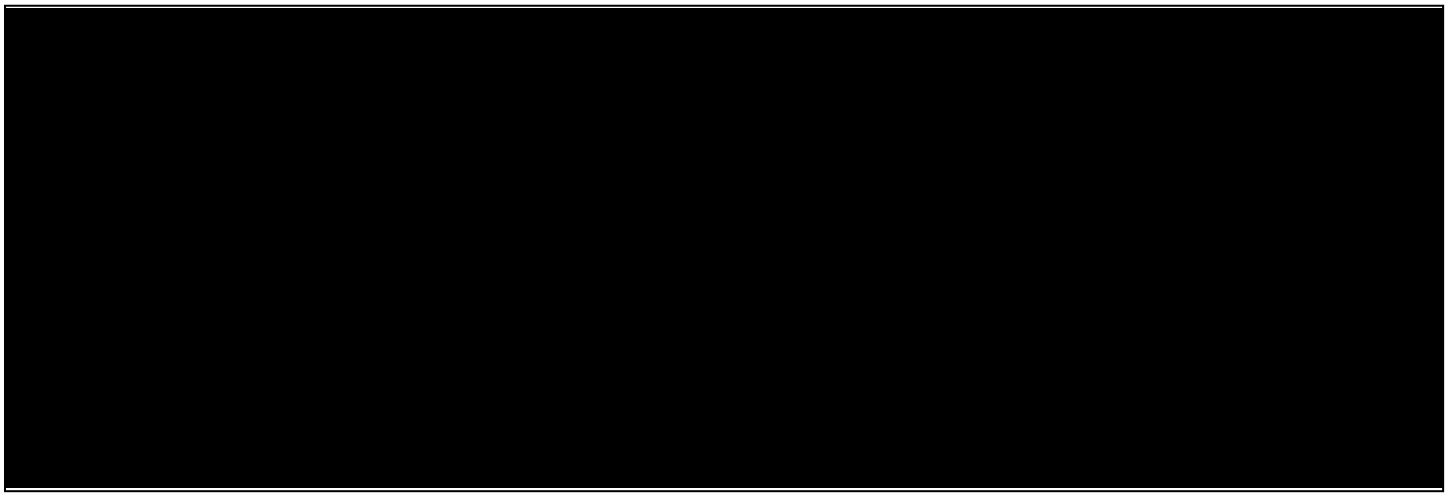

Table 1. Prescriptions for controlling Japanese and giant knotweed stress proper timing of operations to maximize injury to rhizomes. Improper timing (impatience) will result in treatments that provide 'topkill' (shoot injury) but little net effect.

Timing	Treatment	Product rate	comments
June	Cutting prior to foliar herbicide application	n/a	Cutting in June results in shortened regrowth (2 to 5 ft) and elimination of persistent stems from the previous season. This is a particular advantage in riparian settings, where full-size knotweed will hang over the water, making it impossible to treat without contacting the water with herbicide solution.
anytime	cutting	n/a	Cutting does not eliminate knotweed, but it does slow its growth and rhizome spread significantly. If you are going to treat the knotweed with a systemic herbicide, wait at least eight weeks after the last cutting, and do not treat before July.
July to frost, at least 8 weeks after cutting or late spring frost	Foliar Herbicide: 'Rodeo' (or equivalent) or 'Glyphomate 41'	3 qts/acre or 4.3 qts/acre	Use either of these *glyphosate* formulations to treat knotweed foliage, waiting eight weeks after cutting or a late frost to treat. The product rates differ because the glyphosate concentration differs. Applications of 'Rodeo' will require an additional surfactant (e.g. 'CWC 90'). No additional surfactant is needed with 'Glyphomate 41'. If you work at the early end of the operational window, you can make a 'touch-up' application later in the season before a killing frost. Use this treatment for both initial control and maintenance applications. For high-volume (spray-to-wet), mix on a 100 gal/ac basis (e.g. 'Rodeo' would be 96 oz/100 gal, or 0.75 percent by volume). For spot treatment, calibrate your sprayer ("Simplified Sprayer Calibration").

- Jil Swearingen, Integrated Pest Management Coordinator, National Capital Region, Center for Urban Ecology, National Park Service, Washington, DC, jil_swearingen at nps.gov

SUGGESTED ALTERNATIVE PLANTS

Many lovely, perennial, spring-flowering plants are available as non-invasive alternatives to lesser celandine. Some examples of plants native the eastern U.S. include wild ginger (*Asarum canadense*), Dutchman's breeches (*Dicentra cucullaria*), squirrel-corn (*Dicentra canadensis*), cutleaf toothwort (*Cardamine concatenata*), twinleaf (*Jeffersonia diphylla*), and bloodroot (*Sanguinaria canadensis*). Contact your local native plant society for additional suggestions and assistance. The Plant Conservation Alliance provides links to many groups at (http://www.nps.gov/plants).

OTHER LINKS

- http://www.invasive.org/search/action.cfm?q=Ranunculus%20ficaria
- http://www.lib.uconn.edu/webapps/ipane/browsing.cfm?descriptionid=89

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Invasive Plants in Pennsylvania

Lesser celandine

Ficaria verna

Leslie J. Mehrhoff, Univ. of Connecticut

Background:

Lesser celandine was introduced into the United States as an ornamental plant. It is still commercially available. All varieties should be assumed to be invasive.

Range:

Native to Eurasia, lesser celandine can now be found in the Northeast and Pacific Northwest regions of the United States.

John M. Randall, The Nature Conservancy

Description:

Lesser celandine is a perennial herbaceous plant that forms low-growing mats. Plants consist of a basal rosette of dark green, kidney-shaped leaves. The bright yellow flowers are borne singly on stalks that rise above the leaves. Abundant, finger-like tubers are produce by the roots.

Leslie J. Mehrhoff, Univ. of Connecticut

Habitat:

Lesser celandine is characteristic of moist alluvial soils in forested floodplains. It can also be found in low open woods, meadows, roadsides and waste places. It seems to prefer moist, sandy soils. Less frequently, it will invade drier soils.

Biology and Spread:

Lesser celandine spreads primarily through vegetative means. Its abundant tubers and bulblets may be unearthed and scattered by animals, well-meaning weed pullers and flood events.

Ecological Threat:

An exotic vernal plant, lesser celandine is aggressive and emerges earlier than most native species. It easily displaces native spring ephemerals with its thick carpet of vegetation. This, in turn, negatively affects native pollinators, which rely on spring ephemerals for nectar and pollen during a time when other food sources are scarce.

How to Control this Species:

Lesser celandine is very difficult to control. Persistence is key. Small infestations may be pulled up by hand or dug up with a trowel. Be sure to remove all bulblets and tubers. Physical removal causes soil disturbance, which can lead to further infestation. Keep this in mind when dealing with high-quality natural areas.

A wetland-approved concentration of Glyphosate should be applied in late winter to early spring (March through May) in order to minimize impacts to native wildflowers. Be careful to apply the herbicide to lesser celandine only, and be aware of the site's proximity to breeding amphibians.

Look-A-Likes:

Lesser celandine closely resembles marsh marigold (Caltha palustris), a native wetland plant. Please take steps to ensure proper identification before any treatment is initiated.

Marsh marigold

Brett Pifer, DCNR - BOF

Fact Sheet: Lesser Celandine

Lesser Celandine

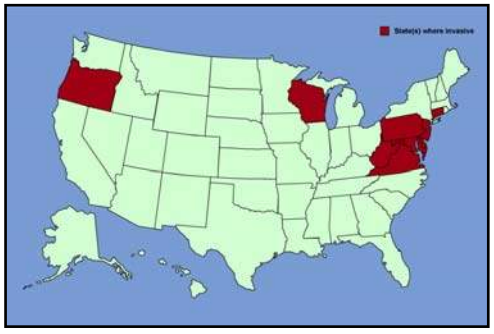
Ranunculus ficaria L.
Buttercup family (Ranunculaceae)

NATIVE RANGE
Europe

DESCRIPTION
Lesser celandine, also known as fig buttercup, is an herbaceous, perennial plant. Plants have a basal rosette of dark green, shiny, stalked leaves that are kidney- to heart-shaped. The flowers open in March and April, have eight glossy, butter-yellow petals, and are borne singly on delicate stalks that rise above the leaves. Pale-colored bulblets are produced along the stems of the above-ground portions of the plant, but are not apparent until late in the flowering period. When in bloom, large infestations of lesser celandine appear as a green carpet with yellow dots, spreading across the forest floor. There are many varieties of lesser celandine including a double-flowered form with many crowded petals and dark green leaves mottled with silvery markings.

NOTE: Lesser celandine closely resembles marsh marigold (*Caltha palustris*), a native wetland plant that occurs in the eastern United States. Marsh marigold is a robust plant with glossy, rounded or kidney-shaped leaves and flowers on stalks that are 8 in (20.3 cm) or more in height and consist of five to nine deep yellow "petals" (actually sepals). Marsh marigold does not produce tubers or bulblets, nor does it form a continuous carpet of growth. Extreme care should be taken to correctly identify lesser celandine before undertaking any control measures to avoid impacts to this plant.

ECOLOGICAL THREAT
Lesser celandine is an exotic spring ephemeral and a vigorous growing groundcover that forms large, dense patches on the forest floor, displacing and preventing native plants from co-occurring. The ecological impact of lesser celandine is primarily on the native spring-flowering plant community and the various wildlife species associated with them. Spring ephemerals complete the reproductive part of their life cycle and most of their above-ground development before woody plants leaf out and shade the forest floor. Native spring ephemerals include bloodroot, common and cut-leaved toothwort, Dutchman's breeches, harbinger-of-spring, squirrel-corn, trout lily, Virginia bluebells, and many others. Because lesser celandine emerges well in advance of the native species, it can establish and overtake areas rapidly.



DISTRIBUTION IN THE UNITED STATES
Lesser celandine is currently found in nineteen states in the Northeast and Pacific Northwest (USDA PLANTS). It is reported to be invasive in nine states (Connecticut, Delaware, Maryland, New Jersey, Oregon, Pennsylvania, Virginia, Wisconsin, West Virginia), and the District of Columbia (WeedUS Database).

HABITAT IN THE UNITED STATES
Lesser celandine occurs in moist forested floodplains and in some drier upland areas, and seems to prefer sandy soils.

BACKGROUND
Lesser celandine was introduced to the United States as an ornamental plant. It is still available commercially in the U.S., along with many colorful varieties. All varieties of lesser celandine should be assumed to be invasive.

BIOLOGY & SPREAD

Lesser celandine is an exotic perennial plant and spring ephemeral that spends much of the year (summer through early winter) underground as thickened, fingerlike tubers or underground stems. During the winter, leaves begin to emerge and photosynthesize in preparation for flowering. Flowering usually occurs from late winter through mid-spring (March through May), depending on conditions. Afterwards, the above-ground portions die back. Lesser celandine spreads primarily by vegetative means through abundant tubers and bulblets, each of which is ready to become a new plant once separated from the parent plant. The tubers of lesser celandine are prolific and may be unearthed and scattered by the digging activities of some animals, including well-meaning weed pullers, and transported during flood events.

MANAGEMENT OPTIONS

Lesser celandine is very difficult to control but it can be managed with persistence over time using methods that are site appropriate. While manual methods are possible for some (small) infestations, the use of systemic herbicide kills the entire plant tip to root and minimizes soil disturbance.

Biological

No biological control agents are currently available for lesser celandine.

Chemical

The window of opportunity for controlling lesser celandine is very short, due to its life cycle. In order to have the greatest negative impact to celandine and the least impact to desirable native wildflower species, herbicide should be applied in late winter-early spring (March through May). Apply a 1.5% rate of a 39 to 41% glyphosate isopropylamine salt (e.g., Rodeo® for wetland areas) mixed with water and a non-ionic surfactant to foliage, avoiding application to anything but the celandine. Glyphosate is systemic; that is, the active ingredient is absorbed by the plant and translocated to the roots, eventually killing the entire plant. The full effect on the plant may take 1-2 weeks. Applications can be made during the winter season as long as the temperature is above about 50 degrees Fahrenheit, and no rain is anticipated within 12 hours. Because glyphosate is non-specific, spray should be controlled such that it touches only lesser celandine and does not drift onto desirable plants. To minimize impacts to sensitive-skinned frogs and salamanders, some experts recommend applying herbicide in March and then switching to manual methods.

Manual

For small infestations, lesser celandine may be pulled up by hand or dug up using a hand trowel or shovel. It is very important to remove all bulblets and tubers.

Mechanical

If mechanical removal is to continue after dieback of the plants, individual plants or clumps will need to be marked with some sort of stakes or flagging because it will be impossible to relocate the plants otherwise. When conducting mechanical removal, care should be taken to minimize soil disturbance as much as possible. For this reason, mechanical control may be inappropriate for large infestations in high quality natural areas.

USE PESTICIDES WISELY: Always read the entire pesticide label carefully, follow all mixing and application instructions and wear all recommended personal protective gear and clothing. Contact your state department of agriculture for any additional pesticide use requirements, restrictions or recommendations.

NOTICE: mention of pesticide products on this page does not constitute endorsement of any material.

CONTACT

For more information on the management of lesser celandine, please contact:

- Sue Salmons, Natural Resources Manager, National Park Service, Rock Creek Park, Washington, DC, sue_salmons at nps.gov

Lesser Celandine *Ranunculus ficaria* L.

Common Names: lesser celandine, fig buttercup

Native Origin: Europe

Description: Lesser celandine is an herbaceous, perennial plant in the buttercup family (Ranunculaceae). Plants have a basal rosette of dark green, shiny, stalked leaves that are kidney-shaped to heart-shaped. The flowers open in March and April, and have 8-12 glossy, butter-yellow petals that are 1 inch wide, and are borne singly on delicate stalks that rise above the leaves. Pale-colored bulblets are produced along the stems of the above-ground portions of the plant, but are not apparent until late in the flowering period. The root system is made up of a cluster of tuberous roots. When in bloom, large infestations of lesser celandine appear as a green carpet with yellow dots, spreading across the forest floor. This plant reproduces by seed and underground tubers.

Habitat: Lesser celandine occurs in moist forested floodplains and in some drier upland areas, and seems to prefer sandy soils.

Distribution: This species is reported from states shaded on Plants Database map. It is currently found in nineteen states in the Northeast and Pacific Northwest. It is reported to be invasive in nine states (Connecticut, Delaware, Maryland, New Jersey, Oregon, Pennsylvania, Virginia, Wisconsin, West Virginia), and the District of Columbia.

Ecological Impacts: Lesser celandine is an exotic spring ephemeral and a vigorous growing groundcover that forms large, dense patches on the forest floor, displacing and preventing native plants from co-occurring. The ecological impact of lesser celandine is primarily on the native spring-flowering plant community and the various wildlife species associated with them.

Control and Management: Lesser celandine is very difficult to control but it can be managed with persistence over time using methods that are site appropriate. While manual methods are possible for some (small) infestations, the use of systemic herbicide kills the entire plant tip to root and minimizes soil disturbance.

- **Manual**- For small infestations, lesser celandine may be pulled up by hand or dug up using a hand trowel or shovel. It is very important to remove all bulblets and tubers. If mechanical removal is to continue after dieback of the plants, individual plants or clumps will need to be marked with some sort of stakes or flagging because it will be impossible to relocate the plants otherwise. When conducting mechanical removal, care should be taken to minimize soil disturbance as much as possible. For this reason, mechanical control may be inappropriate for large infestations in high quality natural areas.

- **Chemical**- It can be effectively controlled using any of several readily available general use herbicides such as glyphosate. Apply herbicide in late winter-early spring (March through May) when temperatures are 40° F or warmer. Follow label and state requirements.

References: www.forestimages.org, http://plants.usda.gov, www.nps.gov/plants/alien, Czarapata, Elizabeth J. Invasive Plants of the Upper Midwest, An Illustrated Guide to their Identification and Control, 2005 p. 113

Invasive Plants in Pennsylvania

Japanese pachysandra

Pachysandra terminalis Sieb. & Zucc.

Jil Swearingen, National Park Service

Background:

This native of eastern Asia was brought to the U.S. as an ornamental groundcover. It is also known as Japanese spurge and Chinese fever vine.

Range:

This plant can be found in scattered locations throughout the Mid-Atlantic states, south to the Carolinas and west to Wisconsin. It is reported as invasive in PA, VA and DC.

Description:

This evergreen perennial groundcover can reach 12 inches in height and spread to form dense mats. The small (two to four inches in length) oval-shaped leaves alternate along the stem. Inconspicuous white flowers appear between March and April.

Jil Swearingen, National Park Service

Ecological Threat:

Because this plant grows very quickly it can displace native vegetation and form a monoculture that provides little benefit to wildlife.

Biology and Spread:

This plant reproduces vegetatively through underground stems and roots.

Habitat:

This plant escapes from cultivation and colonizes forest and meadow edges. It can grow in deep shade.

How to Control this Species:

Hand pulling and controlled burning have been used successfully on this plant.

Pachysandra can also be controlled with several readily available herbicides, such as glyphosate. A pre-emergent herbicide can also be applied to the ground to kill the plants before they emerge. This may have less of an impact on desired native vegetation. Be sure to follow the label's instructions and all state herbicide requirements.

Tree-of-heaven (Ailanthus altissima)

Description

- Tree-of-heaven is commonly known as 'ailanthus'.
- Refer to the DCNR Invasive Plants page, and the Tree-of-heaven factsheet.
- Fast growing, weak-wooded, clonal (root suckering) tree.
- Dioecious – male and female flowers on separate plants.
- Individual stems are typically short-lived, but they can reach heights of 80 ft.
- Grows in dense clones where ailanthus stems can occupy all layers, from understory to canopy.
- Native to East Asia, imported as an ornamental and urban street tree in the late-1700's.
- Grows almost anywhere, from sidewalk cracks or spoil in full sun to fertile, partially-shaded alluvial soils along rivers and streams.

Management Keys

Due to its size and vigor, and extensive spreading root system, ailanthus can be difficult to control. As long as you are willing to invest the up-front effort and treat at the proper time, it can be successfully suppressed.

Be Persistent

There are two phases of invasive species management – control and maintenance. The control phase for ailanthus takes two seasons, and would ideally include two applications the first season and a rigorous follow-up treatment the second year.

After your control efforts have nearly eliminated the ailanthus, you need to periodically monitor the sites and treat any signs of new growth to prevent re-infestation.

Target the Roots – Timing is Key

To control ailanthus, you have to injure the root system. This is most effectively done with systemic herbicides, when the plant canopy is exporting sugars to the roots for growth and storage.

Systemic herbicides are most effective when applied later in the growing season (Figure 1). For ailanthus, we recommend waiting until July 1 to initiate treatment. This is when the foliage is sending sugars produced through photosynthesis back to the roots. Systemic herbicides are moved in the same direction through the plant as the sugars.

Applications made too early in the season do not translocate effectively to the roots, and only injure the aboveground growth.

Mechanical Operations

Cutting ailanthus is often necessary to remove potentially hazardous stems, but it is not useful as a control measure. In situations where you want to remove ailanthus stems, it is better to cut *after* herbicide treatment has taken effect.

Herbicide Applications

Ailanthus can be effectively treated with foliage or stem treatments. Tall, dense growth is best treated with a high volume ('spray to wet') application, while smaller stems can be treated with a low volume foliar or stem treatment approach.

Effective stem treatment methods include basal bark and 'hack and squirt'. Basal bark treatments use a concentrated mixture of herbicide in oil, applied to the complete circumference of the lower 12 to 18 inches of the stem. The 'hack and squirt' method uses concentrated herbicide solution applied to cuts spaced horizontally around the circumference of the stem. It is critical to have small intact spaces between cuts so the applied herbicide can translocate to the roots. If you completely girdle the stem, the herbicide can only move up in the stem, and you will not injure the roots or the stem below the girdle.

Dense, or extensive infestations should be treated initially with a foliar application. This will eliminate the small, dense growth. The 'clean-up' application can be stem treatment, or foliar, depending on the size of the remaining stems. Large, tall plants are easier to treat with stem treatment, while smaller stems are easier to treat with a foliar application.

Recommended Herbicides

There are many herbicides available that are very effective against ailanthus, but we recommend using *glyphosate* or *triclopyr.* They are both effective, have no or little soil activity, and are available as aquatic-labeled products. For foliar applications, we recommend mixing them together (Table 1). Either herbicide can be used

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for hack-and-squirt treatments, and *triclopyr* is also available in oil-soluble formulations for basal bark applications. There are two water-soluble formulations of *triclopyr*, 'Garlon 3A' and 'Vastlan'. 'Vastlan' is a new formulation, and is more concentrated (4 lb vs. 3 lb *triclopyr* /gallon) and less volatile, but has the same labeled uses as the more familiar 'Garlon 3A'.

What about Stump Treatment?

If you need to cut down ailanthus for immediate safety reasons, by all means do so and treat the stump. However, cutting the stems and treating the stumps does not provide effective control of the roots. When you remove the top, there is little downward flow of sugars to the roots. Stump treatment of ailanthus will keep the stump free of sprouts, but it will not prevent root suckering.

If you want to cut ailanthus, treat it first, and then wait until the dormant season to cut it. You should cut it before the next growing season because standing-dead ailanthus decays quickly. If you leave it stand too long, you may be faced with considerable hazard while trying to remove the ailanthus.

Figure 1. The management calendar for ailanthus emphasizes late-season treatment to maximize injury to the roots.

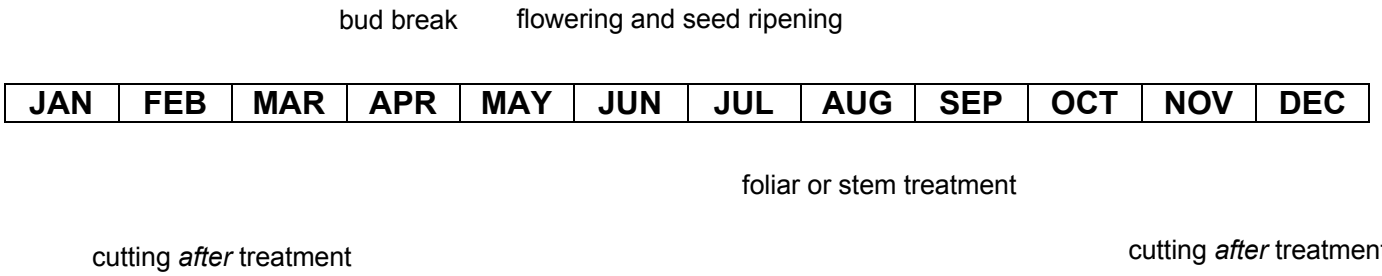


Table 1. Prescriptions for controlling ailanthus stress proper timing of operations to maximize injury to the roots. Improper timing will result in treatments that provide 'topkill' (shoot injury) but little net effect. Product names reflect the current PA State Herbicide Contract.

Treatment and Timing	Treatment	Product Rate	Comments
Foliar Application July 1 to fall color	'Aquaneat plus either 'Garlon 3A' or 'Vastlan'	3 qts/acre plus 2 qts/acre or 1.5 qts/acre	The combination of *glyphosate* and *triclopyr* provides a broad-spectrum treatment that is effective against ailanthus and other woody species that should be targeted as well during the operation. This is a non-selective mixture, but it has little soil activity, poses low risk to non-target organisms, and both products have aquatic labeling. A surfactant (e.g. 'CWC 90') needs to be added. If the *glyphosate* product 'Glyphomate 41' is used instead (4.3 qts/acre), no additional surfactant is needed.
Basal Bark July 1 to fall color	'Pathfinder II'	ready-to-use	'Pathfinder II' is an oil-based formulation of *triclopyr* that can be used for basal bark applications. Treat stems up to 6-in diameter by wetting the entire circumference of the lower 12 to 18 inches, without runoff. You can apply a shorter band to small stems. This technique is laborious, and is best suited for treating small infestations or as a follow-up to surviving stems after a foliar application. If stems are significantly larger than 6-in diameter, use hack and squirt.
Hack and Squirt July 1 to fall color	'Aquaneat' or 'Garlon 3A' or 'Vastlan'	Use either product undiluted or 1:1 with water	Hack-and-squirt is applying a concentrated herbicide mixture to fresh cuts spaced horizontally around the circumference of the stem. Leaving a small, intact space between cuts is critical becauseif you completely girdle the stem, the herbicide cannot translocate to the roots. A simple guideline for number of cutson small stems is 'inches in diameter plus one'. For stems greater than 12-inch diameter, make as many cuts as you can without girdling the stem. This is a laborious treatment best suited for low stem numbers, and stems at least 1-inch in diameter. Treat immediately after cutting, filling the cut with herbicide mixture using a squirt bottle.

PART 3: Implementation Plan

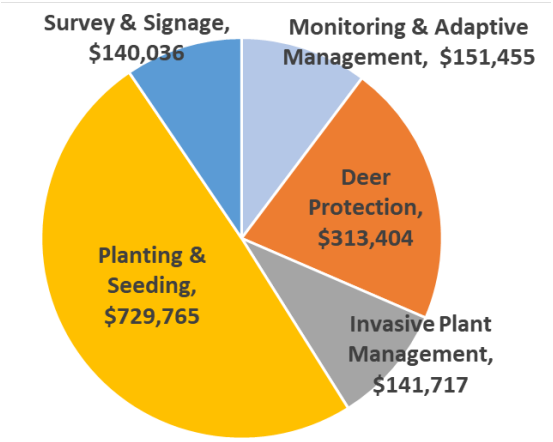
INTRODUCTION

The purpose of the implementation plan is to guide the execution of the management plan by providing cost estimates, a schedule of activities, potential funding sources, and potential contractors.

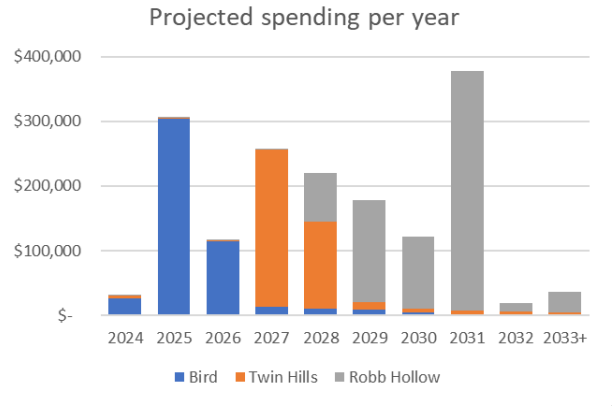
COST ESTIMATES

Opinions of probable cost were developed by detailing the specific materials and labor costs for each proposed activity in each management unit (or park-wide) presented in the Management Plan (Part 2). Estimates are based on recent experience in similar projects, discussions with potential contractors, and internet searches for current prices.

A 15% contingency was added to each line-item cost to account for uncertain and unexpected circumstances. The full line-item opinion of probable cost is provided in the attachments. As an overview, the pie chart at right shows the distribution of costs (2024 dollars) by major activity categories ($2,875/yr for contractor administration is included with the Monitoring & Adaptive Management category). The largest cost category is planting and seeding, followed by deer protection.



When combined with the schedule, costs were spread over projected years of implementation. A 3% annual escalation for inflation was applied to the base-year cost when combining the cost estimate with the implementation schedule to derive a budget calendar. The full budget calendar is provided in the attachments. As an overview, the bar chart at right summarizes total costs by park by year, including contingency and escalation for inflation.



These cost estimates assume all work is performed by contractors. However, certain activities, including tree planting and monitoring and adaptive management of smaller or low-risk areas could be performed by volunteers, which would save costs. High levels of disturbance in large management units introduces more risk so adaptive management for those areas should be performed by contractors.

SCHEDULE

Consensus between Municipality personnel and stakeholders was that as Bird Park is furthest along in the restoration process, it should be prioritized so it would serve as an example of good park management that could demonstrate the general nature of upcoming activities in the other two parks. It was also decided that Twin Hills had the next most focus and should be next in priority. These two parks also have the most use, and therefore restoring them would be most beneficial to park users. Finally, Robb Hollow was recognized as in most need of restoration but had fewer visitors and fewer recent management projects

needing follow-up compared to the other two parks. Therefore, Robb Hollow was scheduled last, except for beginning adaptive management and monitoring in one management unit that required little effort.

The schedule begins in 2024 with a few relatively low-cost projects, mainly consisting of follow-up from previous projects and adaptive management. This gives the municipality time to raise funds for the larger projects that begin in 2025. Due to the scale of the funding required, projects were spread out over a period of ten years. See attached budget calendar representing projected spending for each park management unit by year.

Over the next ten years, new and unforeseen issues may arise that require priorities to be re-arranged or new projects to be added. These changes should be documented along with their rationale and added as amendments to this plan.

POTENTIAL FUNDING SOURCES

The following potential funding sources were identified:

USDA Natural Resources Conservation Service
Various programs
Match required: varies
Contact: Andy Gaver, andy.gaver@usda.gov, NRCS Butler Service Center

PA Department of Conservation and Natural Resources
Community Conservation Partnerships Program Grants
Match required: minimum 50%
Contact: https://www.dcnr.pa.gov/Communities/Grants/pages/default.aspx

PA Department of Conservation and Natural Resources
Community Parks and Recreation Grants (various programs)
Match required: varies, but generally 50%
Contact:
https://www.dcnr.pa.gov/Communities/Grants/CommunityParks%20andRecreationGrants/Pages/default.aspx

Keystone 10 Million Trees
Provides trees and tree tubes
Match required: no
Contact: https://tenmilliontrees.org/

USDA Forest Service
Urban and Community Forestry Program
Annual National Urban and Community Forestry Challenge Cost Share Grant Program
Match required: minimum 50%
Contact: https://www.fs.usda.gov/managing-land/urban-forests/ucf

USDA Forest Service
Community Forest Program (note, this program is only for land acquisition)
Match required: minimum 50%
Contact: https://www.fs.usda.gov/managing-land/private-land/community-forest/program

USDA Forest Service
Landscape Scale Restoration
Match required: minimum 50%
Contact: https://www.fs.usda.gov/managing-land/private-land/landscape-scale-restoration

POTENTIAL CONTRACTORS

The following is a list of potential contractors who have been identified as having experience conducting the kinds of work prescribed in this plan:

Oikos Ecology LLC
https://OikosEcology.com
Contact: Tim Nuttle, 412-867-1299, nuttle.tim@gmail.com
350 Firden Lane, Elizabeth PA 15037
Services: Ecological planning, restoration, invasive plant management, tree planting

Bending Branches Underbrushing LLC
https://www.bendingbranchesunderbrushing.com
Contact: Sam Kaufman, 414-617-3993, bendingbranchesunderbrushing@gmail.com
Services: Forestry mulching

Fourth River Workers Guild
https://www.fourthriver.coop
Contact: Ben Ledewitz, 412-945-0269, yinz@fourthriver.coop
Services: Certified sustainable landscaping contractors

Eisler Landscapes
https://eislerlandscapes.com
Contact: Eric French, 724-865-2830, Eric@eislerlandscapes.com
Services: Landscaping contractors

Eichenlaub Landscapes for Living
https://eichenlaub.com/
Contact: 412-767-4769, contact@eichenlaub.com
Services: Landscaping contractors

NatureWorks LLC
https://natureworksllc.net/
Contact: 855-478-7824, info@nature-work.org
Services: tree planting, invasive plant management

Allstate Surveying & Mapping Co.
http://www.allstatesurveying.com
Contact: Ryan Deglau, 724-863-8558 / 412-829-2607, ryan@allstatesurveying.com
Services: Professional land surveying

Deerbusters.com
https://www.deerbusters.com/
Services: Deer fencing

Bash Contracting LLC
Contact: (814) 765-1531
Services: Deer fencing (constructed deer fence at Churchill Valley Greenway)

SCHEDULE

MOUNT LEBANON CONSERVATION PARKS IMPLEMENTATION PLAN - ACTIVITY SCHEDULE

BIRD PARK	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033+
Boundary survey, signage, consolidation		X								
Contractor administration	X	X	X	X						
MU B1										
Invasive plant management	X									
Seeding	X									
Adaptive management	X	X	X	X	X					
MU B2										
Invasive plant management	X									
Adaptive management	X	X	X	X	X					
MU B3										
Invasive plant management		X								
Planting, seeding, deer protection		X								
Adaptive management			X	X	X	X	X			
MU B4										
Invasive plant management			X							
Planting, seeding, deer protection			X							
Adaptive management				X	X	X	X	X		
MU B5										
Invasive plant management	X									
Planting and seeding	X									
Adaptive management		X	X	X	X	X				

MOUNT LEBANON CONSERVATION PARKS IMPLEMENTATION PLAN - ACTIVITY SCHEDULE (continued)

TWIN HILLS PARK	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033+
Boundary survey				X						
Deer fence, gates, boundary signs				X						
Semi-annual fence inspection, minor repairs					X	X	X	X	X	X
Contractor administration				X	X	X				
MU T1										
Invasive plant management				X						
Planting and seeding				X						
Adaptive management					X	X	X	X	X	
MU T2										
Invasive plant management					X					
Planting and seeding					X					
Adaptive management						X	X	X	X	X
MU T3										
Adaptive management	X	X	X	X	X					
MU T4										
Invasive plant management	X									
Adaptive management		X	X	X	X	X				
MU T5										
Invasive plant management					X					
Planting and seeding					X					
Adaptive management						X	X	X	X	X
MU T6										
Invasive plant management	X									
Adaptive management		X	X	X	X	X				
MU T7										
Soil test, planting, and seeding					X					
Adaptive management						X	X	X	X	X

MOUNT LEBANON CONSERVATION PARKS IMPLEMENTATION PLAN - ACTIVITY SCHEDULE (continued)

ROBB HOLLOW PARK	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033+
Boundary survey, signage, consolidation					X					
Contractor administration							X	X	X	X
MU R1										
Invasive plant management						X				
Planting, seeding, deer protection						X				
Adaptive management							X	X	X	X
MU R2										
Invasive plant management								X		
Planting, seeding, deer protection								X		
Adaptive management									X	X
MU R3										
Adaptive management	X	X	X	X	X					
MU R4										
Invasive plant management							X			
Planting, seeding, deer protection							X			
Adaptive management								X	X	X

OPINION OF PROBABLE COST

BIRD PARK						
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Boundary survey	1	LS	$ 27,800	$ 27,800	$ 31,970	survey and corner markings
Perimeter signage	80	EA	$ 35	$ 2,800	$ 3,220	signs on posts every 100 ft (approximate 8,000 lf park perimeter, no signs along Public Works complex)
Lot consolidation	1	LS	$ 15,800	$ 15,800	$ 18,170	
Contractor administration	4	YR	$ 2,500	$ 10,000	$ 11,500	Coordination between Municipality and contractor, RFIs, etc.
TOTAL				$ 56,400	$ 64,860	

MU B1						
NOTE: as many activities are underway, costs are only included for items that appear to not be included in the current activities.						
Area	2.1	AC				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Follow-up invasive shrub treatment	2.1	AC	$ 200	$ 420	$ 483	herbicide treatment of resprouting shrubs
Planting and Seeding						
Seed mix	42	LB	$ 38	$ 1,596	$ 1,835	ERNMX-140
Cover crop	63	LB	$ 0.60	$ 38	$ 43	grain rye or oats
Seed carrier	105	LB	$ 1.00	$ 105	$ 121	kitty litter
Mulch (straw bales)	141	EA	$ 5.00	$ 706	$ 812	
Seed application (broadcast or hydroseed)	2.1	AC	$ 1,500	$ 3,150	$ 3,623	Broadcast or hydroseed
Monitoring & Adaptive management	10.5	AC* 5YR	$ 200	$ 2,100	$ 2,415	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 8,115	$ 9,332	

MU B2						
Area	3.4	AC				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Follow-up invasive shrub treatment	3.4	AC	$ 200	$ 680	$ 782	herbicide treatment of resprouting shrubs
Monitoring & Adaptive management	17	AC* 5YR	$ 200	$ 3,400	$ 3,910	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 4,080	$ 4,692	

MU B3						
Area	12.8	AC				
Tree planting density (#/acre)	200	TPA				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Marking desirable trees to remain	12.8	AC	$ 100	$ 1,280	$ 1,472	
Cutting and piling downed trees	12.8	AC	$ 500	$ 6,400	$ 7,360	
Invasive shrub management	12.8	AC	$ 1,200	$ 15,360	$ 17,664	Forestry mulching and/or hand cutting; includes herbicide treatment
Invasive herbaceous management	12.8	AC	$ 300	$ 3,840	$ 4,416	
Planting and Seeding						
Trees (3-in pot) installed	2,304	EA	$ 15	$ 34,560	$ 39,744	90% of specified trees as 3-in potted
Trees (5 gal) installed, with guard	256	EA	$ 200	$ 51,200	$ 58,880	10% of specified trees as 5-gal containerized
Shrubs (3-in pot) installed	640	EA	$ 15	$ 9,600	$ 11,040	
Seed mix	256	LB	$ 38	$ 9,728	$ 11,187	ERNMX-140
Cover crop	384	LB	$ 0.60	$ 230	$ 265	grain rye or oats
Seed carrier	640	LB	$ 1.00	$ 640	$ 736	kitty litter
Seed application (broadcast or hydroseed)	12.8	AC	$ 1,500	$ 19,200	$ 22,080	Broadcast or hydroseed
Deer Protection						
Tree tubes w/ stake, installed	1152	EA	$ 15	$ 17,280	$ 19,872	Tree tubes for 3-in pot trees in full sun (assume half)
Tree cages, installed	1152	EA	$ 25	$ 28,800	$ 33,120	Cages for trees in shade (assume half) and all shrubs (though clumped shrubs can have one 8' tall fence around the cluster instead)
Tree guards	256	EA	$ 20	$ 5,120	$ 5,888	Tree guards on all 5-gallon trees
Monitoring & Adaptive management	64	AC* 5YR	$ 200	$ 12,800	$ 14,720	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 216,038	$ 248,444	

MU B4						
Area	5.3	AC				
Tree planting density (#/acre)	350	TPA				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Marking desirable trees to remain	5.3	AC	$ 100	$ 530	$ 610	
Cutting and piling downed trees	5.3	AC	$ 500	$ 2,650	$ 3,048	

Invasive shrub management	5.3	AC	$ 1,200	$ 6,360	$ 7,314	Forestry mulching and/or hand cutting; includes herbicide treatment
Invasive herbaceous management	5.3	AC	$ 300	$ 1,590	$ 1,829	
Planting and Seeding						
Trees (3-in pot) installed	954	EA	$ 15	$ 14,310	$ 16,457	90% of specified trees as 3-in potted
Trees (5 gal) installed, with guard	106	EA	$ 200	$ 21,200	$ 24,380	10% of specified trees as 5-gal containerized
Shrubs (3-in pot) installed	265	EA	$ 15	$ 3,975	$ 4,571	
Seed mix	106	LB	$ 38	$ 4,028	$ 4,632	ERNMX-140
Cover crop	159	LB	$ 0.60	$ 95	$ 110	grain rye or oats
Seed carrier	265	LB	$ 1.00	$ 265	$ 305	kitty litter
Seed application (broadcast or hydroseed)	5.3	AC	$ 1,500	$ 7,950	$ 9,143	Broadcast or hydroseed
Deer Protection						
Tree tubes w/ stake, installed	477	EA	$ 15	$ 7,155	$ 8,228	Tree tubes for 3-in pot trees in full sun (assume half)
Tree cages, installed	477	EA	$ 25	$ 11,925	$ 13,714	Cages for trees in shade (assume half) and all shrubs (though clumped shrubs can have one 8' tall fence around the cluster instead)
Tree guards	106	EA	$ 20	$ 2,120	$ 2,438	Tree guards on all 5-gallon trees
Monitoring & Adaptive management	26.5	AC*5YR	$ 200	$ 5,300	$ 6,095	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 89,453	$ 102,871	

MU B5						
Area	16.2	AC				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Invasive herbaceous management	4.7	AC	$ 300	$ 1,410	$ 1,622	Only garlic mustard and lesser celandine areas
Planting and Seeding						
Seed mix	94	LB	$ 38	$ 3,572	$ 4,108	ERNMX-140
Cover crop	141	LB	$ 0.60	$ 85	$ 97	grain rye or oats
Seed carrier	235	LB	$ 1.00	$ 235	$ 270	kitty litter
Mulch (straw)	316	Bale	$ 5.00	$ 1,580	$ 1,817	
Seed application (broadcast)	4.7	AC	$ 1,200	$ 5,640	$ 6,486	Broadcast or hydroseed
Monitoring & Adaptive management	81	AC* 5YR	$ 200	$ 16,200	$ 18,630	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 28,721	$ 33,030	

ROBB HOLLOW PARK						
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Boundary survey	1	LS	$ 34,750	$ 34,750	$ 39,963	survey and corner markings
Perimeter signage	110	EA	$ 35	$ 3,850	$ 4,428	signs on posts every 100 ft (approximate 11,000 lf park perimeter, no signs along Public Works complex)
Lot consolidation	1	LS	$ 18,500	$ 18,500	$ 21,275	
Contractor administration	4	YR	$ 2,500	$ 10,000	$ 11,500	Coordination between Municipality and contractor, RFIs, etc.
TOTAL				$ 67,100	$ 77,165	
MU R1						
Area	7.7	AC				
Tree planting density (#/acre)	200	TPA				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Marking desirable trees to remain	7.7	AC	$ 100	$ 770	$ 886	
Tree of heaven treatment	3.9	AC	$ 600	$ 2,310	$ 2,657	Western half of MU; hack and squirt tree of heaven, leave standing
Invasive shrub & vine management	7.7	AC	$ 1,200	$ 9,240	$ 10,626	Forestry mulching and/or hand cutting; includes herbicide treatment
Invasive herbaceous management	1.0	AC	$ 300	$ 300	$ 345	
Planting and Seeding						
Trees (3-in pot) installed	1,386	EA	$ 15	$ 20,790	$ 23,909	90% of specified trees as 3-in potted
Trees (5 gal) installed, with guard	154	EA	$ 200	$ 30,800	$ 35,420	10% of specified trees as 5-gal containerized
Shrubs (3-in pot) installed	385	EA	$ 15	$ 5,775	$ 6,641	
Seed mix	154	LB	$ 38	$ 5,852	$ 6,730	ERNMX-140
Cover crop	231	LB	$ 0.60	$ 139	$ 159	grain rye or oats
Seed carrier	385	LB	$ 1.00	$ 385	$ 443	kitty litter
Seed application (broadcast or hydroseed)	7.7	AC	$ 1,500	$ 11,550	$ 13,283	Broadcast or hydroseed
Deer Protection						
Tree tubes w/ stake, installed	693	EA	$ 15	$ 10,395	$ 11,954	Tree tubes for 3-in pot trees in full sun (assume half)
Tree cages, installed	693	EA	$ 25	$ 17,325	$ 19,924	Cages for trees in shade (assume half) and all shrubs (though clumped shrubs can have one 8' tall fence around the cluster instead)
Tree guards	154	EA	$ 20	$ 3,080	$ 3,542	Tree guards on all 5-gallon trees
Monitoring & Adaptive management	38.5	AC* 5YR	$ 200	$ 7,700	$ 8,855	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 126,411	$ 145,372	

MU R2						
Area	17.0	AC				excluding composting area (1 acre)
Tree planting density (#/acre)	200	TPA				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Marking desirable trees to remain	17.0	AC	$ 100	$ 1,700	$ 1,955	
Invasive shrub management	17.0	AC	$ 1,200	$ 20,400	$ 23,460	Forestry mulching and/or hand cutting; includes herbicide treatment
Planting and Seeding						
Trees (3-in pot) installed	3,060	EA	$ 15	$ 45,900	$ 52,785	90% of specified trees as 3-in potted
Trees (5 gal) installed, with guard	340	EA	$ 200	$ 68,000	$ 78,200	10% of specified trees as 5-gal containerized
Shrubs (3-in pot) installed	850	EA	$ 15	$ 12,750	$ 14,663	
Seed mix	340	LB	$ 38	$ 12,920	$ 14,858	ERNMX-140
Cover crop	510	LB	$ 0.60	$ 306	$ 352	grain rye or oats
Seed carrier	850	LB	$ 1.00	$ 850	$ 978	kitty litter
Seed application (broadcast or hydroseed)	17.0	AC	$ 1,500	$ 25,500	$ 29,325	Broadcast or hydroseed
Deer Protection						
Tree tubes w/ stake, installed	1530	EA	$ 15	$ 22,950	$ 26,393	Tree tubes for 3-in pot trees in full sun (assume half)
Tree cages, installed	1530	EA	$ 25	$ 38,250	$ 43,988	Cages for trees in shade (assume half) and all shrubs (though clumped shrubs can have one 8' tall fence around the cluster instead)
Tree guards	340	EA	$ 20	$ 6,800	$ 7,820	Tree guards on all 5-gallon trees
Monitoring & Adaptive management	85	AC* 5YR	$ 200	$ 17,000	$ 19,550	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 273,326	$ 314,325	

MU R3						
Area	5.7	AC				
Tree planting density (#/acre)	200	TPA				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Monitoring & Adaptive management	28.5	AC*5YR	$ 200	$ 5,700	$ 6,555	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 5,700	$ 6,555	

MU R4						
Area	4.8	AC				
Tree planting density (#/acre)	200					
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Marking desirable trees to remain	4.8	AC	$ 100	$ 480	$ 552	
Cutting and piling downed trees	4.8	AC	$ 500	$ 2,400	$ 2,760	
Invasive shrub management	4.8	AC	$ 1,200	$ 5,760	$ 6,624	Forestry mulching and/or hand cutting; includes herbicide treatment
Invasive herbaceous management	4.8	AC	$ 300	$ 1,440	$ 1,656	
Planting and Seeding						
Trees (3-in pot) installed	864	EA	$ 15	$ 12,960	$ 14,904	90% of specified trees as 3-in potted
Trees (5 gal) installed, with guard	96	EA	$ 200	$ 19,200	$ 22,080	10% of specified trees as 5-gal containerized
Shrubs (3-in pot) installed	240	EA	$ 15	$ 3,600	$ 4,140	
Seed mix	96	LB	$ 38	$ 3,648	$ 4,195	ERNMX-140
Cover crop	144	LB	$ 0.60	$ 86	$ 99	grain rye or oats
Seed carrier	240	LB	$ 1.00	$ 240	$ 276	kitty litter
Seed application (broadcast or hydroseed)	4.8	AC	$ 1,500	$ 7,200	$ 8,280	Broadcast or hydroseed
Deer Protection						
Tree tubes w/ stake, installed	432	EA	$ 15	$ 6,480	$ 7,452	Tree tubes for 3-in pot trees in full sun (assume half)
Tree cages, installed	432	EA	$ 25	$ 10,800	$ 12,420	Cages for trees in shade (assume half) and all shrubs (though clumped shrubs can have one 8' tall fence around the cluster instead)
Tree guards	96	EA	$ 20	$ 1,920	$ 2,208	Tree guards on all 5-gallon trees
Monitoring & Adaptive management	24	AC* 5YR	$ 200	$ 4,800	$ 5,520	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 81,014	$ 93,167	

TWIN HILLS PARK						
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Boundary survey	1	LS	$ 17,250	$ 17,250	$ 19,838	survey and corner markings
Deer fence around park perimeter	5100	LF	$ 15	$ 76,500	$ 87,975	8' metal deer fence, clear boundary with forestry mulcher first
Truck gates	5	EA	$ 825	$ 4,125	$ 4,744	
People gate (offset escape)	5	EA	$ 300	$ 1,500	$ 1,725	
Perimeter signage	51	EA	$ 20	$ 1,020	$ 1,173	signage on fence every 100 ft
Semi-annual fence inspection, minor repairs	6	YR	$ 500	$ 3,000	$ 3,450	budgeted through end of 10-yr period
Contractor administration	3	YR	$ 2,500	$ 7,500	$ 8,625	Coordination between Municipality and contractor, RFIs, etc.
TOTAL				$ 110,895	$ 127,529	
MU T1						
Area	9.1	AC				
Tree planting density (#/acre)	150	TPA				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Invasive shrub management	9.7	AC	$ 1,200	$ 11,622	$ 13,366	Forestry mulching and/or hand cutting; includes herbicide treatment; 9.1 acre MU T1 + 0.6 acre strip (10-ft wide) around remaining park perimeter to facilitate boundary fence installation
Tree of heaven treatment	9.1	AC	$ 600	$ 5,460	$ 6,279	hack and squirt tree of heaven, leave standing
Planting and Seeding						
Trees (3-in pot) installed	1,229	EA	$ 15	$ 18,428	$ 21,192	90% of specified trees as 3-in potted
Trees (5 gal) installed, with guard	137	EA	$ 200	$ 27,300	$ 31,395	10% of specified trees as 5-gal containerized
Shrubs (3-in pot) installed	346	EA	$ 15	$ 5,187	$ 5,965	
Seed mix	182	LB	$ 38	$ 6,916	$ 7,953	ERNMX-140
Cover crop	273	LB	$ 0.60	$ 164	$ 188	grain rye or oats
Seed carrier	455	LB	$ 1.00	$ 455	$ 523	kitty litter
Seed application (broadcast or hydroseed)	9.1	AC	$ 1,500	$ 13,650	$ 15,698	Broadcast or hydroseed
Deer Protection						Deer protection provided by 8' tall fence around entire park
Monitoring & Adaptive management	45.5	AC* 5YR	$ 200	$ 9,100	$ 10,465	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 98,282	$ 113,024	

MU T2						
Area	9.2	AC				
Tree planting density (#/acre)	150	TPA				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Invasive shrub management	9.2	AC	$ 1,200	$ 11,040	$ 12,696	Forestry mulching and/or hand cutting; includes herbicide treatment
Tree of heaven treatment	9.2	AC	$ 600	$ 5,520	$ 6,348	hack and squirt tree of heaven, leave standing
Planting and Seeding						
Trees (3-in pot) installed	1,242	EA	$ 15	$ 18,630	$ 21,425	90% of specified trees as 3-in potted
Trees (5 gal) installed, with guard	138	EA	$ 200	$ 27,600	$ 31,740	10% of specified trees as 5-gal containerized
Shrubs (3-in pot) installed	350	EA	$ 15	$ 5,244	$ 6,031	
Seed mix	184	LB	$ 38	$ 6,992	$ 8,041	ERNMX-140
Cover crop	276	LB	$ 0.60	$ 166	$ 190	grain rye or oats
Seed carrier	460	LB	$ 1.00	$ 460	$ 529	kitty litter
Seed application (broadcast or hydroseed)	9.2	AC	$ 1,500	$ 13,800	$ 15,870	Broadcast or hydroseed
Deer Protection						Deer protection provided by 8' tall fence around entire park
Monitoring & Adaptive management	46	AC* 5YR	$ 200	$ 9,200	$ 10,580	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 98,652	$ 113,449	

MU T3						
Area	0.7	AC				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Monitoring & Adaptive management	3.5	AC* 5YR	$ 200	$ 700	$ 805	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 700	$ 805	

MU T4						
Area	1.5					
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Invasive shrub management	1.5	AC	$ 600	$ 900	$ 1,035	shrub resprouts
Invasive herbaceous management	1.5	AC	$ 600	$ 900	$ 1,035	mainly poison hemlock
Monitoring & Adaptive management	7.5	AC* 5YR	$ 200	$ 1,500	$ 1,725	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 3,300	$ 3,795	

MU T5						
Area	1.1	AC				
Tree planting density (#/acre)	100	TPA				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Tree of heaven treatment	1.1	AC	$ 600	$ 660	$ 759	hack and squirt tree of heaven, leave standing
Invasive herbaceous management	1.1	AC	$ 300	$ 330	$ 380	
Planting and Seeding						
Trees (3-in pot) installed	100	EA	$ 15	$ 1,500	$ 1,725	90% of specified trees as 3-in potted
Shrubs (3-in pot) installed	100	EA	$ 15	$ 1,500	$ 1,725	
Seed mix	22	LB	$ 38	$ 836	$ 961	ERNMX-140
Cover crop	33	LB	$ 0.60	$ 20	$ 23	grain rye or oats
Seed carrier	55	LB	$ 1.00	$ 55	$ 63	kitty litter
Seed application (broadcast or hydroseed)	1.1	AC	$ 1,500	$ 1,650	$ 1,898	Broadcast or hydroseed
Monitoring & Adaptive management	5.5	AC* 5YR	$ 200	$ 1,100	$ 1,265	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 7,651	$ 8,798	

MU T6						
Area	3.7	AC				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Invasive Plant Management						
Invasive shrub management	3.7	AC	$ 400	$ 1,480	$ 1,702	Spraying small shrub sprouts
Monitoring & Adaptive management	18.5	AC* 5YR	$ 200	$ 3,700	$ 4,255	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 5,180	$ 5,957	

MU T7						
Area	0.9	AC				
Tree planting density (#/acre)	100	TPA				
Item	**Qty**	**Unit**	**Cost/unit**	**Extended cost**	**Cost + 15% contingency**	**Notes**
Planting and Seeding						
Soil test	1.0	EA	$ 200	$ 200	$ 230	Composite sample, lab analysis, interpretation of results
Trees (3-in pot) installed	90	EA	$ 15	$ 1,350	$ 1,553	
Shrubs (3-in pot) installed	23	EA	$ 15	$ 388	$ 388	
Deer Protection						Deer protection provided by 8' tall fence around entire park
Monitoring & Adaptive management	4.5	AC* 5YR	$ 200	$ 900	$ 1,035	Allowance for twice annual monitoring, consultation with municipality, and light maintenance
TOTAL				$ 2,788	$ 3,206	

BUDGET CALENDAR

The following budget calendars per park include 15% contingency and 3% annual escalation for inflation.

BIRD PARK	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	TOTAL
Boundary survey, signage, consolidation		54,961									**$ 54,961**
Contractor administration	2,875	2,961	3,050	3,142							**12,028**
MU B1											**9,481**
Invasive shrub treatment	483										
Seeding	6,434										
Monitoring & Adaptive management	483	497	512	528	544						
MU B2											**4,934**
Invasive shrub treatment	782										
Monitoring & Adaptive management	782	805	830	855	880						
MU B3											**257,318**
Invasive plant management		31,839									
Planting, seeding, deer protection		208,897									
Monitoring & Adaptive management			3,123	3,217	3,313	3,413	3,515				
MU B4											**109,742**
Invasive plant management			13,579								
Planting, seeding, deer protection			89,091								
Monitoring & Adaptive management				1,332	1,372	1,413	1,456	1,499			
MU B5											**34,775**
Invasive plant management	1,622										
Planting and seeding	12,778										
Monitoring & Adaptive management		3,838	3,953	4,072	4,194	4,319					
TOTALS	**$ 26,238**	**303,799**	**114,138**	**13,144**	**10,303**	**9,146**	**4,971**	**1,499**			**$ 483,238**

TWIN HILLS PARK	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	TOTAL
Boundary survey				21,677							**$ 130,346**
Deer fence, gates, boundary signs				104,483							
Semi-annual fence inspection, minor repairs					647	667	687	707	728	750	
Contractor administration				3,142	3,236	3,333					**9,710**
MU T1											**124,576**
Invasive plant management				21,434							
Planting and seeding				90,603							
Monitoring & Adaptive management					2,356	2,426	2,499	2,574	2,651		
MU T2											**128,804**
Invasive plant management					21,434						
Planting and seeding					94,346						
Monitoring & Adaptive management						2,453	2,527	2,602	2,680	2,761	
MU T3											**855**
Monitoring & Adaptive management	161	166	171	176	181						
MU T4											**3,957**
Invasive plant management	2,070										
Monitoring & Adaptive management		355	366	377	388	400					
MU T5											**10,036**
Invasive plant management					1,281						
Planting and seeding					7,198						
Monitoring & Adaptive management						293	302	311	320	330	
MU T6											**6,356**
Invasive plant management	1,702										
Monitoring & Adaptive management		877	903	930	958	987					
MU T7											**3,717**
Soil test, planting, and seeding					2,433						
Monitoring & Adaptive management						240	247	255	262	270	
TOTALS	**$ 3,933**	**1,398**	**1,440**	**242,853**	**134,468**	**10,799**	**6,262**	**6,449**	**6,643**	**4,111**	**$ 418,356**

ROBB HOLLOW PARK	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033+	TOTAL
Boundary survey, signage, consolidation					73,907						
Contractor administration							3,433	3,536	3,642	3,751	**$ 14,362**
MU R1											**169,419**
Invasive plant management						16,825					
Planting, seeding, deer protection						141,436					
Monitoring & Adaptive management							2,115	2,178	2,243	4,622	
MU R2											**387,896**
Invasive plant management								31,257			
Planting, seeding, deer protection								331,279			
Monitoring & Adaptive management									4,953	20,407	
MU R3											**6,960**
Monitoring & Adaptive management	1,311	1,350	1,391	1,433	1,476						
MU R4											**111,732**
Invasive plant management							13,841				
Planting, seeding, deer protection							90,813				
Monitoring & Adaptive management								1,358	1,399	4,321	
TOTALS	**$ 1,311**	**1,350**	**1,391**	**1,433**	**75,382**	**158,261**	**110,202**	**369,608**	**12,237**	**33,101**	**$ 690,369**

ALL 3 PARKS	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033+	GRANDTOTAL
TOTALS	**$31,482**	**$306,547**	**$116,969**	**$257,430**	**$220,153**	**$178,205**	**$121,435**	**$377,556**	**$18,880**	**$37,212**	**$1,591,670963**