Wilma Quinlan Nature Preserve
&
Miriam Groner Property

Stewardship Plan

Natural Lands Trust

June 2007

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Introduction and Purpose

The following stewardship plan was commissioned by New Britain Borough (Bucks County, PA) to provide a natural resource assessment and stewardship recommendations for two open space parcels within the Borough. The first parcel, the Wilma Quinlan Nature Preserve, is a 24-acre public natural area resting along the Neshaminy Creek that is owned in part by the Borough (15 acres) and New Britain Township (9 acres). The second parcel, the Miriam Groner Property, is a 3-acre residential lot that lies to the northeast of the Nature Preserve. The Borough acquired the Miriam Groner Property through donation. The Stewardship Plan catalogs the existing environmental and ecological conditions and current management issues of the two properties and will serve as a guide for their future use and management to meet the ecological and programmatic priorities and goals set by the Borough. The information presented in this report is based on four site visits – March 7, 2006, May 9, 2006, February 23, 2007, and May 11, 2007 – by Natural Lands Trust staff and existing data and information.

Site Description

Location

The Wilma Quinlan Nature Preserve is bordered by Matthews Avenue and Landis Mill Road to the north and east, respectively. Approximately two thirds of the Preserve lies north of the Creek. The Miriam Groner Property lies across Landis Mill Road from the northeast corner of the Preserve; Aarons Avenue forms the southern border of the parcel.

Inventory and Analysis

Soils

The soils underlying the Wilma Quinlan Nature Preserve and the Miriam Groner property are deep, minimally to moderately eroded silt loam and loam. Prime and statewide important agricultural soils cover approximately half of the two properties. Hydric soils and soils with seasonally high water tables follow the stream valley on the Wilma Quinlan Nature Preserve. See *Soils* map.

SYMBOL	SERIES	TEXTURE	DEPTH TO SHWT	DEPTH TO BEDROCK	HYDRIC	AGRICULTURAL
Bo	Bowmansville	silt loam	0.5′–1.5′	6′-9′	yes	no
PnC	Penn	silt loam	6′	1.5′-3.5′	no	statewide importance
Ro	Rowland	silt loam	1′-3′	6′	yes	prime
UgB	Abbottstown	silt loam	0.5′-1.5′	3.5′-5′	no	no
UrB	Lansdale	loam	6′	3.5′-5′	no	no
LkA	Lawrenceville	silt loam	1.5′-3′	very deep	no	prime

Topography and Slopes

Wilma Quinlan Nature Preserve is dominated by gentle slopes (0 – 12 %), including the variably-wide (225 to 750 feet) floodplain of the Neshaminy Creek which runs along the southeastern portion of the property. The only area of significant slope on the property is a thin band of steep (> 25 %) slopes that separates the floodplain from the Preserve's uplands.

The Miriam Groner property is relatively flat (0-8 % slopes) with no areas of significant slope.

See *Topographic and Hydrologic Features* map.

Hydrology

The Preserve harbors extensive water resources. Two channels of the Neshaminy Creek dissect the Preserve, flowing northeast from the center and southern portions of the southwest border; they join and exit the property near the eastern corner of the Preserve. A spring arises at the base of the steep slope north of the Creek and feeds a small stream that flows into the Creek.

Southern channel of Neshaminy Creek

Spring and small stream

This portion of the Neshaminy Creek is a Trout Stocking Fishery (TSF), according to the Department of Environmental Protection Chapter 93: Water Quality Standards of the Pennsylvania Code. A Trout Stocking Fishery is designated as "Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat." Associated with this stream network are the 100-year floodplain, wetlands, and hydric soils (soils that are periodically wet, in an undrained condition, that often support the growth of wetland vegetation). Together they cover over half of the Preserve.

The Miriam Groner Property does not have any significant hydrologic features, but, if managed properly, can contribute to local groundwater recharge.

See *Topographic and Hydrologic Features* map.

Vegetation

The two properties contain a variety of vegetative cover types including: *Young Upland Woodland/Forest, Mature Upland Forest, Meadow, Riparian Forest,* and *Lawn/Estate Area.*

- ***Young Upland Woodland***
  A Young Upland Woodland is an area dominated by trees less than a foot in diameter. The leaf canopy varies from between 10% and 60%. They rest on well-drained dry to mesic soils.

- *Mature Upland Forest*
  A Mature Upland Forest is an area dominated by larger (> 20" diameter) canopy trees in which the leaf canopy is closed or nearly closed and the majority of the tree crowns are overlapping, typically with between 60% and 100% tree cover. Typically there are well-defined canopy, understory, shrub, and herbaceous layers. They lie on well-drained dry to mesic soils.

- *Upland Meadow*
  An Upland Meadow is an open area dominated by grass and wildflower species. They lie on well-drained dry to mesic soils.

- *Riparian Forest*
  A Riparian Forest is an area adjoining a body of water, normally having soils and forest vegetation characteristics of floodplains or areas transitional to upland zones.

- *Lawn/Estate Area*
  A Lawn/Estate Area typically contains structures, lawn and specimen landscape vegetation.

Structures

With the exception of an entrance sign along Matthews Avenue, there are no structures located on the Wilma Quinlan Nature Preserve. The Miriam Groner property contains a house and garage.

Signage

There are many signs of varying format and message within the Wilma Quinlan Nature Preserve. An entrance sign is located at the main entrance of the Preserve. There are a few plant identification signs located in the meadow area and numerous "No Hunting" signs scattered throughout the preserve. Property boundary signs are not present on the Preserve or the Miriam Groner property.

Land Stewardship

General Condition of Open Space

The variety of vegetative cover within Southeastern Pennsylvania is largely the result of inherent environmental conditions and extensive human management over the past two centuries. Agriculture has played an especially important role in shaping the distribution of current plant communities. Areas with the most marginal soils (rocky, wet) have had the longest time (were released from agriculture first) to revert to the dominant natural landcover—forest—in this region; the best soils are either still in agriculture or have been consumed by suburban development. Once released from agriculture, the local hydrology determines the type of plant community – terrestrial (upland) or palustrine (lowland) – that dominates each area. Finally, the frequency of natural (wind, ice, fire) or human (cutting) disturbance dictates whether the area remains open (lawn, meadow) or succeeds to forest.

The current mixture of vegetation types on the Preserve and Groner Property (the Properties) confirms this interaction between soils conditions and past management use. The oldest forested areas (Management Units 2 and 4) within the Properties rest on the thin band of steep slopes above the Neshaminy Creek and on the floodplain. The areas that have remained open the longest – the meadows (Management Unit 3) and young woodland/forest (Management Unit 1) – contain the best soils on the Properties.

Other management activities have impacted the health of the plant communities within the region and the Properties. The extensive horticultural history of the region coupled with the misguided promotion of exotic plant species for erosion and livestock control has led to the proliferation of several invasive plant species including multiflora rose, oriental bittersweet, Norway maple, and Japanese honeysuckle. These introduced plant species degrade plant communities by displacing native species. Mismanagement of the deer population has created an overabundant population throughout the region that is seriously impacting tree regeneration within forested areas. Finally, miscellaneous activities (agriculture, recreation, recent construction) have left residual conditions (hazards, trash) that could impact the safe and enjoyable use of natural areas. The conservation priorities and management strategies listed below will serve to guide the management of the open space from its current condition.

At the time of the site visits, the Properties suffered from most of these management issues. There is a general lack of native regeneration within the forested areas and several invasive plant species (a few of which originated in the horticultural collection on the Groner Property) are well established within both parcels.

Conservation Priorities

Management of the Properties will be guided by following a regimen that protects and enhances the established ***conservation priorities***. Conservation priorities can be ecological, recreational, historical, or programmatic depending on the context of the site within the local landscape, legal restrictions, the historical use of the properties, and the goals of the landowner. Based upon the existing natural resources within and around the Properties, we are recommending the following conservation priorities to guide the management of the natural areas.

Environmental and Ecological Priorities

The Properties are part of a greater than five mile forested riparian area along the Neshaminy Creek that help protect the Creek's ***water quality***. Due to their proximity to the creek, the Properties have an immediate impact on the surface water flow and quality, particularly during heavy storm flow. The retention of forest vegetation on the Properties is particularly important from the standpoint of maintaining water quality and the natural control of erosion and sedimentation. In addition, forests contribute greatly to the value of stream corridors as wildlife habitat and breeding areas.

The property also contains a number of significant ***wildlife habitats***. These include young upland woodland/forest, mature upland forest, meadow, and riparian forest that includes a spring and stream. Given their current health and the potential future impacts of increased human use, they will require careful management to maintain their environmental and ecological benefits.

Recreational Priorities

The Properties provide opportunities for ***passive recreation*** (walking, wildlife observation), ***nature study***, ***aesthetic enjoyment*** and ***quiet reflection***. Care should be taken to minimize the impact of recreational facilities (trails, benches) on the environmental and ecological priorities. The following Stewardship Plan also includes strategies for maintaining recreational facilities to minimize hazards to users.

Stewardship Plan

The property has been divided into six management units (see *Management Units* map) based on cover type, location, and surrounding influences. The management unit descriptions that follow are based on site visits on March 7, 2006, May 9, 2006, February 23, 2007, and May 11, 2007. The description of each unit includes a list of species observed at the time of the site visit. (Due to the time of year of the site visits, herbaceous plants are under-represented somewhat in the plant list.) A complete list of

species observed, can be found at the end of this section. The list includes common and scientific names for each species; introduced species are designated by the letter "I". Plant species nomenclature follows *The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas* (Rhoads and Klein 1993).

Under each management unit, the description is followed by a discussion of the management issues and opportunities observed during the site visits including recommendations for addressing each issue and opportunity. Techniques and procedures for implementing these recommendations can be found in the appendices.

MANAGEMENT UNIT 1 – YOUNG UPLAND WOODLAND/FOREST

Size – 7.60 acres

Description

This management unit inhabits the upland, south-facing slope across the northern half of the Preserve. Canopy cover is mostly light to moderate, ranging from 10% to 60 % (woodland) with cover occasionally exceeding 60% (forest). Trees generally range between fifteen to thirty feet in height with an average diameter at breast height (dbh) of two to six inches. A few scattered, more mature individuals exhibit diameters of 12 to 30 inches and heights exceeding 30 feet. Because it was released from agriculture relatively recently and has a southern exposure, this area is heavily impacted by several invasive plant species.

Unit 1

The canopy and understory layers are dominated by black walnut (*Juglans nigra*). Subordinate species within the canopy, in order of decreasing abundance, include tuliptree (*Liriodendron tulipifera*), red ash (*Fraxinus pennsylvanica*), grape (*Vitis* sp.),

sassafras (*Sassafras albidum*), bitternut hickory (*Carya cordiformis*), black cherry (*Prunus serotina*), pin oak (*Quercus palustris*), red maple (*Acer rubrum*), white pine (*Pinus strobus*), Douglas fir (*Pseudostuga menziesii*), mulberry (*Morus* sp.), red cedar (*Juniperus virginiana*), shagbark hickory (*Carya ovata*), sweet cherry (*Prunus avium*), honey locust (*Gleditsia triacanthos*), red oak (*Quercus rubra*), and Larch (*Larix* sp.).

Subordinate understory layer elements include, in order of decreasing abundance, grape, sassafras, tuliptree, red ash, bitternut hickory, oriental bittersweet (*Celastrus orbiculatus*), flowering dogwood (*Cornus florida*), crabapple (*Malus* sp.), black cherry, red maple, sweet cherry, mulberry, Norway maple (*Acer platanoides*), shagbark hickory, and hawthorn (*Crataegus* sp.).

The shrub layer is dominated by a generally dense, often impenetrable cover of invasive (mostly introduced) plants including multiflora rose (*Rosa multiflora*), grape, oriental bittersweet, Japanese honeysuckle (*Lonicera japonica*), shrub honeysuckle (L.sp.), winged euonymous (*Euonymous alata*) and wineberry (*Rubus phoenicolasius*). A mature hedge of Forsythia (*Forsythia* sp.) was noted along the southwest boundary of Unit 1. Native shrubs are much less abundant throughout Unit 1 and include spicebush (*Lindera benzoin*) and red raspberry (*Rubus idaeus*).

The herb layer is dominated by introduced, invasive species including garlic mustard (*Alliaria petiolata*), stiltgrass (*Microstegium vimineum*), Japanese honeysuckle, dame's-rocket (*Hesperis matronalis*), and field garlic (*Allium* sp.). Native elements include avens (*Geum* sp.) and probably a few other species not apparent during this early season inventory.

Management Goals

- Protect and enhance the existing plant communities
- Maintain passive recreational activities (walking trails) for public use

Management Issues and Opportunities

Tree Regeneration – Native tree regeneration throughout the unit is sparse, most likely the result of an overabundant deer population and competition from invasive plants. This jeopardizes the perpetuation of the forest and its many environmental and ecological benefits. Recommendations: Determine density of the local deer population and control as needed. (A density of 5 to 10 per square mile, i.e. one deer per 64 to 128 acres, is recommended to maintain healthy forest ecosystems.) See *Techniques and Procedures – Wildlife Management* for control options. To help speed the process of creating a closed forest canopy (which will, in turn, discourage invasives), clear areas where heavy invasive shrub and vine cover has prevented tree regeneration and replant with native trees, as resources permit. Plantings will require protection from deer browse and rubbing.

Invasive Plants – Due to the young age and southern exposure of this unit, the impact of

invasive trees, shrubs, and vines is moderate to heavy throughout the unit. Most problematic are invasive vines (grape, oriental bittersweet, Japanese honeysuckle) and shrubs (multiflora rose, honeysuckle) that have essentially arrested natural succession in several areas. In addition to those species established within the unit, periwinkle, an invasive evergreen groundcover and bamboo are spreading into the Preserve from adjacent properties on the southeastern and the western borders, respectively. Recommendations: Control invasive plants following strategies highlighted under *Techniques and Procedures – Invasive Vegetation Management*. Establish a program to monitor invasives annually and control as needed. Complete a boundary survey of the property in order to confirm this intrusion from adjacent properties and determine the extent thereof.

Aesthetics – There is a small amount of trash scattered within the unit and along the public roads. The volume of trash may increase with the expanded use of the area by residents. Recommendations: Clean up existing trash and schedule regular inspections and cleanups (minimum monthly) to prevent future accumulations.

Hazards – There is old wire fencing within the unit which is a hazard to visitors and wildlife. Recommendation: Remove wire fencing.

Public Use – The three trail entrances within the unit are wide enough to allow the use of motor vehicles. The use of motor vehicles on the trail system would likely lead to soil disturbance and erosion and the transport (via tires) of invasive plant seeds into and within the Preserve. Tire tracks were located on the trail system at the March 7, 2006 site visit. Recommendation: Install gates or chains at the three trailheads to prevent the entrance of unauthorized motor vehicles.

Trail Erosion – The trailhead located at the end of Aarons Avenue is eroding due to the use of motor vehicles and stormwater runoff from the road. While this entrance is needed to mow the meadows, routine disturbance by pedestrians could be minimized by relocating the entrance to an area with less slope. Recommendations: Measures should be taken to divert stormwater from funneling to this point to prevent further erosion (See *Techniques and Procedures - Trail Design and Maintenance*). Relocate the current trail entrance to the north on the flat stretch of Landis Mill Road and in line with a proposed trail entrance (see *Management Issues Map*) in Management Unit 3 on the Miriam Groner property. The existing entrance should be kept to allow access for maintenance equipment.

Trailhead erosion along Aarons Road

Unwarranted Use – Natural areas that are bordered by private parcels often suffer from unwarranted use by neighbors, including yard waste dumping and use as additional landscape area. Frequently this results from unclear boundaries or the misguided belief that organic material is good for natural areas. An area of possible encroachment was identified along the northern border of the Preserve. (see *Management Issues Map*) Also, there is a leaf, debris, and trash dump within the unit along Matthews Avenue the source of which is unclear. Recommendations: Survey the north and west Preserve boundaries to clarify the limits of Borough property. Monument the corners adjacent to private parcels and install unobtrusive boundary signs periodically (every 50' to 100') along the borders. Remove non-organic material from the dump and notify neighbor of the boundary and the prohibition on this activity. Establish a program to monitor property boundaries on a quarterly basis.

Signage – There are signs of varying format and message scattered throughout the unit. Recommendation: Place small boundary signs that denote Borough ownership along the road and property borders. Install entrance signs with the Preserve name and ownership and a consolidated list of rules at all trailheads. Remove all signs (with the exception of interpretive signs) scattered within the property.

MANAGEMENT UNIT 2 – MATURE UPLAND FOREST

Size – 2.65 acres

Description

The Mature Upland Forest exists as two bands within the Preserve. The first is a broad tree 'hedgerow' of evergreen and deciduous trees on the steep slope above the Neshaminy Creek floodplain. The second lies along the southern border of the Preserve. The forest community inhabiting this unit represents the most mature and least disturbed plant community within the Preserve.

Unit 2: North side of Neshaminy Creek

Unit 2: South side of Neshaminy Creek

White pine (concentrated toward the western end of the northern band), bitternut hickory, tuliptree, and red ash dominate the canopy. Subordinate canopy species include sugar maple, red maple, mockernut hickory (*Carya tomentosa*), black walnut, sycamore, box-elder, black cherry, sweet cherry, shagbark hickory, basswood, river birch (*Betula nigra*), elm and beech.

Understory layer elements include sugar maple, red ash, tuliptree, bitternut hickory, beech, black cherry, mulberry, box-elder, Norway maple, flowering dogwood, and hornbeam. Spicebush, multiflora rose, privet, Japanese honeysuckle, grape, and oriental bittersweet occur sparingly throughout the shrub layer. The herb layer consists of a light, spotty cover of Japanese honeysuckle. Occasional occurrences of field garlic and garlic mustard were observed poking through the organic matter duff.

Management Goals

- Protect and enhance the existing plant community
- Create recreational opportunities for local residents

Management Issues and Opportunities

Tree Regeneration – See under Management Unit 1.

Invasive Plants – The impact of invasive trees, shrubs, and vines is generally light (particularly in the southern band) to moderate within the unit. Multiflora rose, moderate to heavy along the northern edge of the northern band, is the most problematic species in the unit. Norway maple, oriental bittersweet and garlic mustard are also species that should receive attention. Recommendations: Control invasive plants following strategies highlighted under *Techniques and Procedures – Invasive Vegetation Management*. Establish a program to monitor invasives annually and control

as needed.

Hazards – There is old barbed wire attached to a large pignut hickory. This is a hazard to the tree, visitors and wildlife. Recommendation: Remove wire.

Public Use – The northern band of Unit 2 provides a commanding view of the riparian area along the Neshaminy Creek, including the associated spring; the southern band is not accessible at this time. Recommendation: To enhance wildlife observation opportunities within the Preserve, consider installing a bench on the bank overlooking the spring in Unit 4 for visitors to enjoy the wildlife and vegetation associated with the area. A short side trail could connect the bench with the main trail that runs along the edge of the unit.

Trail Erosion – The trail linking the Mature Upland Forest to the Riparian Zone is eroding due to stormwater runoff from the adjacent meadow. Recommendation: Take measures (including waterbars, a small berm at the southeast corner of the meadow, or perhaps rerouting the trail) to prevent further erosion (see *Techniques and Procedures - Trail Design and Maintenance*).

MANAGEMENT UNIT 3 – MEADOW

Size – 2.75 acres

Description

This management unit consists of three grass-dominated meadows composed mostly of cool season grasses. Two meadows (West Meadow and East Meadow) within Wilma Quinlan Nature Preserve border the southern edge of Unit 1 and the northern edge of Unit 2. The third meadow is located on the northern portion of the Miriam Groner

property. The West Meadow is located near the Preserve's western boundary and the East Meadow lies near the Preserve's eastern boundary with an access to Landis Mill Road. The West Meadow sports a few mature tree specimens including red maple, red ash and black cherry. Bluebird boxes (one in the West; two in the East) stand near the centers of the Preserve meadows. Height of the meadow vegetation during the site visit was about four inches.

Eastern Meadow in Preserve

Meadow on Miriam Groner Property

Management Goals

- Convert to and maintain the unit as Warm Season Grass and Wildflower Meadow
- Maintain passive recreational activities (walking trails) for public use

Management Issues and Opportunities

Meadow Conversion – The meadows are currently dominated by cool-season grasses that are mowed two to three times per year. Recommendation: To improve wildlife habitat, consider converting them to native grassland/meadow (see *Techniques and Procedures – Convert to Warm Season Grass Meadow*) and maintained according to the guidelines under *Techniques and Procedures – Meadow Management*. A thin strip of the meadow within the Groner property that borders private parcels and the public road should be mowed more frequently (3 to 4 times per year) to provide a "managed" look to the area.

Invasive Plants – In the case of meadow management, any woody vegetation becomes an invasive species, along with invasive herbs. Recommendation: Mow annually in late winter or mid summer to prevent invasion by woody vegetation (see *Techniques and Procedures – Meadow Management*). Monitor the unit annually for invasive herbaceous vegetation and controlled as needed (see *Techniques and Procedures – Invasive Vegetation Management*).

Public Use – This unit offers an opportunity to increase the public recreational benefits of the Properties. Recommendation: Establish and maintain a meandering trail within the three sections of this unit (See *Techniques and Procedures - Trail Design and Maintenance*).

Caution should be taken to minimize the number of trails within the unit to prevent unnecessary disturbance of wildlife.

Unwarranted Use – There appears to be two areas of unwarranted use within the unit. The first is leaf dumping (see *Management Issues Map*) within the meadow on northern boundary of the Miriam Groner property. A potential encroachment – a neighbor's fence and pool equipment appear to be located within the Miriam Groner Property – exists along the eastern boundary of the Miriam Groner property beginning in Management Unit 3 and extending into Management Unit 6. Recommendations: Survey the Properties' boundaries adjacent to private parcels, monument the corners and periodically mark boundaries. Establish a process to monitor property boundaries regularly (at least quarterly). If the leaf dump is on the Groner property, the neighboring landowners should be informed that this practice is not permitted. If the encroachment is confirmed, address as needed.

Nesting Boxes – Open meadows provide good habitat for bluebirds and other birds. Recommendations: Install additional bluebird boxes within the unit to enhance this habitat. (Bird boxes located along property boundaries also have the added benefit of reminding neighbors of the property line.) See *Techniques and Procedures - Bluebird Nesting Boxes* for recommendations on constructing and installing bluebird boxes.

Signage – There are a few plant identification signs located in the east meadow of the Wilma Quinlan Nature Preserve. These signs are the result of a former Boy Scout project. These signs are old and are not in proper placement. Recommendation: Determine the desirability of interpretive signs in this or other units. If the signs are retained (perhaps restored as a new Scout project) they should be placed closer to the plant they are marking without damaging the roots and kept in an area that will not be mowed.

MANAGEMENT UNIT 4 – RIPARIAN ZONE

Size – 10.15 acres

Description

This management unit encompasses the broad floodplain dominating the southern half of the Preserve. Most of the unit is mature floodplain forest adjoining the two channels of the Neshaminy Creek and includes an island between the two channels. An open canopy community inhabits the central floodplain area immediately below (south of) the northern band of Unit 2. A public sanitary sewer line runs through the unit.

Unit 4: North side of Neshaminy Creek

Unit 4: Island in Neshaminy Creek

The forested portion of the floodplain is best described as a maturing sycamore - box-elder - river birch floodplain forest, named for the dominant species present. Several individuals of sycamore (*Platanus occidentalis*) and river birch (*Betula nigra*) exceed 30 inches dbh. Subordinate canopy species include red ash, red maple, silver maple (*Acer saccharinum*), pin oak (to 26 inches dbh), American elm (*Ulmus americana*), shagbark hickory, Norway maple, black walnut (*Juglans nigra*) and Norway spruce (*Picea abies*). In addition to the canopy species mentioned, the understory layer includes bitternut hickory, sugar maple (Acer *saccharum*), box-elder (*A. negundo*), black walnut, red spruce (*Picea rubra*) and hornbeam (*Carpinus caroliniana*). Multiflora rose dominates the shrub layer; other elements, include spicebush, alder (*Alnus* sp.), and wineberry. The herb layer is dominated by a dense cover of lesser celandine (*Ranunculus ficaria*) throughout. Goldenrod (*Solidago* sp.), riverbank wild rye (*Elymus* sp.), garlic mustard, and stiltgrass were also observed.

The open canopy area of the floodplain is in an early stage of succession presently dominated by grass species including reed canary grass (*Phalaris* sp.), stiltgrass and riverbank wild rye. Most likely numerous floodplain forbs (not positively identifiable at this time due to the early season inventory) are also present. A few scattered shrubs and young trees are common with tree cover estimated at < 5%. Young trees include red ash, red elm, bitternut hickory, river birch, red maple, box-elder, willow (*Salix sp.*), and swamp white oak. Shrubs include multiflora rose, red willow (*Cornus amomum*), alder, and autumn olive (*Elaeagnus umbellata*). A spring within the middle of the open canopy area of the floodplain has been colonized by red willow, common cat-tail (*Typha latifolia*), reed canary grass, watercress (*Rorippa* sp.) and some aquatic species including duckweed among others.

Management Goals

- Protect and enhance the existing plant communities
- Create recreational opportunities for local residents

Management Issues and Opportunities

Tree Regeneration – Native tree regeneration is best established within this unit, although still less than ideal. Many saplings are close to the height where they will most likely be safe from deer browse. Recommendation: Augment natural regeneration by planting additional native trees to speed up canopy closure. This will discourage invasive plants (see below) and further protect water resources within the unit. Before doing so the Borough should check with the sewer authority to verify the boundary of the right of way and the vegetation management requirements within the area. For information on planting native vegetation see *Techniques and Procedures – Native Plant Materials* and *Techniques and Procedures – Planting Trees and Shrubs.*

Water Resources – This unit contains all of the water resources of the Properties including the Neshaminy Creek and a spring and associated stream that feed the creek. Recommendations: Management activities and public use should be adjusted to ensure the protection of these resources. Use only herbicides approved for aquatic use within the unit. Minimize public use disturbance of soil and vegetation resources to prevent silt transport to the creek and increased exposure of water.

Invasive Plants – The impact of invasive shrubs and vines is light to moderate throughout the unit. Multiflora rose is moderate to heavy along the edge of the unit. Stiltgrass is moderate to heavy within the unit. Recommendations: Control invasive plants following strategies highlighted under *Techniques and Procedures – Invasive Vegetation Management*. Establish a program to monitor invasives annually and control as needed. As stated above, only herbicides approved for aquatic use should be used in this management unit.

Aesthetics – The unit contains a natural spring that feeds a small stream flowing into the Neshaminy Creek. The spring is visible from the trail and provides an aesthetically pleasing view for Preserve visitors. Recommendation: Monitor this area to prevent human disturbance that could degrade its environmental and aesthetic values.

Hazards – There is a bench located in the unit overlooking the Neshaminy Creek. A cursory inspection during the site visit revealed a hazard tree located in close proximity to the bench. This is a hazard to visitors and a liability concern for the Borough because of the potential for the tree to fall on the bench while it is in use. Recommendation: Include the bench area in a regular (minimum annually) hazard tree inspection program for the Preserve (see *Techniques and Procedures – Hazard Tree Monitoring Program, Pruning*).

Hazard Tree near Bench

Public Use – Because of the importance and sensitivity of this riparian area, public use should be limited to passive recreation along designated trails. Mountain bike tracks were seen on the March 7, 2006 site visit. Recommendation: Restrict trails within the unit to walking only for visitor safety and erosion control. Establish regular inspection schedule (minimum quarterly) to monitor trail use and trail obstructions/erosion.

Stream Crossing - Currently, the trail crosses the small stream flowing from the natural spring to the Neshaminy Creek which leads to soil disturbance. Unfortunately, there is no way to reroute the trail to avoid this wet area. Recommendations: Consider the installation of a small diameter culvert pipe to transport the water flow under the trail or the construction of a short boardwalk across this area. A consultation with the Bucks County Conservation District would be helpful in considering these or other options.

Nesting Boxes – This unit provides good habitat for waterfowl and wading birds. Recommendation: Consider the installation of a few nesting boxes to attract wood ducks to the Preserve.

Signage – Two old and hard to read signs are located at the southwestern trailhead within the unit. Recommendation: Replace old signs with an entrance sign identifying the preserve and listing preserve rules.

MANAGEMENT UNIT 5 – ENTRANCE

Size – 0.11 acres

Description

This management unit is the main entrance to the Wilma Quinlan Nature Preserve. It is an open area and consists of lawn and a loop access and parking area.

Management Goals:

- Provide an inviting and informative entrance to the Preserve

Management Issues and Opportunities

Public Use – This is the main entrance into the Wilma Quinlan Nature Preserve providing parking and information to visitors. The entrance sign is in good condition and appropriately provides the name of the park and park rules, although the Borough may wish to update the rules to address issues such as dog walking. Recommendation:

Create new signage that welcomes visitors and clearly states Preserve rules. If dogs are allowed within the Preserve, a strict leash rule should be imposed to protect wildlife and other visitors. Consider producing a brochure showing trail layout and points of interest to guide use and improve appreciation of the property's natural resources.

Aesthetics – Proper maintenance of the unit will create a first good impression with visitors and discourage unwarranted use. Recommendation: Maintain lawn area through regular mowings during the growing season. Maintain access loop and parking area by regrading and adding gravel as needed. Monitor regularly (at least weekly) to quickly discover and address any adverse impacts (trash, vandalism) to the aesthetics of the area.

MANAGEMENT UNIT 6 – ESTATE AREA

Size – 1.36 acres

Description

Vegetation of this unit consists of a mix of mature native and introduced elements including several of horticultural interest. Invasive vines (grape, Japanese honeysuckle, oriental bittersweet) and shrubs (autumn olive, multiflora rose, wineberry, winged euonymous) are well-established in the area behind (north of) the residence and threaten the vigor of the desirable elements within the unit.

Unit 6: Groner House and Estate Area

Canopy elements include American beech, bitternut hickory, black cherry, black walnut, dawn redwood, elm, maple (red, Norway, sugar), Norway spruce, oak (pin, scarlet), red ash, red cedar, sassafras and tuliptree. The understory includes sapling to pole-size individuals of most of the native canopy trees. Spicebush dominates the shrub layer with introduced elements increasing in density near the main residence. Among the

ubiquitous bed of periwinkle, a collection of native, woodland herbs and ferns surrounds the main residence; species include Christmas fern, maidenhair fern, Solomon's-seal, wild blue phlox and wood geranium.

Woody specimens of horticultural interest include:

Trees

Aesculus x carnea	Red horsechestnut
Betula populifolia	Gray birch
Cerdiphyllum japonicum	Katsuratree
Chamaecyparis obtusa	Hinoki falsecypress
Cornus florida	Flowering dogwood
Cornus kousa	Korean dogwood
Ginkgo biloba	Ginkgo
Ilex aquifolium	English holly
Ilex opaca	American holly
Ilex pernyi	Perny holly
Magnolia x soulangeana	Saucer magnolia
Magnolia stellata	Star magnolia
Malus sp.	Crabapple (white, double flr.)
Metasequoia glyptostroboides	Dawn redwood
Picea abies	Norway spruce
Quercus acutissima	Sawtooth oak
Tsuga canadensis var. or cv.	Canada hemlock

Shrubs

Buxus sp.	Boxwood
Chaenomeles speciosa	Flowering quince
Euonymus alatus cv. *Compactus*	Winged euonymous
Forsythia sp.	Forsythia
Ligustrum sp.	Privet
Philadelphus grandiflorus	Mock-orange
Rhododendron schlippenbachii	Royal azalea
Rhododendron sp.	Hybrid azalea (1.5"- 2" blossom; strong pink / red blotch
Rhododendron sp.	Hybrid azalea (+/- 1" blossom: coral / deep coral blotch
Syringa vulgaris	Lilac (light lavender)
Taxus sp.	Yew
Viburnum plicatum var. *tomentosum*	Doublefile viburnum
Viburnum prunifolium	Blackhaw

Management Goals:

- Protect and enhance the existing specimen vegetation to create an informal arboretum setting

- Maintain house and garage suitable for occupation

Management Issues and Opportunities

Horticultural Collection Management: The unit contains several nice examples of horticultural specimens. The plant survey for this report identified most of the plants to species; some, particularly the exotic azaleas will require further study by an expert in this area. Recommendations: Restore the collection through the removal of competing vegetation. Consider removing several species that are invasive (see below) and pose a threat to the adjacent natural areas. Engage an expert in the genus *Rhododendron* (contact the local chapter of the American Rhododendron Society) to provide more detailed identification of the exotic azaleas and their horticultural significance.

Invasive Plants – The impact of invasive shrubs and vines is moderate to heavy throughout the unit and threaten the health of the specimen plants. Unfortunately, several of the horticultural plantings (e.g., winged euonymous, privet, forsythia) within the unit are now recognized as invasive species. Recommendations: Control invasives starting with vines affecting canopy trees, moving then to invasive shrubs. Remove the horticultural plantings that are invasive (none are unusual or high quality specimens) and replant with native alternatives (see *Techniques and Procedures – Native Plant Materials*). Establish a program to monitor invasives annually and control as needed. (see *Techniques and Procedures – Invasive Vegetation Management*).

Aesthetics –The unit contains a small amount of scattered trash, including an old wire screen around a tree and an old fence pole. The volume of trash may increase with the expanded use of the adjacent unit by residents. Recommendations: Clean up existing scattered trash and debris and develop a schedule for regular inspections and cleanups (minimum quarterly) to prevent future accumulations.

Hazards – Multiple hazards exist within the unit. A large hazard tree is located between the front of the house and Aarons Avenue. A stand of trees along Landis Mill Road (a.k.a. Sand Hill Road) contains potential hazard tree limbs. An abandoned shed that was severly damaged by a felled tree exists within the unit. It is an attractive nuisance as it is easily accessible. Recommendations: Address current hazard trees and establish regular inspections (minimum annually) of the estate area (including the public roads and area around any structures) for hazard trees (see *Techniques and Procedures – Hazard Tree Monitoring Program*). Remove the shed, unless it has historical, value in which case it should be repaired and secured to prevent unwarranted entry.

Public Use – Given that the house will be rented as a private residence, there is limited potential for public use. However, once restored, the horticultural plantings could be of interest to local gardeners. Recommendation: Offer tours of the horticultural plantings by appointment.

Unwarranted Use – There appears to be two areas of unwarranted use within the unit. A leaf dump created by an adjacent property owner (see *Management Issues Map*) appears

to rest within the unit. Also, a potential encroachment - a neighbor's fence and pool equipment appear to be located within the Miriam Groner Property – exists within the unit. Recommendations: Survey the Properties' boundaries adjacent to private parcels, monument the corners and periodically mark boundaries. Monitor property boundaries regularly (at least quarterly). If the leaf dump is on the Groner property, the neighboring landowners should be informed that this practice is not permitted. If encroachment exists, address as needed.

Site Vegetation Inventory

The following is a composite list of species found within the Wilma Quinlan Preserve and Groner Property. Plants are listed in alphabetical order by scientific name. Introduced (i.e., non-native) species are indicated by an [I] following the common name. 'G' indicates plants observed exclusively on the Groner Property; 'Q' indicates plants observed exclusively on the Wilma Quinlan Preserve. Plant entries not so marked were observed on both sites.

Canopy Species

Acer negundo	Box-elder		Q
Acer platanoides	Norway maple	[I]	
Acer rubrum	Red maple		
Acer saccharum	Sugar maple		
Aesculus x carnea	Red horsechestnut		G
Betual nigra	River birch		Q
Betula populifolia	Gray birch		
Carya cordiformis	Bitternut hickory		
Carya ovata	Shagbark hickory		Q
Carya tomentosa	Mockernut hickory		Q
Cerdiphyllum japonicum	Katsuratree	[I]	
Fagus grandifolia	American beech		
Fraxinus pennsylvanica	Red ash		
Ginkgo biloba	Ginkgo	[I]	G
Gleditsia triacanthos	Honeylocust		Q
Ilex opaca	American holly		G
Juglans nigra	Black walnut		
Larix sp.	Larch		Q
Liriodendron tulipifera	Tuliptree		
Metasequoia glyptostroboides	Dawn redwood	[I]	G
Picea abies	Norway spruce	[I]	
Picea rubens	Red spruce		Q
Platanus occidentalis	Sycamore		Q

Prunus avium	Sweet cherry	[I]	
Prunus serotina	Black cherry		
Pseudostuga menziesii	Douglas fir	[I]	
Quercus acutissima	Sawtooth oak	[I]	G
Quercus bicolor	Swamp white oak		Q
Quercus coccinea	Scarlet oak		
Quercus palustris	Pin oak		
Quercus rubra	Northern red oak		
Sassafras albidum	Sassafras		
Tilia americana	Basswood		Q
Ulmus sp.	Elm		

Understory Species

Carpinus caroliniana	Hornbeam		Q
Chamaecyparis obtusa	Hinoki false cypress	[I]	G
Cornus florida	Flowering dogwood		
Cornus kousa	Korean dogwood	[I]	G
Crataeagus sp.	Hawthorn		Q
Ilex aquifolium	English holly	[I]	G
Ilex pernyi	Perny holly	[I]	G
Juniperus virginiana	Red-cedar		
Magnolia x *soulangeana*	Saucer magnolia	[I]	G
Magnolia stellata	Star magnolia	[I]	G
Malus sp.	Crabapple	[I]	
Tsuga canadensis cv.	Canada hemlock cultivar	[I]	G

Shrubs

Alnus sp.	Alder		Q
Berberis thunbergii	Japanese barberry	[I]	
Buxus sp.	Boxwood	[I]	G
Chaenomeles speciosa	Flowering quince	[I]	G
Cornus amomum	Red willow		Q
Elaeagnus umbellata	Autumn olive	[I]	Q
Euonymous alatus	Winged euonymous	[I]	
Euonymous alatus cv. Compactus	Winged euonymous	[I]	G
Forsythia sp.	Forsythia	[I]	
Ligustrum sp.	Privet	[I]	
Lindera benzoin	Spicebush		
Philadelphus grandiflorus	Mock-orange	[I]	G
Rhododendron schlippenbachii	Royal azalea	[I]	G
Rhododendron sp.	Hybrid azalea	[I]	G
Rhododendron sp.	Hybrid azalea	[I]	G
Rosa multiflora	Multiflora rose	[I]	
Rubus idaeus	Red raspberry		Q
Rubus phoenicolasius	Wineberry	[I]	

Rubus sp.	Blackberry		
Syringa vulgaris	Lilac	[I]	G
Taxus sp.	Yew	[I]	G
Viburnum plicatum var. *tomentosum*	Doublefile viburnum	[I]	G
Viburnum prunifolium	Blackhaw		G

Vines

Celastrus orbiculatis	Oriental bittersweet	[I]	
Lonicera japonica	Japanese honeysuckle	[I]	
Toxicodendron radicans	Poison ivy		
Vitis sp.	Grape	[I]	

Forbs

Achillea millefolium	Common yarrow	[I]	
Alliaria petiolata	Garlic mustard	[I]	
Allium sp.	Field garlic	[I]	
Geranium maculatum	Wood geranium		G
Geum sp.	Avens		
Hemerocallus fulva	Orange day-lily	[I]	
Phlox divaricata	Wild blue phlox		G
Phytolacca americana	Pokeweed		
Polygonatum biflorum	Solomon's-seal		G
Ranunculus ficaria	Lesser celandine	[I]	Q
Rorippa sp.	Watercress	[I]	Q
Solidago spp.	Goldenrods		
Vinca minor	Periwinkle	[I]	G
Viola spp.	Violets		

Ferns and Fern Allies

Adiantum pedatum	Maidenhair fern		G
Dryopteris marginalis	Marginal wood fern		
Polystichum acrostichoides	Christmas fern		

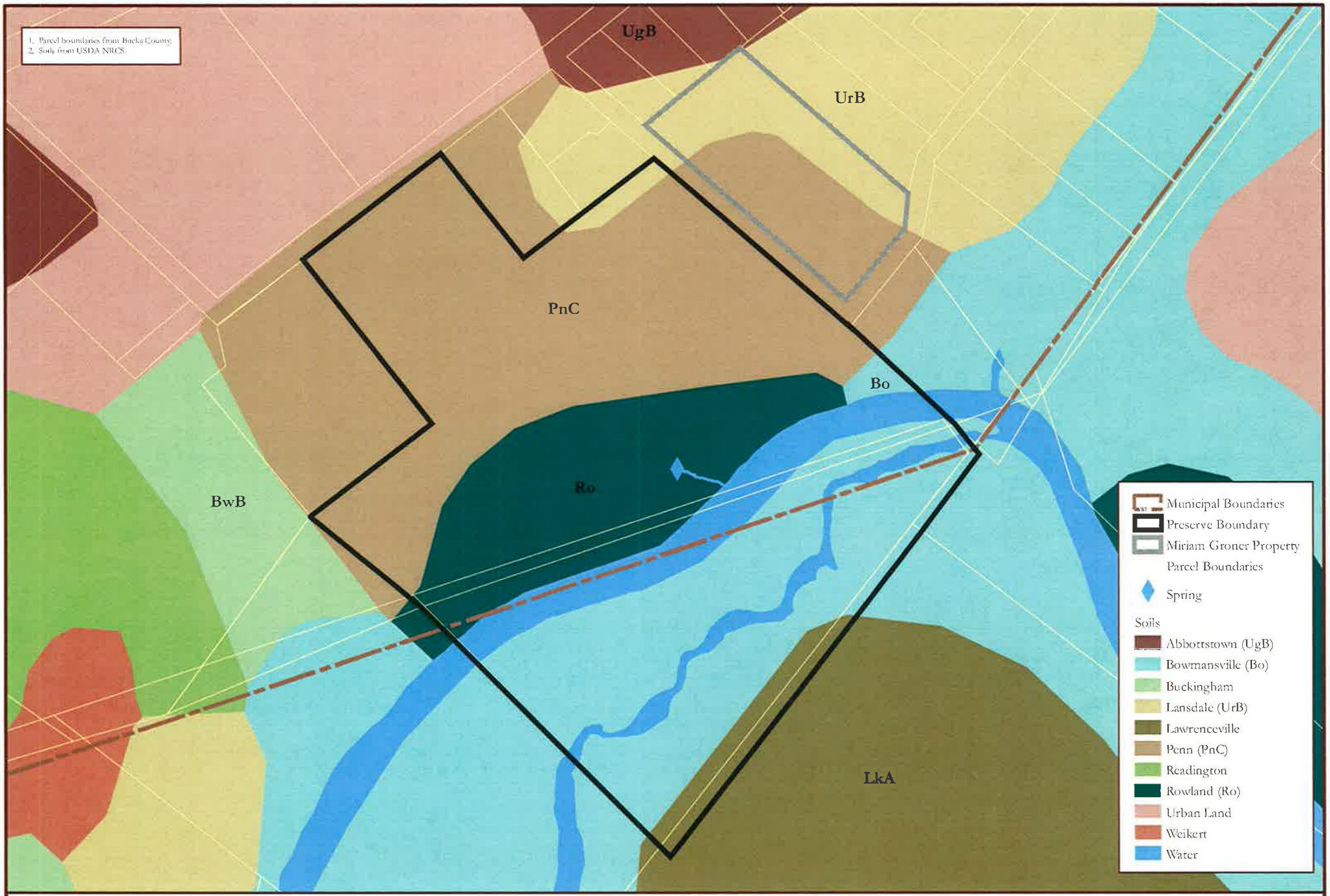
Grasses and Sedges

Carex pensylvanica	Sedge		Q
Carex spp.	Sedge		
Elymus sp.	Riverbank wild-rye		Q
Microstegium vimineum	Japanese stiltgrass	[I]	
Panicum spp.	Panic-grass		
Phalaris arundinacea	Reed canary-grass		Q
Typha latifolia	Common cat-tail		Q

Stewardship Priorities

Unless Borough resources are unlimited, it will be impossible to quickly address all the recommendations offered above. The list below is a prioritized ranking of the recommendations which is compiled to help the Borough address the most critical issues first. This should be considered a best-case scenario list. While safety related issues should be addressed as soon as possible, the remaining activities need not be completed exactly as listed. The order of activities can be adjusted as Borough and outside (grants, volunteers) resources become available and as time is available during the appropriate season (e.g., winter for invasives control and survey; spring for tree planting) for each activity.

1. Survey and address hazard trees
2. Remove old wire fence in Unit 1, barbed wire fence in Unit 2
3. Install gate or chain at entrances in Unit 1 to prevent motor vehicle use
4. Address soil erosion in Units 1, 2 and 4
5. Survey property boundaries adjacent to private parcels to determine unwarranted use, including encroachment
6. Monument corners and mark boundaries adjacent to private parcels
7. Remove trash and materials from dumping areas in Units 1, 3, and 6
8. Contact owner of property to south of Preserve to discuss protection options
9. Establish monitoring programs for hazard trees, invasive plants and unwarranted use
10. Establish a deer management program
11. Cut vines in canopy trees in Units 2 and 4
12. Cut vines in canopy trees in Units 1 and 6
13. Develop and install undated trailhead signage and remove old signs
14. Create new pedestrian trail entrance along Landis Mill Road (a.k.a. Sand Mill Road) in Unit 1
15. Establish trail on Miriam Groner property in Unit 3
16. Remove invasive trees and shrubs in Units 2 and 4
17. Verify the ability to plant near the sewer line in Unit 4 and, if permitted, plant with native trees
18. Remove invasive trees and shrubs in Unit 1
19. Clear the open areas in Unit 1 and plant with native trees
20. Convert meadows from cool-season grasses to native warm season grassland/meadow in Unit 3.
21. Spot spray invasives in Unit 3
22. Install Bluebird and Wood Duck nesting boxes
23. Develop brochure for visitors
24. Install bench in Unit 2 overlooking the spring



SOILS

Wilma Quinlan Nature Preserve
and Miriam Groner Property

New Britain Borough and New Britain Township, Bucks County, Pennsylvania

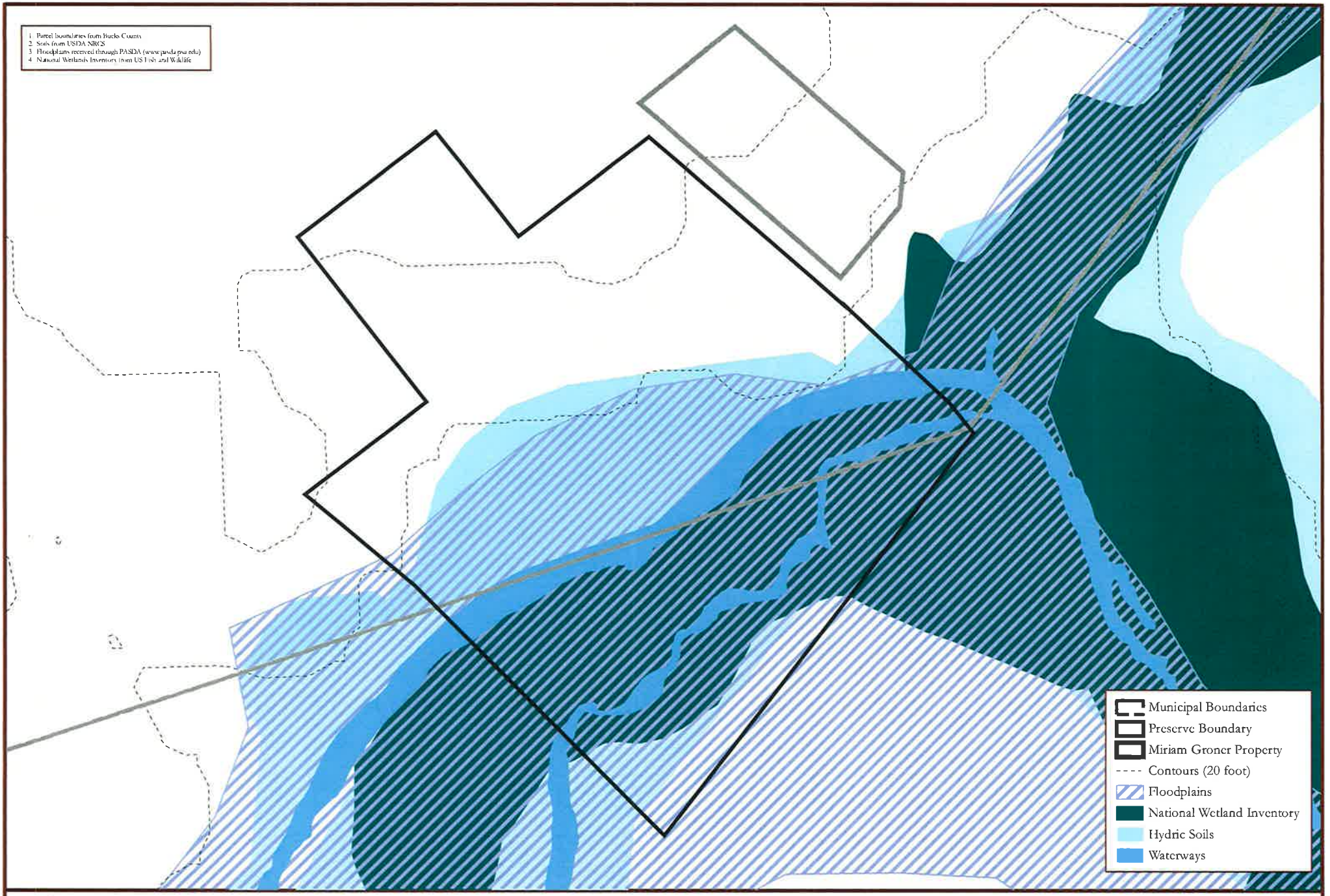
Natural Lands Trust
1031 Palmers Mill Road, Media, PA 19063
610-353-5587 ~ www.natlands.org

N

0 125 250 Feet

Compiled By: MEB 06/4/07

1. Parcel boundaries from Bucks County
2. Soils from USDA NRCS
3. Floodplains received through PASDA (www.pasda.psu.edu)
4. National Wetlands Inventory from US Fish and Wildlife



TOPOGRAPHIC & HYDROLOGIC FEATURES

Wilma Quinlan Nature Preserve and Miriam Groner Property

New Britain Borough, Bucks County, Pennsylvania

Natural Lands Trust
1031 Palmers Mill Road, Media, PA 19063
610-353-5587 ~ www.natlands.org

N

0 125 250 Feet

Compiled By: MEB 05/31/07

NATURAL LANDS TRUST
1031 Palmers Mill Road
Media, PA 19063
610-353-5587
www.natlands.org

MANAGEMENT UNITS

Wilma Quinlan Nature Preserve
and Miriam Groner Property
New Britain Borough, Bucks County, Pennsylvania

N

0 100 200 Feet

Compiled By: DCR 05/04/06

STEWARDSHIP ISSUES

Wilma Quinlan Nature Preserve and Miriam Groner Property

New Britain Borough and New Britain Township, Bucks County, Pennsylvania

Natural Lands Trust
1031 Palmers Mill Road, Media, PA 19063
610-353-5587 ~ www.natlands.org

N

0 125 250 Feet

Compiled By: MEB 06/4/07

Techniques and Procedures

Wildlife Management

White-tailed Deer

The question is not if a landowner will manage the deer population within their property borders, but whether management will be passive or active. Passive management allows existing natural conditions and human activities within the local landscape to influence deer survival and reproduction. Active management involves human intervention to ensure that the desired management goals of a property are met, i.e., ambient controls within the landscape are considered insufficient to maintain the population at an acceptable level.

Passive Management

Passive deer management is only an option in areas with overabundant deer populations if the landowner is not concerned with the health of the forest or if the landowner believes that the ecological degradation will eventually be resolved through measures that do not modify deer access to forest vegetation. The only possible scenario for a reduced deer population under this management regime is through disease or a series of severe winters. Otherwise, deer densities will likely remain high or increase.

Based on the current understanding of deer ecology and results from properties under passive management in high-density situations, passive management of the deer population will make healthy natural forest communities unsustainable in southeastern Pennsylvania. As forest health declines, so will the many goods and services it provides. The loss of native species diversity and structural variation in the understory will reduce the habitat for local and migratory wildlife. A forest without a diverse understory lacks cover for ground nesting birds (e.g., ovenbirds) and protected feeding areas for other interior forest birds such as woodthrush and worm-eating warbler. A forest devoid of an understory also lacks shelter and moisture for reptiles and amphibians, including salamanders, frogs and turtles. The likely shift in plant dominance to exotic invasives from natives (preferably browsed by deer) will decrease food resources for insects, birds (fruits of exotic shrubs are less nutritious), and aquatic invertebrates (they are largely unable to digest leaves of exotic plant species) in associated forest streams.

Under a passive management scenario, perpetuation of some semblance of the current forest communities will require the use of artificial regeneration (i.e., human plantings) to regenerate the forest until the deer population collapses through disease or starvation. This will require that the trees and shrubs planted in the forest will need to be tall enough (> 5 feet) to escape browsing of terminal buds and be planted in numbers sufficient to maintain a closed canopy under pressure from other pests and pathogens. It will also mean that native herbaceous species will likely disappear from the forest.

Active Management

Active methods to control the impacts of deer overabundance can be grouped into two categories: those that restrict or deter deer access to desired vegetation and those that reduce the on-site population within a tract of land. The current tools used to actively modify the impact of white-tailed deer include barriers, repellents, contraceptives, trap and transfer, and lethal removal. Given the open nature suburban landscape in southeastern Pennsylvania and the expense and impracticality of other options, lethal removal within a structured and supervised management program is the recommended method for addressing the deer population.

Before severe modification of the landscape by European settlers, deer populations were primarily controlled by natural predators (wolf, mountain lion and black bear) and hunting by Native Americans. With the virtual elimination of animal predators from the southeastern counties, hunting is the most frequently used and most effective reduction method commonly available to landowners. Other lethal removal options, including deprivation permits for farmers and the use of sharpshooters are available, but tightly controlled by the Pennsylvania Game Commission.

A controlled hunting program is probably the most effective deer management tool available to landowners in southeastern Pennsylvania at this time. However, there are several concerns surrounding its effective use that should be considered by any landowner prior to implementation.

The foremost issue is the safe use of firearms or archery in a region with a growing population and use of natural lands. This is a particular concern in communities where natural lands are part of the common open space that is used by members of the local community. Any hunting program should be closely monitored by the land manager of the property and controlled by restrictions that minimize the potential conflict between hunters and other users of the natural areas. These should include limitations on hunting areas and times, notification of appropriate persons when hunting is in progress, and an easy way to identify permitted hunters by other users. Most importantly, all hunters should be carefully screened for firearm proficiency and a history of ethical hunting practices. Any hunter that violates any program rules should be immediately removed from the program.

Ideally, hunting can lower the deer population to a level where only a few deer need to be removed each year to maintain the population at a level that allows healthy regeneration of the forest. Achieving this maintenance level is complicated often by ongoing development in the surrounding landscape, which will concentrate more deer on the remaining natural lands. If this is the case, it will probably require an extended period of more intense hunting until the development of unprotected natural areas in the landscape is complete. It is also complicated by the fact that at lower population levels, it may take hunters as much time to remove a few deer as it now takes to remove a few dozen deer. You will need to engage proficient, dedicated hunters to maintain the population at acceptable levels. Until additional options become available, hunting will

be a long-term method of keeping the population in check and allowing for limited forest regeneration until a point where populations stabilize in the surrounding area, which could be decades.

There are several potential alternatives and modifications within the lethal removal option that can speed the reduction in the deer population. The first is the use of archery, particularly on small properties or properties with numerous residential structures on its borders. This would greatly expand the hunting area (the safety zone for archery is 50 yards; firearms require a 150 yard safety zone) and hunting time during the year by several weeks. An added benefit of allowing expanded access by hunters is that permitted hunters will monitor for unwarranted hunting while they are in the field.

Another alternative for expanding the number of deer harvested each year is enrollment in the Pennsylvania Game Commission's Deer Management Assistance Program (DMAP). This program provides additional permit applications (coupons) to landowners that they can then give to hunters. One coupon is granted for every 5 acres of farmland and every 50 acres of other land cover (forest, meadow, successional). Additional permits above the standard formula are available if the landowner submits a management plan with their request. Unlike in past years, the landowner no longer is required to open their land to the general public.

A final option is the use of sharpshooters to harvest deer. Under this option qualified professional sharpshooters are hired to harvest a high quantity of deer from a property. This requires a special permit from the Pennsylvania Game Commission. The process is very rigorous and requires the landowner to prove that hunting within current game laws is not a viable option for managing the deer population. However, this is probably the safest (hunting is often done at night over bait piles) and quietest (hunters use rifle silencers) hunting method and would be the most effective option for reducing the deer population in the shortest time.

In some situations, it might be most efficient to engage a local hunting club to implement the program described above. They could handle all program administration, including proficiency tests, the scheduling of hunting times, and data collection. The group should provide proof of insurance and be in close contact with the natural area's manager to avoid conflicts with other activities in hunting areas.

Natural Lands Trust has been employing a regulated hunting program on its preserves for 15 years. It could be a template for instituting a deer management program on the Wilma Quinlan Nature Preserve and Miriam Groner property or be a measure for engaging a local hunting club. At Natural Lands Trust, our goal is to preserve and enhance the plant communities within our preserve system to maximize wildlife benefits. With that goal in mind and based on an understanding of the requirements of the state wildlife code, we have instituted a deer management program that focuses on reducing deer populations to a level that will allow forest regeneration and survival of native herbaceous species. First, we employ tree shelters and fencing to protect vegetation from deer browsing and rubbing, and second, we implement controlled

hunts to reduce the numbers of deer.

The rules that hunters must adhere to reflect an overriding concern for safety, not only for the participants of the management program but for other preserve users such as walkers and bird-watchers (see below). The mandatory proficiency test assures that hunters are familiar and competent with their sporting arm. A flagged map locates hunter positions for the preserve manager and other hunters. Participants wear bright NLT armbands that allow preserve managers as well as others to tell from a distance if a hunter has permission to hunt. The rules place due emphasis on removing does from the population. Preferentially harvesting does brings populations to tolerable levels far more quickly than would a random removal strategy.

Operating the program requires relatively little staff time to administer. In fact, staff time expended in administration is readily made up through time saved by the reduction in staff patrolling time during the hunting season. Permitted hunters monitor unwarranted access to the preserve during the hunting season, enabling managers to attend to other responsibilities.

NATURAL LANDS TRUST REGULATED HUNTING PROGRAM

RULES AND REGULATIONS

Natural Lands Trust conducts controlled deer hunts on properties to manage deer populations consistent with the preserve's natural resource management goals. Hunters receiving permits for the deer management program are expected to conduct themselves in a safe, honest and ethical manner. Any hunter who does not act accordingly will have his or her hunting permit revoked immediately. Listed below are the requirements that

must be met to receive a permit, examples of what the Trust considers unacceptable behavior, and the regulations that must be followed while hunting on any Trust preserve.

Permit Requirements

1. All hunters must attend a preseason orientation course to be conducted by the preserve manager.

2. All hunters must present proof that they have completed the Pennsylvania Game Commission Hunter/Trapper Education Course. Bowhunters must present proof that they have completed a Bowhunter Education Course.

3. Hunters must have an antlerless deer license for the deer management unit of the preserve

4. All hunters must pass a proficiency test using the sporting arm they plan to hunt with. For **firearms**, a hunter must place 4 out of 5 slugs in a 9-inch paper plate at 45 yards. No buckshot allowed. Shooting from a treestand 10 feet above the ground, an **archer** must place 5 out of 6 arrows in the vitals of a 3-D target. The target will be placed at 5, 10, and 15 yards from the base of the tree.

Unacceptable Behavior (includes, but is not limited to the following)

1. Shooting in marginal situations such as at running deer, when vital organs are obstructed, and at excessive distances.

2. Disrespect of Trust employees, adjacent landowners, and other preserve users.

3. Consumption of alcoholic beverages or use of controlled substances.

4. Failing to appropriately follow up every shot.

5. Displaying game animals unnecessarily.

Hunting Regulations

1. The Trust will determine the days and hours of hunting permitted at a site.

2. Hunters must comply with all Pennsylvania Game Commission regulations (including returning report cards).

3. Hunters must endeavor to harvest an antlerless deer. Any hunter that does not make

a good faith effort to harvest an antlerless deer will have their permit revoked. Archers must take an antlerless deer before being eligible to harvest a buck.

4. Hunters must hunt at least 20 hours.

5. Only two shells can be loaded at any one time (one shell in the chamber, one in the magazine).

6. Only portable tree stands may be used and hunters must wear a safety belt. No screw-in steps are allowed. All tree stands must be removed by January 26th, or they will be forfeited.

7. Crossbows and .410 shotguns are not allowed.

8. Hunters must follow the hunting procedure listed below.

Hunting Procedure

A metal box will be placed in a convenient spot, accessible to all hunters. The box will contain armbands, a map of the preserve, and the hunting log. ***Prior to each hunting stand the hunter must:*** (1) remove one of the armbands from the box and put it on the exterior of his or her hunting coat (once the supply of armbands is exhausted, no additional hunters may hunt until a hunter returns from the field and returns an armband to the metal box); (2) mark the map to indicate where they plan to hunt; (3) sign in on the hunting log; and (4) display a parking permit on the dashboard of their vehicle. ***While hunting, the hunter must:*** (1) wear the armband; and (2) carry their permit. ***At the end of each stand, the hunter must:*** (1) return the armband to the metal box; (2) remove the mark from the map; and (3) fill in the hunting log completely.

Termination Procedure

If the preserve manager witnesses a case of Unacceptable Behavior or a violation of one of the Hunting Regulations by a permitted hunter, or is informed of such an incidence by a reliable source, he will abide by the following procedure to address each incidence:

1. The preserve manager will verbally inform the hunter of the infraction.

2. The hunter will be provided the opportunity to respond to the accusation.

3. If, in the opinion of the preserve manager, the hunter has clearly exhibited an Unacceptable Behavior or has violated one of the Hunting Regulations, he will verbally inform the hunter that his hunting permit is revoked immediately.

4. If there are legitimate extenuating circumstances surrounding a violation of Hunting Regulation 6 or 8, the hunter will be given a warning. A second violation of these regulations will result in immediate loss of hunting privileges. Violations of any other Hunting Regulation or Unacceptable behavior rule will not receive a warning and will result in immediate termination of hunting privileges.

5. The hunter will be notified in writing of a warning or the loss of hunting privileges.

Invasive Vegetation Management

Management Strategy

Often the most difficult step in controlling invasives is deciding what to do first. Creating a "plan of attack" is critical in order to make the most efficient and effective use of limited stewardship resources. Although it may seem logical to address the most severely degraded areas first, this may not be the best use of resources. The following

two rules may help focus management efforts.

The first rule is that, in general, the future rate of forest degradation is inversely proportional to the current level of degradation. When a tree within a healthy, closed-canopy forest is toppled by invasive vines or a gap is colonized by an invasive tree, the resulting loss of growing space has a major impact on the entire forest stand, by providing a seed source for the rapid spread of invasives from that point. On the other hand, the loss of a single tree in a heavily degraded, open-canopy area creates relatively little change in the total amount of growing space in the stand that is controlled by invasives.

The second rule is that management efforts should be focused on restoring that part of the plant community that controls the most growing space. In a forest community the canopy trees take up the majority of the growing space. Once the canopy is free of invasive impact, the manager can proceed to the next layer until the ground level is reached.

The focus of initial restoration efforts, therefore, should be to halt the degradation of the canopy layer in the healthiest areas, moving then to the moderately invaded areas, and so on to the most degraded areas. Those areas that are severely invaded should, for now, be left for "dead." Since they essentially cannot degrade any further, their restoration (which will usually require significant resources, including heavy equipment and years of high maintenance) is best left until the healthier, less impacted sites are stabilized. This approach is also healthier, psychologically, for the personnel involved in restoration. Spending the initial phase of a project stabilizing the majority of a site is more rewarding than struggling through a highly degraded area that is only a small portion of the site.

Priorities may need to be modified for best short-term efficiency of labor and long-term results, according to the time of year or availability of labor. For example, the cutting and herbiciding of understory invasive trees is best done during fall and early winter when sap is flowing into the roots, whereas the planting of seedlings is best done in the late winter and early spring. If labor is first available in the spring, then it would be best to plant seedlings in moderately to heavily invaded forest areas first and wait till the fall to cut the invasive trees in lightly to moderately invaded areas.

Two points should be noted while planning an invasives control program. First, invasive plant removal must be done properly or it can have catastrophic impacts to the health of natural lands and its wildlife. Removing trees such as Norway maple and groundcovers such as English ivy opens up the canopy and scarifies the soil, conditions that are ideal for the rapid establishment from seed of opportunistic species, a category that includes most invasives. Removing understory shrubs such as shrub honeysuckles, privet or sapphire-berry can transform a forest stand that was a haven for migratory and resident birds and other animals to one devoid of understory cover and thus no longer a viable refuge (from predators), feeding or breeding habitat for many species. Removal without replacement has numerous subtle effects but some effects can be dramatic, such as a

striking decline in birds that were once common. In general, the restoration of a degraded community, particularly forest, should be done in stages so that wildlife has time to adjust to cover and food conditions.

Replacement planting should be undertaken in the same year as invasives removal. This will provide the native species with an edge in recapturing the growing space made available by weeding out invasive species. Any site where plants to be removed comprise more than 25% of the cover within their forest layer (canopy, subcanopy, shrub, herbaceous) will probably require planting to augment any natural regeneration. Removal should be undertaken at times of year when direct disturbance of wildlife would be minimal, preferably late fall or winter. Replacement plantings should precede the onset of the spring breeding season because many birds return to the same sites year after year to reestablish territories and renest. To insure their survival and to maintain ecosystem integrity, replacement plants must be of native tree, shrub or herbaceous species carefully selected to be appropriate to soil conditions and the community type at each individual restoration site within the natural area.

Replanting after removing invasive plants accomplishes several objectives. It replaces vertical forest structure and bird cover where they had been provided mainly by the invasive species (e.g., where shrub honeysuckles, privet or sapphire-berry are removed). Where invasive species have eliminated entire forest layers (e.g., Norway maple and English ivy, which eradicate native shrub and herbaceous layers in forests), replanting after removal restores long-lost vertical forest structure and bird cover. Where invasive plants are removed from streambanks or floodplains (especially Japanese knotweed) or from steep slopes, replanting renews protection against soil erosion. In all cases, the planted native species restore lost components of the indigenous food web; invasive species' leaves and stems are little utilized as food by native wildlife, which is one of the reasons they succeed so well here.

It must be emphasized, however, that planting should be viewed as only one component of forest restoration where invasive species are removed. The goal of maintaining natural lands as a set of natural communities dominated by native species will be met only by reducing the deer population to a level that allows natural regeneration from seed produced by native species already growing on the natural lands. Once natural regeneration is restored, a healthy crop of seedlings and saplings of native species will be poised to assume the growing space vacated by the natural decline and mortality of native species or the deliberate removal of invasive species.

Any invasives program must be undertaken in concert with a serious effort to reduce the overabundance of deer, if needed. Without sufficient native regeneration, any long-term effort to restore native plant communities will be futile. If the deer population is not addressed, perpetual reliance on planting will be a severe drain on stewardship resources and will require permanent, extensive use of unsightly measures (fencing, tree shelters) to protect plantings from deer browsing.

Management Options

In natural area management, the most efficient and effective strategy usually results from basing stewardship goals on a thorough understanding of the environmental forces in the area and adopting only those that work with, and not against, these forces. This is true in developing a strategy for minimizing the impact of invasive plants. Any attempt to alter the vegetation of a site will succeed or fail according to its effects on the major forces (light, water, inorganic nutrients, temperature, humidity, soil structure and other factors collectively known as the "growing space") that support plant growth in that area. Given that growing space in any area is finite, successful management will result from those practices that make more growing space available to desirable species (native members of natural communities) and less to non-desirable species (introduced invasives).

There are many management options for controlling invasive vegetation. These include physical removal, cutting, planting, herbicides and fire. Usually, the control of invasives on any given site requires a combination of two or more methods. The most effective mixture and timing will be unique to each site. What is common to all sites is the fact that the prolific nature of invasive plants mandates periodic monitoring and control to prevent a major disruption to the aesthetics, native biodiversity and ecosystem function of the impacted site.

Physical Removal

The most effective practice is the selective removal of invasives without disturbing the surrounding native vegetation. The invasive plant is denied growing space and the surrounding desirable vegetation is well-positioned to occupy the vacated growing space. This approach is preferable wherever possible, although it may be limited in particular cases as a practical alternative by the availability of workers and equipment relative to the size, quantity, and type of invasive(s) present.

Relatively small quantities of invasives can be effectively removed through manual pulling, digging with hand tools (shovel or spade) or pulling with a heavy-duty truck or tractor. One specialized hand tool that works well on small single-stemmed plants is called by one manufacturer a *Weed Wrench*. It is designed to clamp to the base of a tree or shrub and lever the entire plant out of the ground. A tractor-mounted front-end loader is ideal for removing larger trees or shrubs by several methods. One method entails elevating the lower branches with the bucket while a chain (a logging slip chain is best) is attached to the base of the plant and then, by raising the bucket, the plant can be removed from the ground. A second, easier tractor method is to use a single fork attachment on the front-end loader to pop the shrub out by positioning the fork under the crown (the swollen area from which the roots and stem emerge) and raising the bucket. The third, and most efficient, method requires replacing the loader bucket with a tool called a *Brush Brute*—a 4 to 6-foot steel frame with 18-inch "teeth." With this tool the operator simply drives into the unwanted shrub or small tree until the base of the plant is impaled between the teeth and then lifts the entire plant out of the ground.

Regardless of which means is employed, it is generally desirable to remove as much of

the root system as possible to prevent resprouting, although removal of the crown is usually sufficient to prevent rapid reestablishment of the plant. In individual cases the success of this method depends on the thoroughness with which the plant is removed and the speed at which desirable vegetation can occupy newly available growing space.

Cutting

Removing some or all of the photosynthetic (food-producing) area of invasive plants without disturbing the surrounding vegetation is another way to redistribute the available growing space and control invasives. It is less effective, but also less labor intensive, than physical removal. Cutting the plant with a pruner, handsaw, or lightweight chainsaw reduces its aboveground growing space without disturbing surrounding vegetation. However, the entire root system and any uncut stems can resprout and reoccupy the growing space. For this reason, it is best to cut the plant as low as possible to the ground and to add an herbicide application (refer to the Herbicides section, below, for further details).

This option is most appropriate for controlling invasives in forested areas. In this situation, leaves of the surrounding vegetation (trees) are often situated above the target plant material. Because the surrounding trees limit the sunlight needed for food production, a cut plant is forced to rely on stored root reserves to maintain the remaining parts of the plant and support new leaf growth. Although invasives are usually able to survive cutting, they may be weakened sufficiently to slow their full recovery for an extended period.

Cutting is less effective in open areas. Typically, resprouting ability and rapid growth allow invasives to quickly reoccupy the available growing space. The problem is alleviated only temporarily; cutting will be required again within a few years. This is particularly true at edge sites (where open fields or lawns meet forests) and hedgerows. There the vines gain the added benefit of tree support, which they can utilize to occupy greater growing space to the detriment of the trees.

Late fall and winter are the most efficient and least arduous times to perform cutting operations. Problem areas are more easily traversed and cool-weather clothing gives added protection to the work crew. Following initial treatment, an annual or biennial inspection and control schedule should be adopted to prevent initial conditions from recurring. After a thorough first treatment, frequent but small-scale treatments are effective in preserving the native diversity, ecosystem integrity and aesthetic quality of a site.

Planting

Another option to take away growing space from invasives is by planting native trees and shrubs to increase their density and shade out invasives. It is particularly important to minimize the amount of interior and exterior edge of a forest (high light areas where invasives thrive) by encouraging native species growth in forest gaps and rounding off

sinuous or concave borders with open areas.

In areas where invasives are a significant component of the vegetation, it is desirable to plant trees and shrubs where invasives have been removed. Killing or removing the invasives often disturbs the soil surface, giving a strong advantage to opportunistic species as plants colonize the newly vacated growing space. Invasives will quickly reoccupy such a site unless they are suppressed by other plantings.

Planting should occur in early spring or fall to optimize plant survival. Because they must compete with invasives, only species highly adapted to a site's conditions (particularly light and soil water availability) should be planted.

Herbicides

In most cases the use of herbicides alone is not an effective long-term solution for controlling invasives. Difficulties in delivering adequate amounts to the target plants at the correct time in their growth cycle the near-impossibility of avoiding collateral damage to native plants and other organisms, and the potential health risks to workers are all drawbacks to their use. In addition, inherent in the sole reliance on herbicides is a "once and done" attitude that is not conducive to the long-term control of invasives. Used appropriately, however, herbicides can be an important tool for land managers in certain situations. Herbicides should be applied only by personnel properly trained in both the safe use of each herbicide and the identification of desirable versus undesirable species.

To safely administer herbicides to the target plant it is best to minimize the aboveground volume of the plant prior to herbicide application. To control small trees, shrubs, or vines, an herbicide with glyphosphate (such as *Roundup* or *Rodeo*) should be applied to the fresh sprouts two weeks after cutting. Larger plants can be most effectively controlled by applying an appropriate formulation of the herbicide triclopir (such as *Garlon, Escort* or *Clean Cut*) or glyphosphate directly to the freshly cut stump. This second method works best in fall and winter when sap flow is into the roots.

Recommended Techniques and Procedures

Groundcover and Vine Removal

Equipment: Pruners, pruning saws, loppers, blade weedwhips, chainsaws, herbicides

Groundcovers can be pulled on a regular basis or herbicides can be used to control or eliminate patches. A mixture of *Garlon* and diesel fuel has been used successfully when sprayed on foliage in the winter. Care must be given to not spray non-target species.

As mentioned above, the first priority in invasive control is to address vines impacting canopy trees. Cut woody vines at ground level and at least 5 feet above ground level and

remove from trees if removal won't cause damage. Immediately following cutting, large stumps should be painted with a systemic herbicide such as *Roundup* or *Garlon*.

It should be noted that while invasive vines pose a significant threat to the forest, there may be native vine species within a natural area that have high food value for wildlife. Poison-ivy, Virginia creeper and grape should not be cut from trees unless they begin to seriously compromise the health of the tree. Usually, this only happens with grape, which can eventually overtop the canopy of a tree. At this point the grape should be cut and not treated with herbicide so that it can resprout.

Shrub and Sapling Removal

Equipment: Pruners, pruning saws, loppers, blade weedwhips, *Weed Wrench*, chainsaws, tractor-mounted brush hog, front-end loader, herbicides

Eliminate or control invasive and undesired shrubs and saplings by manually or mechanically pulling or by cutting. Stumps cut manually should be immediately painted with a systemic herbicide such as *Roundup* or *Garlon*. In areas that have been brush-hogged, cleanly recut all saplings over 2 inches in diameter and immediately paint with the systemic herbicide. Limbs and related debris can be flychipped on-site or removed if there are fruits with viable seeds.

Tree Removal

Equipment: Pruners, pruning saws, loppers, *Weed Wrench*, chainsaws, front-end loader, herbicides

In areas adjacent to trails and other high-use locations, drop invasive and hazardous trees without damage to surrounding desirable trees and either let lie or section trunks to create brush piles for wildlife habitat (see below). Trunks and limbs of Norway maple that are large (>6-inch diameter) and straight (>8-foot sections) may be useful for trail stabilization and restoration. Some other invasive tree species such as ailanthus will decay rapidly and are not useful for this purpose. Stumps of felled trees should be cut flush to the ground and immediately treated with a systemic herbicide such as *Roundup* or *Garlon*. In many areas ailanthus will root-sprout vigorously following cutting, even with herbicide treatment. If this occurs do not cut, but apply herbicide directly to the bark at the base of the tree using oil-based *Garlon* mixed with a basal oil. For more information refer to the Nature Conservancy's weed-control website (http://tncweeds.ucdavis.edu/esadocs/documnts/ailaalt.html). Smaller limbs and related debris should be left to rot or fly-chipped on-site. In appropriate areas, larger (>6-inch diameter) trees can be girdled to create snags for cavity-nesting wildlife. All dead trees, snags, or branches that do not pose a safety hazard or a threat to the ecological health or stability of the forest should be left in place for their wildlife habitat benefits.

To create a brush pile, first build a base by placing four large logs, set 1 foot apart and

parallel to each other, and then place four more logs of the same size, stacked perpendicular to the first logs. Add brush to the top and sides, starting with the larger limbs first, then adding smaller pieces until the pile is about 6 feet high and 6 feet wide.

Planting

As mentioned previously, it is particularly important to establish trees and shrubs in forested areas where invasives have been removed. This can be done through natural or artificial (planting) regeneration. The former is the preferred method because new seedlings will be derived from a gene pool that has evolved under the environmental conditions of the property over centuries or thousands of years.

Only wild-type (no cultivars) native tree and shrub species appropriate to site conditions should be used. Selecting species that are high in wildlife food and cover value increases the benefits. They should also be locally grown if possible. Ideally, they would be grown from seeds or cuttings collected on-site. Trees should be 4 to 6 feet tall at planting to help assure that they can outcompete invasives and so that most of their foliage is above the reach of browsing deer. Container trees, both potted and in tree bands, are easier to plant and have a much greater survival rate than bare-root trees, especially if soil conditions in the planting area become dry. Using container trees also extends the planting season.

Forest gaps should be planted with trees on roughly 10-foot x 10-foot spacings and protected, if needed, from deer damage with fencing, tree shelters, flexible tree wraps, or rigid stakes. Fencing and tree shelters prevent deer from browsing leaves and buds. The tree wraps and stakes minimize damage to the bark and cambium layer (girdling) of young trees caused by antler rubbing. The wraps should cover the trunk from 1 foot to 5 feet above the ground. The stakes should be placed in the ground close to, and on opposite sides of, the trunks. They can be made of wood, metal, or other rigid materials (including bamboo) and should be at least 5 feet tall (above ground level). Shrubs should be a minimum of 18 to 24 inches tall at planting. Where it is not practical to reduce and maintain deer at a density of 5 to 10 per square mile, only the most highly unpalatable species, such as spicebush, should be planted.

Planting design should be spaced to allow access to control competing vegetation, but close enough for the canopy to close quickly. It should also be naturalistic in form (i.e., straight lines or rows should be avoided).

Watering at the time of planting is recommended, especially if the plant is not dormant or planted during warm or dry weather. If water is easily accessible, water all plants at the time of planting to help remove air pockets from backfilled soil. Monitor the plantings for at least the first summer, watering them if conditions become dry. A little maintenance goes a long way. If available, put a layer of mulch 2 to 3 inches thick over the planting area, but no closer than 2 inches to planted trees' and shrubs' trunks.

Schedule

Invasive and undesired vegetation is best removed in September through February when systemic herbicides are most effective (when sap is flowing into the roots). Conduct removal preferably when the ground is frozen, otherwise when the ground is dry.

Plant trees and shrubs in early spring before they leaf out or in early fall to allow for root growth before the ground freezes. If needed, install flexible tree guards in August and remove in January, until the tree is large enough (2 inches in diameter) to withstand buck rubs.

Ongoing Management

Following restoration, every effort should be made to minimize future disturbance to forest areas, from natural and human sources. This includes removing any trash and monitoring annually for intrusion or regrowth by invasive or other undesirable plants.

Control invasive trees and shrubs by spot spraying or wick application of an appropriate systemic herbicide or by manual or mechanical pulling. Areas that are disturbed by removal should be replanted with native trees and shrubs and mulched with woodchips or on-site leaf litter. Any resprouting invasive and undesirable vines should be prevented from climbing into trees and shrubs, at a minimum by pruning. They should eventually be eliminated by spot spraying or wick application of an appropriate systemic herbicide or by manual or mechanical pulling and replanting of the area with native trees and shrubs.

Until natural regeneration becomes adequate, the planting of trees and shrubs should continue on an as-needed basis to assure that sufficient regeneration is available to replace canopy trees as they die. Reduce vegetative competition through selective cutting or herbicide use around the bases of trees during the growing season until the canopy has closed.

INVASIVE INTRODUCED SPECIES OF PLANTS, *currently associated with the greatest harm to native biodiversity in southeastern Pennsylvania*

Common Name	***Scientific Name***	**Description**
akebia, five-leaved	*Akebia quinata*	liana or creeping shrub
angelica-tree, Japanese	*Aralia elatus*	tree
bamboo, garden	*Pseudosasa japonica*	upright shrub
bittersweet, oriental	*Celastrus orbiculatus*	liana (woody vine)
cherry, bird	*Prunus avium*	tree
burning-bush	*Euonymus alatus*	shrub
Celandine, lesser	*Ranunculus ficaria*	perennial spring-ephemeral herb
corktree, amur	*Phellodendron amurense*	tree
crownvetch	*Coronilla varia*	herbaceous plant aggressively

Common Name	*Scientific Name*	Description
		spreading in open areas
gill-over-the-ground	*Glechoma hederacea*	herbaceous plant aggressively spreading in the forest
goutweed	*Aegopodium podagraria*	perennial herb
honeysuckle, amur	*Lonicera maackii*	shrub
honeysuckle, Japanese	*Lonicera japonica*	creeping shrub or liana
hops, Japanese	*Humulus japonicus*	herbaceous plant aggressively spreading in open areas
jetbead	*Rhodotypos scandens*	upright shrub
ivy, English	*Hedera helix*	prostrate or climbing woody vine
knotweed, Japanese	*Polygonum cuspidatum*	very large Eurasian perennial herb
loosestrife, purple	*Lythrum salicaria*	herbaceous plant aggressively spreading in open areas
maple, Norway	*Acer platanoides*	tree
mile-a-minute	*Polygonum perfoliatum*	herbaceous plant aggressively spreading in open areas
mock-orange	*Philadelphus* sp.	upright shrub
multiflora rose	*Rosa multiflora*	upright or often climbing shrub
garlic-mustard	*Alliaria petiolata*	biennial herb
periwinkle	*Vinca minor*	creeping shrub
phragmites, common reed	*Phragmites australis*	very large perennial herb; the species is native to both North America and Eurasia, but the invasive form is thought to be descended from Eurasian populations
plumegrass, Japanese	*Miscanthus sinensis*	herbaceous plant aggressively spreading in open areas
porcelain-berry	*Ampelopsis brevipedunculata*	liana (woody vine)
privet, border	*Ligustrum obtusifolium*	shrub
sapphire-berry	*Symplocos paniculata*	upright shrub
spurge, Japanese	*Pachysandra terminalis*	creeping shrub
stilt grass, Japanese	*Microstegium vimineum*	herbaceous plant aggressively spreading in the forest
strawberry, Indian	*Duchesnea indica*	herbaceous plant aggressively spreading in the forest
tree-of-heaven	*Ailanthus altissima*	tree
viburnum, linden	*Viburnum dilatatum*	upright shrub
viburnum, doublefile	*Viburnum plicatum*	upright shrub
viburnum, Siebold	*Viburnum sieboldii*	upright shrub
wisteria,	*Wisteria*	liana (woody vine)

Common Name	*Scientific Name*	Description
Japanese/Chinese	*frutescens/sinensis*	

Convert to Warm Season Grass Meadow

(1) Prepare the area for seeding by eliminating all existing vegetation. Remove any trees and shrubs manually or mechanically; use a non-selective (it will kill all vegetation) herbicide as needed (it may take multiple applications at two-week intervals) to eliminate undesirable plant species, such as invasive vines (oriental bittersweet, Japanese honeysuckle), shrubs (multiflora rose), or herbs (stiltgrass, Canada thistle) that might compete with native meadow plants. *(Note: Inappropriate use of herbicides can degrade soil and water resources and harm wildlife, particularly amphibians and aquatic animals. Only qualified applicators should use herbicides in natural areas. Training and licensing for herbicide application is provided by the Pennsylvania Department of Agriculture.)*

(2) Use only native grass and wildflower species appropriate to site conditions (See ***Native Plant Materials*** for a list of species adapted to wet and dry sites). Plant at a rate of 10 to 15 pounds (pure live seed) per acre. Add an annual grass (Canada wild-rye, Virginia wild-rye or oats) to the seed mix (at one half pound per acre) to provide a quick cover for erosion control—except when using a herbicide, such as Plateau, with pre-emergent effects (it will prevent the annual grass from sprouting). Plant in spring (preferred) prior to June 1st or fall (mid to late November). Liming and fertilization is not necessary for native species. It is usually best to initially establish grass species and add wildflowers to the meadow after a few years. This allows time to monitor the meadow and to use broadleaf herbicides (which would also kill native wildflowers) to treat any residual weeds.

(3) Mow meadow once or twice a year at a height of 4" – 6" to prevent intrusion by woody vegetation or invasive vegetation. Recommended dates are mid-July and early March. With the exception of trails, do not mow more than three times per year. Meadows should not be mowed between March 15th and July 15th, when wildlife is nesting. Maintain trails at a 6' – 8' width.

(4) The alternative to mowing is to use prescribed fire to burn the area every few years. Obviously, this should only be undertaken by persons trained in the use of prescribed fire and after notification of neighbors and public officials, particularly the local fire company. The preferred vegetation and weather conditions for using prescribed fire in southeastern Pennsylvania are typically encountered in mid March to mid April. A second window of opportunity is sometimes available in early to mid November.

(5) Monitor the meadow for intrusion by invasive plants. Spot spray as needed to prevent re-establishment of invasives. For recommendations see ***Invasive Vegetation Management***.

(6) If desired or needed, augment existing meadow species with native species appropriate to site conditions through overseeding or installation of plugs.

Meadow Management

Historically, meadows occurred as breaks in the eastern deciduous forest resulting from disturbances such as fire, periodic flooding, insect infestation, and human clearing or because of site conditions (saturated soil or unusual geology). Most meadows existed as temporary ecosystems; without repeated disturbance, succession would eventually return the area to forest. As the Native American and then European populations increased, disturbance by fire, logging and agriculture maintained a shifting mosaic of meadow communities.

Most meadows in southeastern Pennsylvania have an agricultural past (old hayfields or pasture) and are dominated by exotic "cool-season" grasses[1] such as fescue, ryegrass, bluegrass, orchard grass and timothy.[2] These grasses as so named because they grow best during spring and fall. However, the grasses native to this region are mostly "warm-season" grasses,[3] which prosper during the summer months. Examples of warm season species include little bluestem, big bluestem, Indian grass, broomsedge and switchgrass.[4] Because they are native to this region, warm-season grasses are well adapted to the soils and climate. They can thrive on marginal soils and survive periods of low rainfall due to their deep fibrous root systems, which penetrate the soil to a depth of 5 to 15 feet.

Wildlife Benefits

Warm-season grasses are prime habitat for grassland birds because they are bunch grasses, in contrast to the sod-forming growth habit of cool-season grasses. This means that they grow upright with bare ground between clumps. This characteristic provides high-quality nesting sites and materials and allows grassland birds to move through the meadow more easily and better protected from avian predators in their search for food. The open space between clumps also provides space for wildflowers to become established.

In spring, ground-nesting birds utilize the cover afforded by the grasses to brood and rear their young. Flowers attract insects, which constitutes the most important element in the diet of young birds. During the autumn months, native wildflowers and grasses

[1] Cool-season grasses possess the most common photosynthetic pathway, known as C3 photosynthesis; new leaves emerge in late winter or early spring and they generally flower and set fruit in spring or early summer.

[2] Fescues — *Festuca arundinacea, F. elatior, F. longifolia, F. ovina, F. pratensis, F. rubra;* ryegrasses — *Lolium multiflorum, L. perenne;* bluegrasses — *Poa annua, P. pratensis, P. trivialis;* orchard grass — *Dactylis glomerata;* timothy — *Phleum pratense.*

[3] Warm-season grasses possess modified leaf anatomy and an unusual photosynthetic pathway, C4 photosynthesis; their emergence is often delayed until late spring or early summer and they generally flower and set fruit in late summer or fall.

[4] Little bluestem — *Schizachyrium scoparium;* big bluestem — *Andropogon gerardii;* Indian grass — *Sorghastrum nutans;* broomsedge — *Andropogon virginicus;* switchgrass — *Panicum virgatum.*

produce highly nutritious seeds. These are relished by a variety of songbirds and will attract many migrants that stop over on their long journey south. Throughout the winter, the upright grasses provide food and cover for the resident birds to help them survive the winter months.

Populations of grassland nesting birds such as bobolink, eastern meadowlark, grasshopper sparrow, savannah sparrow, upland sandpiper and northern bobwhite have declined drastically in recent years due to the loss of habitat from development and changes in farming practices, such as earlier mowing times and the extensive planting and cultivation of cool-season grasses.

Many butterfly species have also developed close relationships with native wildflowers. As our few remaining undisturbed habitats continue to be lost to development, many native plants are becoming increasingly rare. The implications for butterflies are dire; with the loss of their host plants, some butterfly species are inching closer toward extinction. Unless native wildflowers and butterfly habitats are restored, we can expect to see further declines in overall butterfly populations and continued losses of rare and endangered species.

Establishment

To maximize the ecological benefits (and reduce maintenance costs) it is recommended that large areas of turf and cool-season grass meadows be converted to warm-season grass and wildflower meadows. This is best achieved by eliminating the cool-season grasses, which are highly competitive, inhibiting the natural spread of native grasses and wildflowers. Cool-season grasses can be eliminated either by physically removing the sod (digging small areas; plowing and disking larger sites) or treating the area with an herbicide and seeding with a no-till drill. (Herbicides should not be used within 50 feet of a stream unless it is a formulation approved for aquatic use.) Spring (before the beginning of June) and late summer or early fall are the preferred times to plant meadows. If a rapid conversion to warm-season grasses is not an option for lack of funding or equipment, the landowner can encourage a gradual change from cool- to warm-season grass dominance through the timing of management (see below).

Management

Because a meadow is typically a temporary successional stage, it must be periodically disturbed to prevent woody vegetation from becoming established. This can be accomplished either by an annual mowing or prescribed burning every few years.

The frequency and timing of mowing has a dramatic affect on the composition of a meadow and its wildlife residents. Spring is the time of year when many wildlife species utilize meadows for reproduction. Mowing between the beginning of April and late June, even though appealing to suburban aesthetic sensibilities, is the worst time to mow. It removes nesting cover, destroys nests and eggs, and kills young birds and

animals. Mowing between mid-July and late October does not leave enough of the growing season for the vegetation to renew itself and therefore provides little food and cover for wildlife until the following spring. Mowing at this time of year would be appropriate only in patches where noxious species such as Canada thistle or multiflora rose may be prevented from reproducing using this method.

There are two preferred times to mow meadows. Early July is desirable because it removes the browning stems and leaves of cool-season grasses, leaving more space for the warm-season species to grow, flower and provide habitat for the remainder of the year. This would be the best time to mow if the landowner wishes to gradually convert the meadow to warm-season grass dominance. Another good time to mow is in March. This will minimize the amount of time birds and animals lack cover. If environmental conditions such as wet soils prohibit early-spring mowing, winter mowing, when frost has hardened the ground, may be a good alternative. The most effective frequency and combination of these two mowing times will vary with different soil conditions, species composition, and other factors from site to site.

To maintain a meadow, it should be mowed either once or twice a year. Once-a-year mowing is sufficient to keep a meadow from reverting to woodland, but may not be sufficient to discourage woody seedlings, brambles, invasive vines and multiflora rose. Mowing more than twice a year will only encourage cool-season grass species. It is best to mow meadows when the ground is dry. They should be cut at a height of 6 to 8 inches during the growing season and 4 to 6 inches during the dormant season. Meadows must also be monitored for intrusion by invasive plants. Invasives in meadows may be eliminated by spot mowing, spot spraying or wick application of an appropriate herbicide, or manual or mechanical pulling.

To give the appearance that a meadow is intentional and managed, it is often beneficial to maintain a mowed turf swath around the public edges and consider incorporating a trail network. Well-maintained trails encourage people to get into the meadow and discover its beauty up close and first hand.

Another tool for managing meadows is prescribed fire. Fire was commonly used by Native Americans and early European settlers and selected fire-adapted species to dominate warm-season grass meadows. Periodic spring fires (every three years on average) will effectively discourage invasion by woody plants. Prescribed burning should be done only by well-trained personnel and in accordance with federal, state and local laws.

Trail Design and Maintenance

General Guidelines

In general, three types of guidelines should be followed in constructing new trails and maintaining existing trails: recreation enhancement, environmental protection, and public use and safety. If followed during trail layout, they will result in trail alignments that offer a more aesthetically pleasing and varied recreational experience, a more stable trail that can be maintained with less expense, and a safer and more enjoyable outdoor experience for users. In general, the more time spent during this phase of trail planning, the better the trail. Well-designed trails take advantage of natural drainage features, are low maintenance, and meet the needs of the user. The trail might meander around trees and rocks, follow natural ridges, and otherwise take advantage of natural land features. The best trails show little evidence of the work that goes into them. A little extra effort spent widely scattering cut vegetation, blending slope cuts, or raking leaves back over fillslopes pays off in a more natural-looking trail.

Recreation Enhancement

- Trails should be varied so as to enhance the user's enjoyment and visual experience.
- Trails should provide scenic views and incorporate points of interest such as historic structures or sites, wetlands, ponds or rock outcrops. Main trails should bypass these resources where possible, with only secondary trails providing access to them.
- Trails should be buffered from the sight, sound and hazards associated with manmade features, including roadways, buildings, and developed land uses.
- The trail designer should make creative use of vegetation to enhance the hiking experience.
- Trails should blend into the natural surroundings by maintaining continuity and regularity in the way they traverse the land.
- The trail designer should look for varying vegetative cover, avoiding alignments through continuous stands of similar vegetation.
- Trails should not have long straight sections which are unbroken by vegetation or topography. Short trail sections with many broad turns are desirable.
- Sudden changes in direction or too much meandering should be avoided.
- Planting showy native plants and butterfly/hummingbird-attracting plants in a naturalistic style in key areas along trails can greatly improve user enjoyment.

- Locating resting areas (benches, etc.) near features such as streams and ponds will allow users opportunities to enjoy the sights and sounds of the resources on the property.

Environmental Protection

- Every attempt should be made to position trails outside of environmentally sensitive areas, but with careful planning, a trail may incorporate special features of the landscape into its design without adverse environmental impact.

- When locating a trail, primary emphasis should be placed upon characteristics of soils and topography which control trail stability.

- Trails should fit the land by following the contour of the landscape.

- Trails should not go straight up steep grades.

- Areas having slopes in excess of 20% should be avoided, unless those areas are to be paved or otherwise stabilized.

- Soils which are deep, well drained, resistant to erosion, and do not have high seasonal water tables are most suitable for trail development.

- Where trails follow steep grades, sidehilling should be used to reduce grades and erosion, as well as to improve surface drainage.

- Switchbacks should be used when going up steep gradients where sidehilling cannot gain elevation fast enough.

- Switchbacks should not be visible from one another.

- Wide turns should be used in switchbacks to limit shortcutting, particularly where the trail is in an open hardwood forest where users can see ahead.

- Trail layout should provide for low impact on sensitive resources, such as wetlands. If highlighting these areas, special precautions should be taken to reduce the impact of hikers through the use of bridges and elevated walkways.

- Side trails leading to fragile resource areas should generally be longer and more difficult so as to discourage the majority of main trail users from using them.

Public Use and Safety

- Where there are road crossings, the hiker's exposure should be minimized by crossing in the shortest practical manner, usually at right angles, with adequate sight

distances.

- Trails should not parallel road rights-of-way.
- Trails should avoid areas of streams and ponds with steep banks, deep water, or other potential hazards to children.
- Where trails are in the vicinity of developed land uses, they should have as wide a buffer as possible, and as long sight lines as possible, so as to keep potential conflicts with adjacent landowners to a minimum.

Trail Construction

Constructing good, easily maintained trails and their associated structures is somewhat complicated. The basic concepts are described below, but please refer to the following manuals for more detailed information.

> *Complete Guide to Trail Building and Maintenance*, Carl Demrow and David Salisbury, Appalachian Mountain Club, 1998
>
> *Design, Construction, and Maintenance*, William Birchard, Jr., Robert D. Proudman, and the Regional Staff of the Appalachian Trail Conservancy, Appalachian Trail Conference, 2000
>
> *Trail Construction and Maintenance Notebook*, U.S. Department of Agriculture, Forest Service, 2000

Trail Clearing

When rerouting an old trail or establishing a new trail, the general alignment should be walked and flagged to determine exactly how the treadway should wind and dip, which rocks should be removed and which trees might need to be cut. This is a critical step in the trail building process, as slight shifts in the alignment can significantly affect drainage and treadway durability.

After the precise location of the trail is determined, the treadway should be cleared. For hiking trails, a 2' treadway should be cleared with all projecting limbs cleared an additional 1' for a total horizontal width of 4'. For equestrian trails, a 3' treadway should be cleared with all projecting limbs cleared an additional 2.5' for a total horizontal width of 8'. The trail should be cleared to a vertical height of 8' for a hiking trail and 10' for an equestrian trail. See ***Trail Clearing Dimensions***.

In clearing trails all shrubs, vines, low-hanging branches, blowdowns, small trees, and fallen logs should be removed. Shrubs and small trees should be cut flush with the ground surface. Care should be taken not to disturb the ground surface or to pull plants

out by the roots as this will lead to erosion of the treadway. See ***Trail Vegetation Removal***. Large trees fallen across the trail should be left in place by making two cuts and removing a 4' wide section from the trunk across the trail. See ***Blowdowns***. If motorbikes or mountain bikes are a problem, the logs can be notched to provide a flat surface for hikers, yet prohibit the passage of wheeled vehicles.

When clearing is completed, cuttings should in general be scattered in areas adjacent to the trail and left to decompose. It may be necessary to collect the cuttings and remove them from the immediate trail area where the trail runs through more formally landscaped areas such as along public roads and through developments.

In the first year of a trail, repeated clearing will be required to deter continued vegetation growth. In subsequent years, clearing will probably be necessary only two or three times a year. The exception would be in the areas of open fields and grassy areas where mowing will be required to maintain a clearly visible treadway.

Treadway Stabilization

The type of tread surface on trails will ultimately be determined by the rate of use and the terrain through which the trails pass. Initially, once a trail has been cleared, it should be surveyed to ascertain where special measures should be taken to stabilize the treadway. These special measures will primarily include treadway hardening and erosion control measures. Most problems are likely to occur where a trail traverses steep slopes and wet areas, or where surface water drainage flows across the trail during storms.

In most areas there will be no need for actual trail construction, as careful trail design should have selected stabilized areas. In existing stable areas with slopes of less than 10%, the exact alignment of the treadway can be located by sweeping herbaceous and trailing plants and leaf litter off the path. If with time and use initially stable areas begin to show signs of wear and erosion, then some stabilizing type of material, such as crushed stone, should be placed on the treadway.

Trails on Slopes

Where a trail cuts across a slope greater than 10%, a slightly outsloped, or "sidehill," treadway should be excavated into the side of the hill to prevent trail widening and erosion. Depending on the slope of the hill, the amount of excavation and the use of the excavated material varies. See ***Typical Trail Cross Sections***. On steeper slopes, soil excavated from the hill is not used at all in the fillslope. This soft material is likely to erode away quickly, creating dangerous soft spots on the downhill edge of the trail. As the slope of the hill decreases, it becomes more feasible to use fill material as part of the treadway.

Switchbacks and climbing turns are used on steep slopes where sidehill trails alone

cannot provide the needed rise in elevation in a limited distance. A climbing turn is a reversal in direction that maintains the existing grade going through the turn without a constructed landing. A switchback is also a reversal in direction, but has a relatively level constructed landing. See ***Switchbacks and Climbing Turns***. Switchbacks usually involve special treatment of the approaches, barriers, and drainages. Long sections of trail between these turns are usually better than short ones; fewer will need to be built and there will be less of a temptation to shortcut them. Both switchbacks and climbing turns take skill to locate and are relatively expensive to construct and maintain, therefore, every effort should be made to minimize their use when designing a trail.

Surface Water Control

Diverting surface water off the trail is one of the first priorities in designing and maintaining trails. Running water erodes the treadway and support structures and can even lead to loss of the trail itself. The first choice to address surface water is to enhance the natural drainage by outsloping the treadway and creating grade dips such as Coweeta dips, bleeders, and/or drainage dips. The aim is to take advantage of the natural topography wherever possible, making sure the water won't return to the treadway. Coweeta dips use a reversal in grade on sidehill trails to shed water; bleeders are a shallow graded depression across the treadway; and drainage dips, appropriate only on grades less than 8%, are channels reinforced with earthen mounds running diagonally across the treadway.

Waterbars are the second most common drainage structure after outsloping. They are diagonal rock or log barriers that divert water off the treadway. See ***Log or Treated Timber Waterbar and Anchors***. While they have been standard practice in the past, they are less encouraged than using some form of a grade dip. By design, water hits the waterbar and is turned. The water slows down and sediment drops in the drain. The number one cause of waterbar failure is sediment filling the drain until the water tops the bar and continues down the trail. The waterbar becomes useless. A good grade dip can be built quicker, it works better, requires less maintenance, and it is less obtrusive on the landscape.

Waterbars are useful on trails where there isn't much soil to work with, in areas that experience torrential downpours, and where a tripping hazard is acceptable. They may also be necessary when repairing older trails where no provision was made during design or construction for proper drainage. Waterbars are not only an erosion control technique, but can be used preventively, such as at the top of downgrades and where water is entering a trail.

To correctly install a waterbar, it must be constructed of rock or a rot-resistant type of wood. Logs should be a minimum diameter of 6"–8" at the small end, greater if water flow is heavy, and all bark must be removed. It should be placed at a 30°–45° angle and extend at least 1' past the outside edge of the treadway on both sides. If natural topography doesn't ensure that water will not return to the trail, it is essential that an

outlet trench be extended beyond the end of the rocks or log. Where water flow is heavy or the bar directs water down a steep slope, runoff may erode the soil adjacent to the treadway. Where this is a problem, rocks should be placed in the channel to slow the water and make it drop its sediment.

Drainage ditches are trenches along the side of a trail to collect water seeping from a hillside or runoff entering a trail that can't be immediately removed with a grade dip. The water can then be diverted across the treadway at appropriate points with a dip or water bar.

Trails in Wet Areas

Trails should be designed to avoid wet areas, but where this is impossible or an existing trail has developed a drainage problem, several options exist. Because nearly every technique for fixing trails in wet areas is expensive and needs to be repeated periodically, relocating the problem section of trail should be considered first.

Using stepping stones is a simple and relatively inexpensive technique for crossing small drainage swales and muddy areas. See ***Stepping Stones***. The stones should be large, fairly flat on top, and buried such that they rise above standing water, but don't rock. Space the stones for the average stride, remembering that trails are for children, too.

Turnpikes are used to elevate the trail above wet ground. The technique uses fill material from parallel side ditches and from offsite, if necessary, to build up the treadway higher than the surrounding water table. See ***Turnpike***. The most important consideration is to lower the water level below the treadway base and carry the water under and away from the trail at frequent intervals. Turnpike construction is used to provide a stable trail base in areas of high water table and fair to well drained soils. They are practical up to 10% grades.

A puncheon, or bog bridge, is a wooden walkway used to cross muddy areas. See ***Puncheon***. It can be used where lack of tread material makes turnpike construction impractical or firm mineral soil cannot be easily reached; puncheons can be supported on muddy surfaces better than turnpikes, which require good drainage. They consist of decking made from flat-topped logs, called stringers, notched into base logs, or mud sills, set into firm ground. If firm footing is not available, use rock and fill to solidify the bottom of the trench they're set in, increase the length of the sill to give it better flotation, or use more sills for the needed flotation.

Crossing Drainage Swales, Streams and Wetlands

For minor crossings of small streams and drainage swales, there is no need for construction of elaborate bridges. Natural stream crossings using stepping stones are ideal in this setting where the stream flow is generally low and there are not significant

fluctuations in flow, except following major storm events. The stepping stones should be large and flat-topped. They should be placed approximately 2' apart across the stream. Ideally, the bottom on which the stones are laid should be stone in order to prevent movement. See ***Stepping Stones***.

Any new stream crossing that involves a structure will require a permit from the Pennsylvania Department of Environmental Protection, Bureau of Dam Safety, Obstruction, and Stormwater Management.

Boardwalks are elevated post and decking structures that provide access to marsh and wetland ecosystems with minimal negative impacts. Boardwalks are usually constructed of wood and the foundation is usually a pier or wood post. If touching the ground or submerged in water, the posts most often are chemically treated with an oil-based or water-borne wood preservative such as creosote, pentachlorophenol, chromated copper arsenate, or zinc chloride. Most of these wood preservatives are toxic to the natural environment and can be harmful to human health. They do, however, add the necessary longevity and structural safety. Two alternatives are posts made from recycled plastics that do not release harmful chemicals into the ground or water system and galvanized steel helical piers and anchors. The recycled plastic post is either mechanically driven to the depth of firm soil or bedrock or secured in a concrete footing set in an excavated hole. The helical piers and anchors screw into the ground quickly, much the same as a wood screw goes into a piece of wood. Railings are an optional consideration for boardwalks that meander through wetland habitat. When the height of the decking above the ground exceeds 30", rails are recommended.

Again, permits may be required for a boardwalk. The U.S. Army Corps of Engineers (Philadelphia District, 215-656-6729) requires a permit for any discharge of fill within wetlands.

Abandoning Trails

When it becomes necessary to abandon a trail, it should be done effectively and with sensitivity. Naturalizing abandoned trails requires as much attention and planning as constructing new trail. The goal is to reduce the impact human trails have on the landscape. Simple restoration may consist of blocking new shortcuts and allowing the vegetation to recover. Complex restoration projects include obliterating the trail, recontouring, and revegetating the treadway with appropriate plant species. Careful monitoring and follow-up are necessary to ensure that eventually almost all evidence of the trail is gone.

Each abandoned trail should be closed. If the trail is not blocked to prevent further use, the trail may persist indefinitely. Closure is particularly important if stabilization and revegetation are being attempted. The abandoned treadway should be blocked to all

traffic, recontoured, and disguised to prevent users from being tempted to take it. This work should be accomplished for all segments visible from trails that remain open.

If the section of trail to be abandoned is short, it is simplest to just pile brush along its entire length. If it is long, brush should be placed far enough along from its entrance to obscure the path. Extending the brush a few feet on either side of the entrance will help deter users from going around the blockage. If there are any areas of active erosion, these should be stabilized to restore the natural contour and drainage patterns. Revegetation can be accomplished passively or actively. Passive revegetation allows surrounding vegetation to colonize the abandoned trail. This works when erosion has been stopped, adequate precipitation occurs, and adjacent vegetation spreads and grows rapidly. Active revegetation ranges from transplanting onsite vegetation to planting appropriate seeds or propagated plants. Successful revegetation almost never happens in a single season.

Trailheads and Parking Facilities

Determine where trailhead and parking should be located, taking into consideration safe vehicular access, site conditions suitable for construction of a parking area, proximity of neighbors, and ease of policing. Try to avoid locating parking facilities and trailheads in areas where the trail would deteriorate under heavy use Before you finalize the site location, you should contact "PA One Call" to determine if there are any underground utility lines near the site.

The most critical element in the design process is accurately projecting the number of parking spaces which should be constructed at a trailhead. Parking should be provided for the average high day of trail use. This would be a typical weekend day in the spring or fall. Do not attempt to design for a peak day.

The second most important step in the design process is the development of standard construction specifications for trailheads and parking areas. Functional, aesthetic, and maintenance considerations are important to establishing these specifications. The trailhead areas should be simple, well built to minimize maintenance needs, and attractive, blending in with the natural setting as much as possible, with minimum grading and vegetation disturbance. The entrance drive and parking areas should be properly constructed with crushed stone laid over a base suitable for soil and drainage conditions on the site. Asphalt paving should not be used except to stabilize entrance areas, or where it is needed due to site conditions or excessive use. Along the perimeter of the parking areas and where there has been clearing for construction, native plant species should be planted to restore the area after construction. Place a signboard or kiosk to provide users with rules and regulations, management information, maps, and other important information (see below).

Trail Signage

Trail signage is used to guide trail use and to provide information about features along the trail. Trailhead signage or kiosks provide basic information (e.g., name of property), orient visitors to trail rules and regulations, such as the uses allowed on the trails and the times when the trails are open or closed, and present information about the property and the organization that owns and manages it. This is also an excellent location for distributing trail maps.

Along the trail, signage can be used to highlight natural features (e.g., large tree, unique geology), historical uses (e.g., old stone walls) of the property, or to illustrate the complex interactions in natural ecosystems. They are also a good way to inform visitors of ongoing restoration activities—such as riparian buffer plantings—and how it will improve the conservation value of the property. Although there are endless amounts of information that can be communicated on any property, interpretive signage should be: (1) limited in number and (2) concise (if possible, include illustrations or photos to more clearly make the intended point).

Other appropriate types of signage for trails are signs to indicate the distance to other locations, points of interest, or improvements (e.g. office, shelters) and signs that show when you are leaving the property.

Trail signage should be constructed of materials that are in harmony with the natural environment and are sufficiently rot-resistant. Options include wood (black locust, white oak for posts; cedar for the sign), recycled plastic, metal, fiberglass embedded, laminated, or for temporary signs, paper. Wood signs should be 0.75 to 1.5 inches in thickness with wording created by a router or sandblaster. The sign should either be left unpainted or painted with two contracting colors.

If possible, the signs should be installed on 4" by 4" posts with zinc-plated, galvanized, or stainless steel hardware. To make it easier to read the sign, the top end of the post should be cut at a 45 degree angle; to prevent it from walking away, attached a cross-piece (wood, rebar, spikes) to the bottom of the post before backfilling the hole. Locate the sign carefully, keeping it off the pathway, but close enough that visitors notice it. Signs located near roads (particularly those in the right-of-way) may require a permit or be subject to size limitations. You should check with the municipality (if a township road) or PennDOT (if a state road) to determine any restrictions.

If a sign is destroyed or removed by vandals, temporary signs made of laminated paper or paperboard can be used where critical information needs to be conveyed. These types of signs are also appropriate in cases where there is a temporary hazard or obstacle on the trail (e.g., a fallen tree, trail erosion).

Trail Marking

Trail markers include cut or painted blazes on trees; wood, plastic, or metal marker tags; and marker posts. These markers are used to help travelers identify the trail corridor

when the treadway is indistinct, the ground is covered with snow, or when the path is confused by multiple trails or obscured by weather such as dense fog. They should be used only when the trail is not obvious, there is a sudden change in direction, and at trail junctions.

As with signage, standards should be developed for marking a trail system. This includes color, placement, frequency, and form of the markers. A common system is to use a primary color for each major trail and to have a standard color for all secondary trails. This enables users to know when they have diverged from a main trail whenever they see that color, regardless of which of the major trails they may be following. Colors considered most visible by experienced trail builders include blue, red, yellow, white and, orange. Keep in mind the use of the trail when selecting a color—white might not be a good choice for a trail used in the winter.

Markers should be placed carefully. They should be as close to the trail alignment as possible and plainly visible when walking the trail in all seasons, preferably without the need for routine clearing of foliage. Eye level is generally considered most effective, slightly higher if the trail is used in winter. Large trees should be used in preference to smaller ones and never use a dead tree. If markers are light-colored, dark trees should be used, and vice-versa. Markers should not be placed on trees or features that are important elements of a view or setting; they should be visible but not mar the visual character of the trail.

The frequency of marker placement is a balance between reassuring, not confusing, the user and maintaining the natural character of the trail. If part of a trail has markers, all of it should be marked, but abrupt changes in spacing should be avoided, as they are confusing to users. Be conservative. It's better to improve tread visibility than to rely on markers.

The marking decisions should be based on traffic traveling in both directions. Where a trail has a clearly defined treadway, markers should be placed only at points of possible uncertainty. Markers should be clearly visible from any point where the trail could be lost. When a trail turns into or off another trail or road, a double mark should be placed, one directly above the other. Then, after the change in direction, another marker should be placed so that it can be clearly seen from the turning point. Markers should also be placed immediately after road crossings in a location where it will not be affected by street maintenance or snow clearing activities and where it will not be vulnerable to vandalism.

Hazard Tree Monitoring Program

All landowners are required to make a reasonable effort (real or pretended ignorance does not diminish your liability) to prevent trees within their property from causing injury or property damage. This is best accomplished through a regular program of monitoring areas of high use such as public roads, adjacent properties with structures,

and sites used for recreational (e.g., play areas, benches, boardwalk, bird blind, sleeping platforms or cabins) or educational (e.g., pavilion, bleachers) activities. These areas should be monitored at least once each year and after major storm events. Ideally, the landowner should hire a certified arborist to perform the inspection. Private landowners who cannot afford an arborist or who wish to augment this annual inspection with their own ongoing monitoring can attend workshops on hazard trees. Morris Arboretum (see Resources for contact information) holds workshops on hazard trees on a regular basis. Public landowners could also consider training one or more staff in the identification of hazard trees to reduce monitoring costs.

Of course, once a hazard tree is identified the landowner should make a reasonable effort to address the hazard. The first course of action is to make sure that the tree is within your property boundary. Along public roads, trees (for this purpose it is the base of the tree that matters) within the public right-of-way are usually the responsibility of the municipality or state. Contact your municipality to determine the width of the right of way along your property. If the tree is completely within the right-of-way, notify the municipality or state of the hazard tree. Although it may be technically their responsibility (tree law is still evolving), often municipalities will not address the hazard tree due to lack of resources or other priorities. In this case you will need to weigh the cost of removing the tree against the possibility of being sued, along with the municipality, if injury or damage occurs. If the tree is outside the right-of-way the landowner should engage a qualified contractor to eliminate the hazard through pruning or felling the tree.

For trees along a common boundary, if any part of the base is within your property you are jointly responsible for the trees; a tree with its base entirely within your property is, of course, your sole responsibility.

Often, when a landowner initiates a hazard tree program, a large number of trees are identified as hazards. This reflects the aging of the forested resources in our area and the fact that few landowners are aware of their responsibility and as a result have not addressed hazard trees in the past. Unless your resources are unlimited, you or your contractor will need to prioritize your actions in addressing the hazard trees, removing the most hazardous trees first.

Regular monitoring followed by reasonable action will not only prevent potential injury or damage, it will help to significantly reduce the landowners liability if a tree does cause injury or damage. Although the landowner will be responsible for any injury or damage regardless of the actions taken, showing that you have made a reasonable effort to identify and address hazard trees will help eliminate charges of negligence.

The final key to an effective hazard tree program is documentation. All activities related to the program should be cataloged including monitoring (when, where, and by whom) and actions taken and by whom. Again, this will be the proof that the landowner made a reasonable effort to identify and address hazard trees in the unfortunate occurrence of

injury or damage.

Below is the hazard tree program used by Natural Lands Trust on its 45-property preserve system in southeastern Pennsylvania and southern New Jersey.

NATURAL LANDS TRUST'S HAZARD TREE PROGRAM

Policy: The Natural Lands Trust will make a reasonable effort to minimize the potential for injury and property damage associated with hazard trees on the properties it owns and manages. It is our understanding that as a landowner we are responsible for the maintenance of trees outside the public right of way. The Trust will strive to eliminate, in a timely fashion, any tree deemed hazardous. Because the Trust has extensive land holdings and limited fiscal and staff resources, each year we will address the most hazardous trees to the limit of our dedicated resources.

Implementation: All NLT properties will be inspected on a periodic basis using standardized criteria for identifying hazard trees. The standard for rating the potential risk of a tree will be the hazard evaluation system use by the National Park Service. The Trust's Arborist will administer this program and have final judgment concerning the mitigation measures to be taken to address any tree identified as a hazard. All trees identified as a hazard will be treated (monitored, pruned, removed) according to the degree of hazard and their value to the Trust and the local community. The degree of hazard is a function of the likelihood of tree failure and the presence of people or built resources (targets) near each tree. Trees along trails will be evaluated according to different criteria than trees along public roads and other high target areas (including next to trail structures). Because of the Trust's desire to provide wildlife habitat and the relatively low frequency of use of the trails, only those trees which have failed and are either obstructing the trail or hanging over the trail will be removed, if reasonably possible.

Type of Area	Implementation Strategy
Public road borders	Monitor on foot every 12 months (1st quarter of each year) Monitor by vehicle after major storms * Remove hazard trees

Property borders adjacent to structures and lawns NLT estate and programmatic areas Internal roads, parking lots, and trails to buildings	Monitor on foot every 12 months (1st quarter of each year) Monitor after major storms * Remove hazard trees
Trails and trail structures (bridges, benches, signage)	Monitor as part of trail inspection program Monitor after major storms * Remove hazard trees

** Because storm events can be very localized, the preserve manager will need to make a reasonable determination of the need for hazardous tree assessment on a preserve by preserve basis. For the purpose of this policy, a "major storm" is one that results in downed trees or large (> 4" diameter) limbs in the surrounding area.*

Documentation: For each tree that shows some degree of hazard the monitor will complete a hazard tree form that catalogs its size, location, current condition, degree of hazard, and recommended course of action. The completed forms for each property will be sent to the Trust's Arborist who will coordinate the appropriate action (further review by Trust arborist, monitoring, pruning, or removal) for each tree. A sheet will be completed for each preserve that summarizes all related activities. A master summary of all hazard tree activities on Trust preserves will be completed each year by the Trust's Arborist.

Native Plant Species

Large trees

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Acer rubrum	red maple	Piedmont Coastal Plain	Height: 40'–60', Spread: same Habit is pyramidal in youth and rounded with age. Tolerant of most soils, but prefers slightly acid, moist conditions. Naturally occurs in wet area. Excellent fall color.	Buds, flowers, and leaves provide food for many birds and mammals. Chipmunks and squirrels eat seeds and some songbirds use twigs for nest building.
Acer saccharinum	silver maple	Piedmont Coastal Plain	Height: 50'–70', Spread: 40'–50' Has strong spreading branches which form a rounded crown. Tolerant of many soil types. One of the best trees for poor soils and wet conditions. Use of this tree should be limited to areas free of buildings and heavy human use as it is prone to internal decay and subsequent loss of branches. Provides fast shade.	See red maple.

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Acer saccharum	sugar maple	Piedmont Coastal Plain	Height: 60'–70', Spread: 40'–50' Upright oval to rounded habit. Prefers moist, well drained soils. Tolerates some shade.	See red maple.
Betula nigra	river birch	Piedmont Coastal Plain	Height: 40'–70', Spread: 40'–60' Pyramidal in youth and rounded with age. Often grown multistemmed. Best adapted to moist soils. Used in areas that are alternately wet and dry.	Catkins are used by redpolls and pine siskins. Foliage is used by browsers.
Betula lenta	sweet birch	Piedmont Coastal Plain	Height: 40'–55'+, Spread: 35'–45' Pyramidal in youth, forming an irregular, rounded, sometimes wide-spreading crown at maturity. Best development in deep, rich, moist, slightly acid soils, however, is often found on rocky, drier sites. Flowers are catkins, 2"–3" long. Yellow leaves in fall are best among birches.	See river birch.
Carya ovata	shagbark hickory	Piedmont Coastal Plain	Height: 60'–80', Spread: 40'–60' Straight trunk with an oblong crown. Bark breaks up in thin plates. Difficult to transplant, start as seedling. Good for woodland border.	Leaves are used by browsers. Nuts are also consumed by deer, turkey, foxes, wood ducks, and squirrels.

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Celtis occidentalis	common hackberry	Piedmont Coastal Plain	Height: 40'–60', Spread: same In youth weakly pyramidal; in old age the crown is a broad top of ascending-arching branches. Medium to fast growth. Prefers rich, moist soils, but grows in dry, heavy, or sandy, rocky soils; withstands acid or alkaline conditions; moderately wet or very dry areas; tolerates wind; full sun. Fruit is fleshy, orange to dark purple, ripening in September to October. Leaves are yellow to yellow-green in fall. Useful tree for adverse growing conditions.	Fruit is popular with winter birds, especially cedar waxwing, mockingbird, and robin.
Fagus grandifolia	American beech	Piedmont Coastal Plain	Height: 50'–70'+, Spread: same Often has short trunk with wide-spreading crown. Likes moist, well drained soils. Does best in full sun, but tolerates shade.	Beechnuts are eaten by birds and mammals and are important food for chipmunks and squirrels.
Fraxinus americana	white ash	Piedmont Coastal Plain	Height: 50'–80', Spread: same Pyramidal in youth and later developing an open rounded crown. Grows best on deep, well drained soils and full sun.	Moderate importance to wildlife. Seeds eaten by wood ducks, finches, and cardinals.

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Fraxinus pennsylvanica	red ash	Piedmont Coastal Plain	Height: 50'–60'+, Spread: 25'–30' Pyramidal in youth, developing upright, spreading habit at maturity. Grows quickly in full sun and in a wide range of soil conditions. Naturally found on moist bottomlands	See white ash.
Gleditsia triacanthos	common honeylocust	Piedmont Coastal Plain	Height: 30'–70', Spread: same Usually has short trunk with open, oval crown. Fast grower. Withstands a wide range of conditions but prefers rich, moist bottomlands.	Limited wildlife value.
Juglans nigra	black walnut	Piedmont Coastal Plain	Height: 50'–75', Spread; same Well-formed trunk with an oval crown. Prefers rich, moist soils. Often found on bottomlands. Difficult to transplant; should be started as seedling. Produces toxins which are poisonous to many plants giving it an advantage in open field situations but creating problems for gardeners.	Nuts are eaten by woodpeckers, foxes, and squirrels.

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Juniperus virginiana	eastern redcedar	Piedmont Coastal Plain	Height: 40'–50', Spread: 8'–20' Densely pyramidal when young and slightly pendulous in old age. Medium rate of growth. Tolerant of adverse conditions. Prefers deep, moist soils. Will tolerate shade only in youth. Handsome reddish brown bark. Produces small cones. Useful for windbreaks, shelter belts, hedges.	Twigs and foliage eaten by browsers. Seeds are eaten most extensively by cedar waxwings. Evergreen foliage provides nesting and roosting cover for sparrows, robins, mockingbirds, juncos, and warblers.
Liquidambar styraciflua	American sweetgum	Coastal Plain	Height: 60'–75'+, Spread: 40'–50' Pyramidal in youth, rounded crown at maturity. Likes deep, moist, acid soils. Occurs naturally on bottomlands.	Goldfinches and purple finches eat winged seeds.
Liriodendron tulipifera	tuliptree	Piedmont Coastal Plain	Height: 70'–90', Spread: 30'–50' Long, straight trunk with a narrow canopy. Fast grower. Plant in full sun and a well drained loam. Wood somewhat weak.	Moderate wildlife importance. The purple finch and cardinal are principal users.
Nyssa sylvatica	black gum	Piedmont Coastal Plain	Height: 30'–50', Spread: 20'–30' Pyramidal in youth and irregularly crowned at maturity. Prefers moist, well drained, acid soils. Full sun or semi-shade. Deep taproot.	Fruit is relished by many songbirds. Users include wood ducks, robins, woodpeckers, thrashers, flickers, and mockingbirds.

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Pinus strobus	eastern white pine	Piedmont Coastal Plain	Height: 50'–80'+, Spread: 20'–40'+ Pyramidal in youth, crown at maturity has several horizontal and ascending branches. Fast grower. Grows best on fertile, well drained soils but is very adaptable.	Provides valuable cover and nesting sites for songbirds and mammals. Needles are used as nesting material. Seeds are eaten by quail, chickadees, grosbeaks, nuthatches, and woodpeckers.
Quercus alba	white oak	Piedmont Coastal Plain	Height: 100', Spread: 50'–80' Pyramidal in youth, becoming broad and rounded with wide spreading branches. Transplant as small tree. Prefers moist, well drained soils. Difficult to obtain from nurseries. Sometimes available as seedling.	Oaks, in general, are of major importance to wildlife. Acorns are at the top of the food preference list for wood ducks, pheasants, grackles, jays, nuthatches, thrushes, woodpeckers, rabbits, foxes, squirrels, and deer.
Quercus palustris	pin oak	Piedmont Coastal Plain	Height: 60'–70', Spread: 25'–40' Strongly pyramidal with ascending branches. One of the faster growing oaks. Full sun. Tolerates wet soils but is adaptable to many soil types.	See white oak.
Quercus rubra	red oak	Piedmont Coastal Plain	Height: 60'–75'+, Spread: 40'–50' Habit is round-topped and symmetrical. Full sun. Prefers loamy, well drained soils. Fast growing.	See white oak.

Scientific Name	Common Name	Physiographic Region	Description	Wildlife Users
Tilia americana	American linden	Piedmont Coastal Plain	Height: 60'–80', Spread: 35'–50' Pyramidal in youth, assuming a rounded shape with age. Full sun or part shade. Prefers deep, moist soils, but is tolerant of heavier soils.	Limited wildlife value.
Tsuga canadensis	eastern hemlock	Piedmont Coastal Plain	Height: 40'–70', Spread: 25'–35' Pyramidal in youth becoming more pendulous with age. Likes moist, well drained soils. Plant in sheltered area. Tolerates shade. Relatively fast growing. Excellent for screens, hedges.	Provides excellent cover for deer and songbirds. Nesting site for several warblers. Seeds are eaten by juncos, chickadees, and siskins.

Small trees

Scientific Name	Common Name	Physiographic Region	Description	Wildlife Users
Cercis canadensis	eastern redbud	Piedmont	Height: 20'–30', Spread: 25'–35' Small tree with rounded crown. Likes moist, well drained soils. Full sun to light shade.	Limited wildlife value.

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Chionanthus virginicus	white fringetree	Coastal Plain	Height: 12'–20', Spread: same Open habit, often wider than high. Prefers moist, fertile soils and full sun.	Limited wildlife value.
Cornus florida	flowering dogwood	Piedmont Coastal Plain	Height: 20', Spread: 15'–20' Small tree with flat-topped crown. Place in well drained soil. Full sun to partial shade. Has character in all four seasons.	Fruit is an important source for songbirds including evening grosbeak, cardinals, robins and cedar waxwings.
Crataegus phaenopyrum	Washington hawthorn	Piedmont Coastal Plain	Height: 25'–30', Spread: 20'–25' Broadly rounded to oval, dense, thorny tree. Plant in well drained soil in full sun.	Dense thorns make excellent nesting sites for songbirds. Fruit is used by grouse, cedar waxwings, and sparrows.
Ilex opaca	American holly	Piedmont Coastal Plain	Height: 15'–30', Spread: 18'–25' Dense, pyramidal in youth, opening up with age. Plant in moist, well drained soil. Full sun or partial shade. Use one male for every three females.	Used extensively by many songbirds including thrushes, mockingbirds, catbirds, bluebirds, and thrashers. Foliage provides cover for songbirds and mammals.

Shrubs

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Amelanchier canadensis	shadbush or shadblow serviceberry	Piedmont Coastal Plain	Height: 6'–20', Spread: 10' Erect stems, often clumped. Blends well on the forest edge.	Important berry producer during the early summer months. Fruit eaten by crows, bluebirds, cardinals, and tanagers. Foliage used by browsers.
Aronia arbutifolia	red chokeberry	Piedmont Coastal Plain	Height: 6'–10', Spread: 3'–5' Upright multi-stemmed shrub, somewhat open and rounded. Adaptable to many soil types. Full sun to half shade.	Fruit eaten by grouse, chickadees, and other songbirds.
Aronia melanocarpa	black chokeberry	Piedmont Coastal Plain	See red chokeberry.	See red chokeberry.
Clethra alnifolia	summersweet clethra	Coastal Plain	Height: 3'–8', Spread: 4'–6' Oval, round-topped, erect, dense, leafy shrub. Transplant into moist organic soils. Full sun or shade. Good plant for wet areas and heavy shade.	Limited wildlife value.
Cornus racemosa	silky dogwood	Piedmont Coastal Plain	Height: 10'–15', Spread: 10' –15' Erect, multi-stemmed shrub with short spreading branches. Suckers profusely and forms large colonies. Very adaptable, withstanding wet or dry soils, but prefers moist, well drained conditions. Full sun or shade.	High wildlife value for fruit and browse. Used by a wide variety of mammals and songbirds, including cardinals, evening grosbeaks, robins, thrush, vireos, and cedar waxwings.

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Hamamelis virginiana	common witchhazel	Piedmont Coastal Plain	Height: 20'–30', Spread: 20'–25' Small tree or multi-stemmed shrub. Prefers moist soils in full sun or partial shade.	Limited wildlife value.
Ilex glabra	inkberry	Coastal Plain	Height: 6'–8', Spread 8'–10' Upright, multi-branched, rounded shrub. Prefers moist, acid soils.	Berries used by a wide variety of wildlife.
Ilex verticillata	winterberry	Piedmont Coastal Plain	Height: 6'–10', Spread: same Oval, rounded, deciduous shrub holly. Tends to form multi-stemmed clumps. Does well in light and heavy soils. Prefers moist, organic soils. Red fruit is beautiful in winter. A male plant is necessary for fertilization.	Used extensively by many songbirds, particularly thrushes, mockingbirds, robins, bluebirds, and thrashers.
Itea virginica	Virginia sweetspire	Coastal Plain	Height: 3'–5', Spread: 6'–8' Erect shrub with clustered branches. Prefers moist, fertile soils. Full sun or shade. Suited for wet areas. Excellent fall color.	Fruit capsules are used by some songbirds.
Kalmia latifolia	mountain laurel	Piedmont Coastal Plain	Height: 7'–15', Spread: same Large, robust shrub, becomes open with age. Requires moist, well drained soils in full sun or shade.	Mammals eat foliage and twigs. Utilized extensively by mammals and birds for winter shelter.

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Magnolia virginiana	sweetbay magnolia	Coastal Plain	Height: 10'–20', Spread: same Multi-stemmed, open shrub. Likes wet, acid soils. Tolerates shade.	Wildlife value is low. Seeds are eaten by some mammals and birds. Foliage is used by several birds for nest building.
Myrica pensylvanica	northern bayberry	Coastal Plain	Height: 5'–12', Spread: same Tends to sucker to form large colonies. Deciduous to semi-evergreen. Upright, rounded, dense shrub. Adaptable to many soil conditions, including poor soils. Full sun to partial shade.	Fruit is eaten by a variety of birds in small quantities including tree swallows and myrtle warblers.
Rhododendron maximum	rosebay rhododendron	Piedmont Coastal Plain	Height: 4'–10', Spread: same Rounded, evergreen shrub. Plant in moist, well drained soil. Prefers partial shade.	Limited wildlife value except as browse for deer and winter cover for songbirds.
Rhododendron periclymenoides	pinxter-flower	Piedmont Coastal Plain	Height: 4'–6', Spread: 6'–8' Multi-stemmed, stoloniferous shrub. Adapted to dry, sandy, rocky soils. Useful for naturalizing.	Limited wildlife value except as browse for deer and grouse
Vaccinium corymbosum	highbush blueberry	Piedmont Coastal Plain	Height: 6'–12', Spread: 8'–12' Upright, multi-stemmed shrub with spreading branches. Requires moist, well drained soils. Full sun or light shade.	Used heavily by grouse, scarlet tanager, bluebirds, thrushes, and other songbirds.

Scientific Name	**Common Name**	**Physiographic Region**	**Description**	**Wildlife Users**
Viburnum dentatum	southern arrow-wood	Piedmont Coastal Plain	Height: 6'–8', Spread: 6'–15' Multi-stemmed, dense, rounded shrub. Adaptable to most soil conditions, but prefers well drained. Suckers freely.	Used by grouse, brown thrasher, cedar waxwing, squirrels, and deer.
Viburnum lentago	nannyberry	Piedmont Coastal Plain	Height: 15'–18', Spread: 6'–10' Shrub or small tree with open habit. Adapts to a wide range of soil conditions. Sun or partial shade.	See southern arrow-wood.
Viburnum prunifolium	blackhaw virburnum	Piedmont Coastal Plain	Height: 12'–15', Spread: 8'–12' Round-headed tree or multi-stemmed shrub. Adaptable to many soil types. Sun or shade.	See southern arrow-wood.
Viburnum trilobum	American cranberry	Piedmont Coastal Plain	Height: 8'–12', Spread: same Multi-stemmed shrub, round-topped, fairly dense. Prefers well drained, moist soil. Full sun to partial shade.	See southern arrow-wood.

Meadow wildflowers

Scientific Name	**Common Name**	**Upland or Wet Meadow Preference**
Asclepias incarnata	Swamp Milkweed	Wet
Asclepias syriaca	Common Milkweed	Upland
Asclepias tuberosa	Butterfly-weed	Upland
Aster novae-angliae	New England Aster	Upland
Chelone glabra	Turtlehead	Wet
Echinacea purpurea	Purple Coneflower	Upland
Eupatorium fistulosum	Joe-pye-weed	Wet
Eupatorium maculatum	Spotted Joe Pye-weed	Wet
Helianthus decapetalus	Thin-leaved Sunflower	Wet
Liatris spicata	Spiked Gayfeather	Upland
Lobelia cardinalis	Cardinal-flower	Wet
Lobelia siphilitica	Great Lobelia	Wet
Monarda didyma	Bee-balm	Wet
Monarda fistulosa	Wild Bergamot	Upland
Penstemon digitalis	Foxglove Beardtongue	Upland
Rudbeckia fulgida	Eastern Coneflower	Wet
Rudbeckia hirta	Black-eyed Susan	Upland
Rudbeckia laciniata	Green-headed Coneflower	Wet
Rudbeckia triloba	Thin-leaved Coneflower	Upland
Sisyrinchium angustifolium	Blue-eyed Grass	Wet
Solidago juncea	Early Goldenrod	Upland
Solidago nemoralis	Gray Goldenrod	Upland
Solidago speciosa	Showy Goldenrod	Wet
Solidago gigantea	Blue-stemmed Goldenrod	Wet
Verbena hastata	Blue Vervain	Wet
Vernonia noveboracensis	New York Ironweed	Wet
Veronicastrum virginicum	Culver's-root	Wet
Zizia aurea	Golden Alexanders	Wet

Meadow grasses

Scientific Name	**Common Name**	**Upland or Wetland Preference**
Agrostis alba	Redtop	Upland
Andropogon gerardii	Big Bluestem	Upland, Wet
Andropogon virginica	Broom-sedge	Upland
Elymus virginicus	Virginia wild-rye	Wet
Panicum virgatum	Switchgrass	Upland
Schizacharium scoparium (*Andropogon scoparius)*	Little Bluestem	Upland
Sorghastrum nutans	Indian-grass	Upland
Tridens flavus	Purpletop	Upland

Sources

Nurseries specializing in native plants

David Brothers Bean Road Nursery

P.O. Box 123

Whitehall and Bean Roads

Worcester, PA 19490

610-584-1550

North Creek Nurseries, Inc.

388 North Creek Road

Landenberg, PA 19350

877-ECO-PLUG

www.northcreeknurseries.com

Natural Landscapes

354 North Jennersville Road

West Grove, PA 19380

610-869-3788

Octoraro Native Plant Nursery

6126 Street Road

Kirkwood, PA 17536

717-529-3160

www.octoraro.com

Pinelands Nursery

323 Island Road

Columbus, NJ 08022

609-291-9486

www.pinelandsnursery.com

Redbud Native Plant Nursery

1214 N. Middletown Road

Glen Mills, PA 19342

610-358-4300

www.redbudnativeplant nursery.com

Sylva Native Nursery and Seed Company

3815 Roser Road

Glen Rock, PA 17327

717-227-0486
www.sylvanative.com

Temple University/Ambler Nursery

580 Meetinghouse Road

Ambler, PA 19002-3994

215-283-1330

(Wholesale only)

Yellow Springs Farm

1165 Yellow Springs Road

Chester Springs, PA 19425

610-827-2014

www.yellowspringsfarm.com

Other nurseries that carry native plants

Buddies Nursery

P.O. Box 14

Birdsboro, PA 19508

610-582-2410

Moon Nurseries

P.O. Box 672

145 Moon Road

Chesapeake City, MD 21915

800-803-TREE

www.moonnurseries.com

Musser Forests

1880 Route 119 North

Indiana, PA 15701

800-643-8319
www.musserforests.com

(Seedlings only)

Princeton Nurseries

P.O. Box 185

Allentown, NJ 08501

800-916-1776

www.princetonnurseries.com

Shemin Nurseries

P.O. Box 649

100 Green Tree Road

Oaks, PA 19456

610-666-0595

www.sheminnurseries.com

(Wholesale only)

Wildflower sources

Brandywine Conservancy

Box 141

Chadds Ford, PA 19317

610-388-2700

Ernst Conservation Seeds

9006 Mercer Pike

Meadville, PA 16335

800-873-3321

www.ernstseed.com

Prairie Nursery

P.O. Box 306

Westfield, WI 53964

800-476-9453

www.prairienursery.com

Sandy Wilson

Native Plants and Aquatic Nursery

834 Church Road

Harleysville, PA 19438

610-584-6302

Additional sources for general lists

Guide to Pennsylvania Nursery Stock

Pennsylvania Nurserymen's Association, Inc.

1924 North Second Street

Harrisburg, PA 17102

New England Wild Flower Society, Inc.

Garden in the Woods

180 Hemenway Road

Framingham, MA 01701

508-877-7630

Information sources

*Manual for Woody Landscape Plants*Michael Dirr

Stipes Publishing Company, 1990

American Wildlife and Plants: A Guide to Wildlife Food Habits

Alexander C. Martin, et. al.

Dover Publiciations, 1951

The Plants of Pennsylvania

Ann Fowler Rhoads and Timothy A. Block

University of Pennsylvania Press, 2000

Planting Trees and Shrubs

- Use only straight (no cultivars) native tree and shrub species appropriate to site conditions (see *Native Plant Materials*). They should be locally grown if possible.

- Planting should occur only in spring or early fall unless otherwise recommended as a sound conservation management practice. Deciduous trees and shrubs should be planted prior to bud break, leafing out, or after leaf fall to optimize plant survival.

- All plants should be nursery grown and in accordance with the American Standards for Nursery Stock, latest edition.

- All plants should be typical of their species or variety and should have a normal habit of growth. They should be sound, healthy and vigorous, well branched, and densely foliated when in leaf. They should be free of disease and insect pests, eggs, or larvae. They should have healthy, well-developed root systems.

- Hardwood trees should be 0.75" – 1.5" in caliper and/or 6' – 8' tall at planting. Softwood trees should be 6' – 8' tall at planting to assist in survival from invasives and so that most of their foliage is above deer browse line. Shrubs should be a minimum of 18" – 24" tall at planting.

- All plants should be balled and burlapped or containerized.

- Root balls of all plants should be adequately protected at all times from sun, drying winds, and frost.

- Forest gaps should be planted with trees on 10' x 10' spacings and protected from deer damage with fencing, tree shelters, or flexible tree guards.

- The planting hole should be 2–3 times as wide as the diameter of the root ball, but need not be much deeper than the root ball. As necessary, mound soil in the hole that when set in place, the plant will have the top of its root ball at or slightly above ground level. If debris is encountered, e.g., rocks, broken concrete, trash, etc., remove it to a minimum depth of 30" and backfill with soil, leaving a hole as deep as the root ball (Figure 1).

- Any burlap, twine, or wire basket covering the upper half of the ball must be loosened and laid flat in the hole or curt away completely after the plant has been set in place. It is essential to completely remove all synthetic string and fabric from around the root ball (natural burlap will decompose in time).

- Backfill with soil and lightly tamp soil surface (Figure 2).

- If space permits, mound soil into a collar 4" – 5" high surrounding the perimeter of the root ball to retain water (Figure 3).

- If planting on a slope, mound the soil downslope to prevent water runoff (Figure 4).

- Watering is only necessary if the plant is planted with foliage and not during optimal planting times. However, if water is easily accessible, water all plants to help remove air pockets from backfilled soil. In this case, the planting hole should be backfilled ¾ full with soil and watered well. When the water has been absorbed, the hole should be filled the rest of the way with soil and tamped lightly (Figure 5).

- If available, and/or desired, put a layer of mulch 2" – 3" thick over the planting area, but no closer than 2" to the trunk of the tree.

- Stakes should not be used unless the tree is planted with a loose root ball or later found to be displaced. If they are required, hardwood stakes no less than 2" x 2" across should be driven into the ground outside the root ball. Use two stakes for trees smaller than 2.5" – 3.5" in caliper, three stakes for larger trees. The stakes should be tall enough to provide the firm support necessary for proper root development, but not too tall to permit the tree to flex in the wind. The stakes should all be the same height for uniform support. Number 10 galvanized wire should be looped around the trunk, allowing enough space for growth, and tied to each stake. The trunk should be protected by placing a short piece of 0.75" diameter, 2-ply reinforced hose around the wire where it comes into contact with the trunk. All stakes and wire should be removed from the plants after one year (Figure 6).

- Heavy equipment should be used only in extreme situations. If necessary, protect existing trees by staying as far away as possible (at least outside the drip line) to prevent soil compaction and trunk scarring.

- Mow as necessary to maintain any herbaceous vegetation at a height no greater then 6" until areas are permanently re-established with new plantings.

- Planting should continue on an as-needed basis to assure that sufficient regeneration is available to replace canopy trees as they die.

Pruning

- Although it may occur in conjunction with the removal of invasive and/or

undesirable vegetation, pruning within forests should be minimized and selective.

- Branches that pose a safety hazard or a threat to the ecological health or stability of the forest should be pruned.
- No cleats should be used in the climbing of healthy trees.
- All cuts should be made close to the trunk or parent limb without cutting into the branch collar (figure at right).
- To prevent slitting or peeling of the bark, precut all branches that are too heavy to handle.
- Cuts and wounds should not be treated with wound dressing.
- All girdling root visible to the eye should be severed.
- Any pruned limbs or related debris should be left to rot, used to create brush piles for wildlife habitat, or fly-chipped on-site.
- Heavy equipment should be used only in extreme situations. If necessary, protect existing trees by staying as far away as possible (at least outside the drip line) to prevent soil compaction and trunk scarring.

1. Forked Top. If left on tree, this will cause the development of two leaders, thus wasting growth energy. Later, as the two leaders get larger, the fork may split and damage the tree.

2. Parallel branch

3. Branch growing at a sharp angle. When this branch becomes larger, it may rub on the trunk, split out, or even cause rot to develop by giving water a chance to collect.

4. Temporary branch

5. Crossing branches. These interfere with each other's growth and create bad form.

6. Water sprouts

7. Basal sprouting from the root crown. This drains energy from the tree.