Greenway Lands Stewardship Guide

West Vincent Township
Chester County, Pennsylvania

December 2005

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NATURAL LANDS TRUST

Hildacy Farm
1031 Palmers Mill Road
Media, PA 19063
610-353-5587
www.natlands.org

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Table of Contents

Introduction

The need to protect and steward remaining natural lands has grown along with the wave of development in southeastern Pennsylvania. In response, public programs and private foundations are helping municipalities and land conservancies protect critical natural lands within the region through fee acquisition and conservation easements. In addition, public agencies and private conservation organizations are working to inform landowners about the "best management practices" for the remaining—both protected and unprotected—natural lands.

In order to maximize the ecological and community benefits of natural lands in West Vincent Township, landowners and land managers must establish an effective long-term land stewardship program. Defining stewardship goals for individual properties and understanding the existing resources and various issues and opportunities associated with each site is critical to sustaining healthy ecosystems beneficial to wildlife and safe and enjoyable recreational facilities for human visitors. The *Greenway Lands Stewardship Guide for West Vincent Township* is designed to provide a framework in which to make decisions on the stewardship of natural lands and to facilitate the dissemination of available information to the appropriate decision makers (landowner, land manager). It will assist the owner or manager of existing or potential natural lands in developing stewardship goals and a regimen to implement and maintain those goals. To these ends, the *Guide* will:

- *Provide information on the suite of stewardship options and the challenge and opportunities associated with each option;*
- *Guide the landowner through a "decision tree" to determine which option is best for the individual landowner and;*
- *Provide a list of additional resources and contacts on major stewardship topics.*

The *Stewardship Guide* is written for owners and managers of natural lands, developers, homeowners' associations, and planning professionals engaged in the design, layout, and preparation of management plans for natural lands within West Vincent Township. However, most of the planning concepts and stewardship issues and recommendations are applicable to natural lands throughout the greater

Philadelphia region and beyond. It is intended to provide the means to employ current best management practices and to gain a greater understanding of the importance of protecting and restoring a broad range of native ecosystems including forests, grasslands, wetlands, and riparian areas. It can be

used for properties of any size and type—from forested parcels of thousands acres to small natural lands within conservation subdivisions.

The *Stewardship Guide* is organized to first introduce you to the types and composition of natural lands in southeastern Pennsylvania in general and West Vincent Township in particular, and the current stewardship issues impacting these areas that should be addressed within a stewardship plan. The *Guide* then walks you through the process of developing a stewardship plan. It specifically assists the landowner or manager in determining the driving consideration, or "conservation priority," for maintaining their natural lands. After the conservation priority is determined, the *Guide* provides perspective and guidelines for converting and/or maintaining the current cover types as natural lands. The **Stewardship Techniques and Procedures** section gives additional detail on the major stewardship issues and recommendations. Finally, the main body of the *Stewardship Guide* is followed by: (1) a glossary to define terms used within the *Guide*; (2) a list of resources from which you can find additional information on subjects within the *Guide*; and (3) an accompanying case study for the Weatherstone property to illustrate how a stewardship plan develops from the *Guide*.

A few notes of caution are offered about using this or any other land management resource. First, ***today's stewardship recommendations are based on current knowledge and technology***. This information will have a limited shelf life due to the natural evolution of plant communities and the ongoing introduction of new environmental, ecological, and human influences, some of them detrimental to natural lands. In addition, our knowledge of natural systems will grow and new techniques and technologies will be developed to address stewardship issues. To illustrate this point, remember that within the past twenty years, best management practices have included maximizing edge and habitat diversity on every property and the planting of invasive plant species for erosion control and wildlife food. Both ideas are strongly discouraged today. You should use the *Stewardship Guide* knowing that resource information and technology will change and new impacts to natural lands are inevitable that may require new strategies to address.

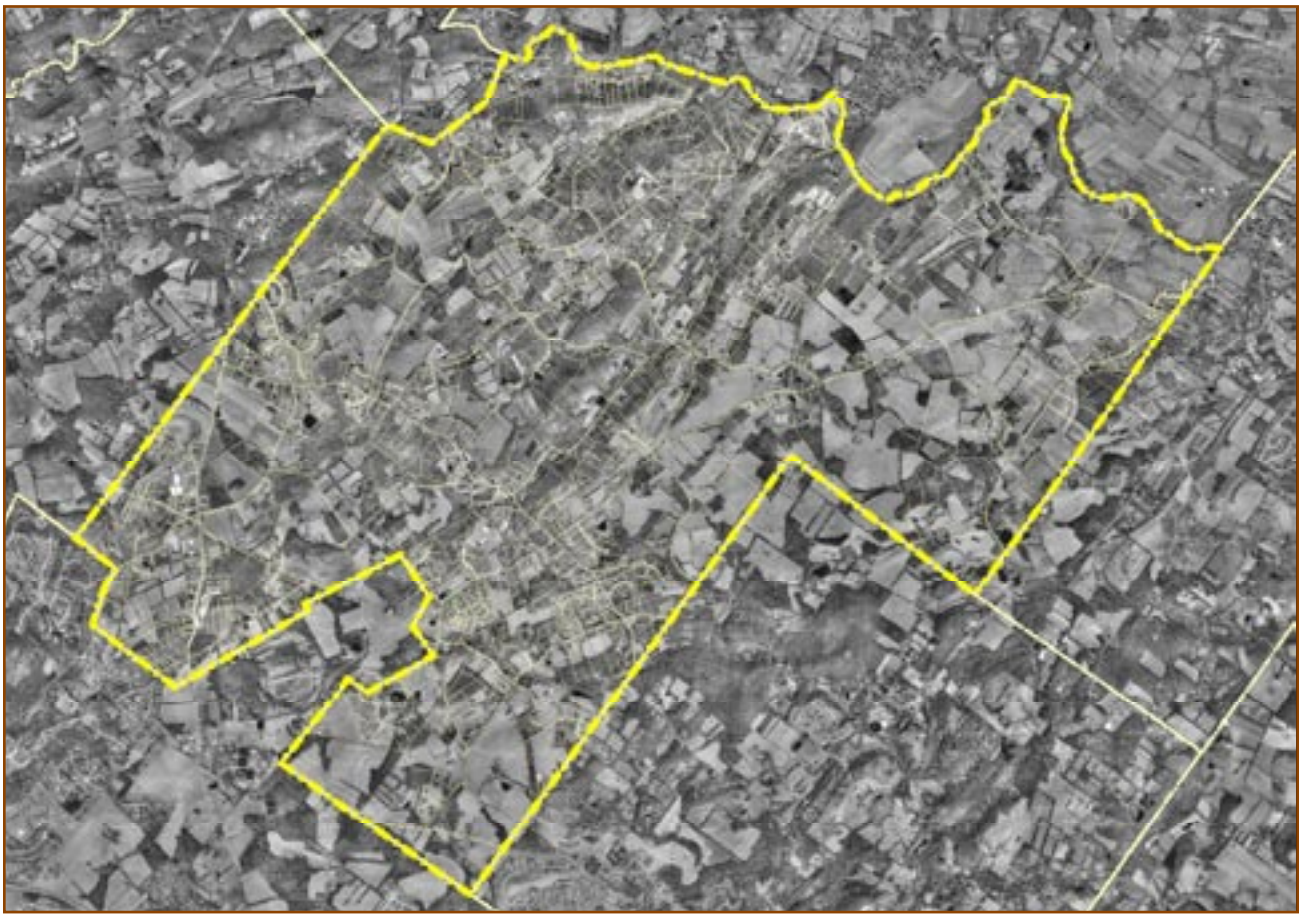
Second, ***every property has a unique combination of inherent environmental conditions (geology, soils, slope, aspect, hydrology, climate) and management history***. Every parcel of land will require a stewardship plan tailored to its particular conditions and history. It is extremely important to be patient, observant, and not afraid to modify your original stewardship plan (a process that scientists call "adaptive management") if you are not meeting your stewardship goals. It also does not hurt to question any recommendation from this or any other source if it does not fit into the reality that you experience on a particular land parcel.

Finally, ***managing natural lands in our region is truly a relationship*** that benefits from mental flexibility, a light approach, and more humor and humility than hubris. Indeed, history is littered with evidence—failed projects and civilizations—that testifies to the human capacity for stubbornly mismanaging natural systems. This capacity is painfully evident in the human origins of the most serious stewardship issues (overabundant deer, invasive plants, water quality degradation) facing landowners today. Like other relationships, the stewardship of natural lands requires an ongoing commitment to understand (which will take many years) and respect your "partner;" and it is guaranteed to provide you with unexpected surprises (good and bad) along the way.

Land Stewardship in West Vincent Township

Overview

Natural lands in West Vincent Township are typical of southeastern Pennsylvania in that they consist of forests, meadows, streams, and wetlands that support a diverse assortment of plant and wildlife species. They have been shaped by human use and management for thousands of years—from agricultural clearings and the extensive use of fire by Native Americans to wholesale clearing of forests by European settlers for agriculture and wood products to the suburban development of the late 20th and early 21st centuries. As a result of this interaction and random environmental stresses



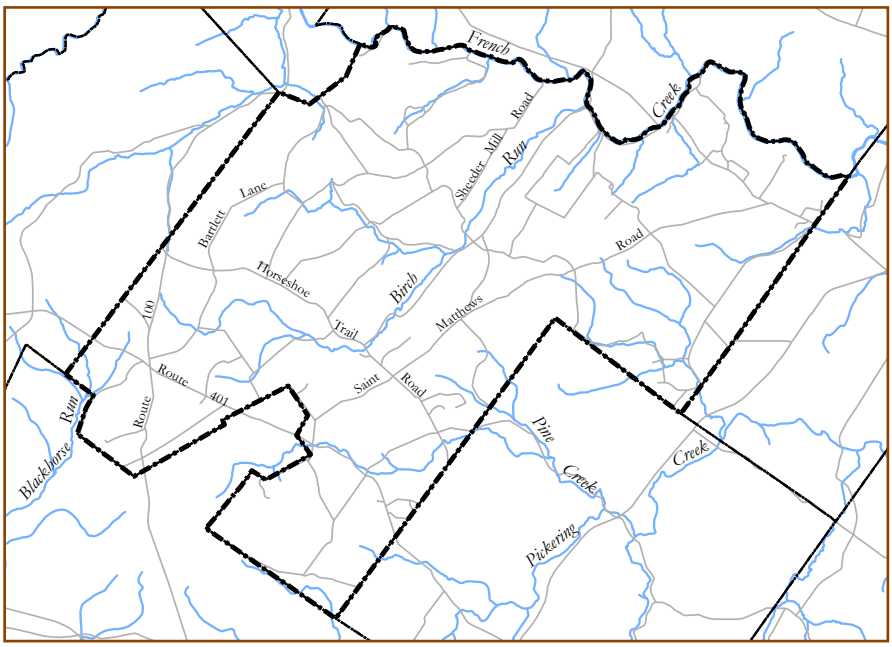
(high wind, drought, ice) natural lands have shifted back and forth from open ground to forest cover over the centuries.

Today, natural lands continue to provide important environmental and ecological benefits to local and migratory wildlife and nearby human communities. They are also valuable locations for recreation and contemplation, the observation of nature and education of our children, and a welcomed visual change from shopping malls and concrete highways. Unfortunately, humans are creating new and more permanent stresses at the same time we are demanding greater goods and services from natural lands. Stewarding natural lands is becoming an increasingly complex task as they decrease in area and we test their resiliency through increased stresses.

This section will provide an introduction to the different plant and water resources that dominate southeastern Pennsylvania and West Vincent. It will also detail the numerous issues involved with managing these plant and water resources. This will orient you to the main subjects of your stewardship plan and all the issues that might need to be detailed and addressed within a stewardship plan.

Water Resources

Water resources are generally divided into groundwater and surface water. As the names imply groundwater is that reservoir of water that occurs in fissures and aquifers located below the soil surface while surface waters are visible above ground and typically include wetlands, streams and rivers. The land area that drains to and includes an interrelated network of ground and surface water resources is known as a watershed. All watersheds eventually drain into one of the major river basins.



Southeastern Pennsylvania is located almost entirely within the Delaware River Basin. The exception is the southwest corner of Chester County which lies within the Octorara watershed of the Susquehanna River basin. Much of the central half of the region is within the Schuylkill River watershed.

West Vincent is situated within headwaters areas for two major watersheds of the Delaware River basin—the Schuylkill River and the Brandywine Creek. Most streams in West Vincent flow to French Creek, which forms the northern boundary of the township. These include Birch Run, flowing through the middle of West Vincent, and a series of unnamed

tributaries of French Creek. The areas south and east of St. Matthews Road form the headwaters of Pickering Creek, which flows into the Pickering Reservoir at Phoenixville before reaching the Schuylkill River. The far western section of the township, near Ludwig's Corner, is drained by Black Horse Run, a tributary to Marsh Creek and the East Branch Brandywine Creek. All waters flowing from West Vincent eventually end up in the Delaware River and the Delaware Bay Estuary.

The majority of streams in West Vincent are small, first order or second order headwaters streams which are high in the watershed and are generally not prone to severe flooding. Larger streams such as French Creek, lower Birch Run and lower Pickering Creek are more vulnerable to concentrated flood flows. The numerous small streams are vulnerable to pollution from adjacent land use activities such as construction, agriculture, lawn care practices, and paved areas such as roads and parking lots. The French Creek, Pickering Creek, and Brandywine Creek are all used as drinking water supplies for hundreds of thousands of local residents. For these reasons, adequate natural buffers along streams and wetlands are essential to maintain water quality.

Wetlands in West Vincent Township typically follow stream networks and can be found at the source of small tributaries, along the bases of slopes, and in floodplains. The National Wetland Inventory (NWI) (see **Additional Information Sources**) provides general mapping of more pronounced wetlands, however, many potential wetland areas are better indicated by hydric soils where the depth to the seasonal high water table is less than 2' at certain times of year. Certain forested areas in West Vincent are temporarily wet following the snowmelt and spring rains, forming an important wetland type known as a vernal pool. Vernal pools are vital breeding areas for many species of frogs and salamanders, since they lack the fish and other aquatic life that would eat their eggs.

Seep feeding a first order stream

Groundwater is locally defined by geologic formations (see below) and is everywhere vulnerable to contamination from failing septic systems, livestock, pesticides and herbicides, and leaks and spills of toxic substances.

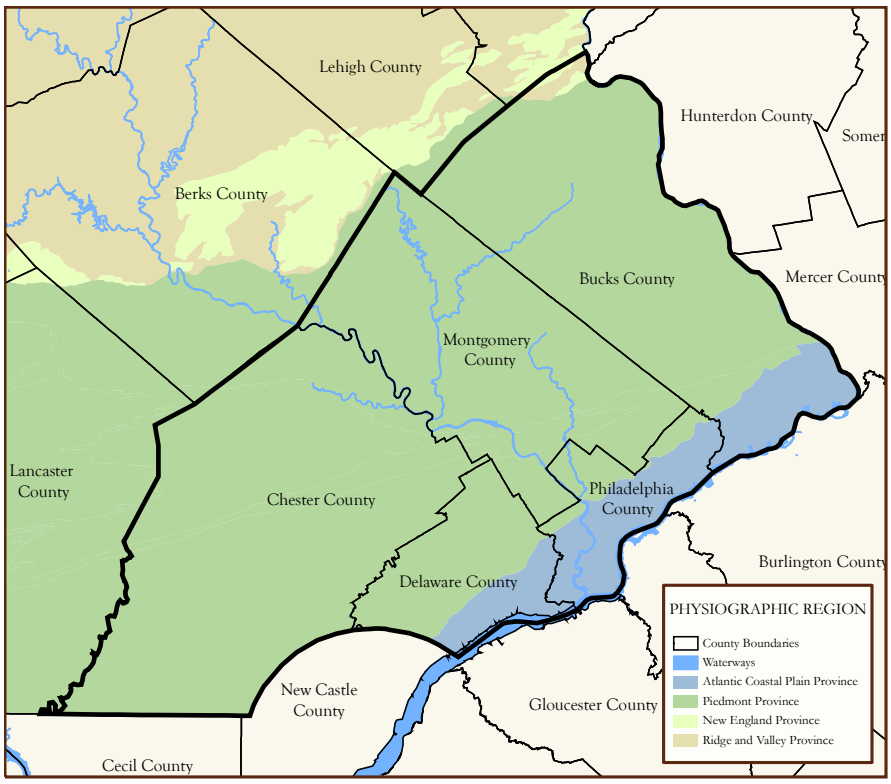
Maintaining and enhancing the health of local watersheds requires a focused strategy including:

- Retain and restore broad, natural vegetated buffers along streams
- Retain and restore wetlands and wetland buffers
- Require effective stormwater management practices to promote groundwater recharge and filter stormwater runoff
- Identify and protect critical groundwater recharge zones and wellheads for community drinking water systems

Geologic and Soil Resources

The types of rock formations that form the foundation of our region are quite variable in southeastern Pennsylvania. A long history of folding, compression and intrusion has left us a legacy of rock types ranging from soft limestones and shales to very durable gneisses, diabase and quartzite. Typically, hard rocks form the high lands and soft rocks the lower lying areas. Variation in porosity means that different rock formations will allow or not allow ground water to pass through to feed streams and rivers. Generally, the softer rocks are more porous. In West Vincent Township, gneiss is the dominant rock type. This dense, metamorphic formation provides moderate to low well yields with higher amounts in fractures. Differences in chemical composition of rocks have a strong influence on soil quality. Taken together, soil wetness and soil chemical composition tend to be the strongest influences on soil fertility.

Much can be predicted about the types of plants that will grow on a site by understanding the type of soil occurring there. Extreme wetness or dryness in soils creates stress for plants and so specialized floras typically grow in these locations. In between the harsh conditions imposed by wetness or dryness, plant growth is more strongly determined by soil fertility. Descriptions of soils in County Soil Surveys can be very useful in determining whether a soil is extremely wet or dry and fertile or infertile. Fertility can be related back to geology, with quartzite, gneiss and many sandstones and shales producing lower fertility soils and limestone, diabase, schist and some shales and sandstones producing richer soils. In southeastern Pennsylvania we also have one very unusual soil type based on geology, the soils derived from serpentine rock, which can be very toxic to most plants when these soils are thin.



In southeastern Pennsylvania, the geology of the area allows us to break sites into physiographic regions. Closest to the Delaware Bay and Estuary, we find a thin strip of land with no hard bedrock near the surface. This area, where the surface is composed of pre-historic deposits of sands, gravels, silts and clays is known as the coastal plain. Its soils can be very wet or very dry, depending how close the water table is to the surface. Beyond the coastal plain one enters the piedmont physiographic region, which can be divided into sections by major rock types. The first areas encountered are rolling hills supported on a foundation of schists and gneisses,

relatively hard rocks, with the schists typically supporting better soils than the gneisses. Going further away from the Delaware Estuary, we then find the Great Valley, a narrow limestone valley with rich soils. Today, this is a very settled area with few exposures of unaltered soils. Much of this area shows signs of heavy settlement with industry, commerce and roadways. Following this thin strip, we will encounter more schists and gneisses in places and then thin or thick stretches of red shales, sandstones and conglomerates, punctuated by high areas underlain by a volcanic rock known as diabase. The conglomerates typically support poor, rocky soils. The diabase areas produce thin, less productive soils on steeper slopes and rich soils on shallower slopes. While there are many exceptions to these general patterns, most areas will conform to these general patterns.

Plant Communities

For the most part, the stewardship of natural lands involves the manipulation of resources at and above ground level, namely, vegetation, water, or exposed rock. In our region this mostly means plant resources within forested and open areas, and to a lesser extent (due to far less surface area and current regulations) surface water resources. Understanding the different types of plant and water resources, their characteristics and requirements, is critical to the development of a stewardship plan.

Many scientists through the years have studied and developed ways to organize the natural world. Ecologists have noted for centuries that plant species tend to sort themselves out in a pattern of roughly repeated assemblages or "communities" across the landscape. In this *Stewardship Guide* we will use the classifications presented in *Terrestrial and Palustrine Plant Communities of Pennsylvania* (Fike 1999) to describe the various plant "communities" that are found within southeastern Pennsylvania and West Vincent.

In general, plant communities are divided into two major groups—***terrestrial*** and ***palustrine***—depending on the hydrologic characteristics of the site where they occur. In this context, terrestrial corresponds closely with "upland" and palustrine is synonymous with "wetland." Palustrine communities are typically found along streams and rivers and in areas with a shallow water table. These two categories are each broken down further into ***forest***, ***woodland***, ***shrubland***, and ***herbaceous openings***. Forests, which cover the majority of the region's natural lands, are dominated by trees where the leaf canopy is closed or nearly closed and the majority of tree crowns are overlapping, typically with between 60% and 100% tree cover. Woodlands are also tree dominated, but are more open in character and have between 10% and 60% tree cover. Shrublands are dominated by shrubs and small trees, and herbaceous plants may be present. Herbaceous openings are communities dominated by plants with no persistent woody stem.

The next differentiation in community types is based on the dominant species within the community. Which species dominate a forest is generally the result of the site's physical characteristics (soil, slope, and water) and how past stewardship activities and environmental stresses (wind, ice, drought) have impacted the availability of light to the forest floor. Some species (often referred to as pioneer species) are shade-intolerant and require full sun conditions to colonize a site. Examples of shade-intolerant

species in our region include black birch, red cedar, and quaking aspen. Species with intermediate shade tolerance include oak, hickory, tuliptree, and ash. These species can both colonize open areas (tuliptree and ash are often the first trees into abandoned farm fields) and forest gaps that are not open enough for pioneer species. Shade-tolerant species such as red maple, sugar maple, hemlock, and beech have the ability to survive in low light conditions and can persist in the understory until canopy trees die. Since their seedlings are best adapted to grow under the low light conditions that they create, they are able to maintain dominance until the site suffers a significant disturbance (high winds, extensive logging) that modifies the amount of light reaching the forest floor in favor of the intermediate or shade-intolerant species.

In West Vincent Township and the rest of southeastern Pennsylvania, most of the natural forest communities are dominated by deciduous broadleaf (hardwood) species. Communities dominated by conifers are limited and typically the result of abandoned plantations established in the middle part of the last century. Like most of Pennsylvania, communities dominated by oak species are the most common communities in the region. This is largely the result of the decline of the American chestnut, and the extensive clearcutting and subsequent fires—oak can tolerate fire very well—that occurred between 1850 and 1920 throughout the state to increase agricultural production and to supply the growing cities and towns with construction materials and fuel (firewood, charcoal). Because there is a general aversion to clearcutting and fire—although both are considered appropriate management practices when properly used—the conditions required to perpetuate oak dominance occur less often now. With overabundant deer population consuming much of the annual acorn crop and the few oak seedlings that do sprout, indications are that oak communities will eventually give way to maple-dominated communities after the current canopy trees decline.

Examples of common terrestrial communities in southeastern Pennsylvania include:

Red oak – mixed hardwood forest: A broadly defined community type that much of Pennsylvania's hardwood-dominated forests occurring on fairly mesic sites, and is therefore quite variable in composition. Typically, this forest type occurs on soils developed from red shales, diabase, serpentine, schist and gneiss. In addition to soil influences, such stands often have had a history of heavy cutting and/or fire disturbance. Northern red oak is usually present, often dominant/codominant, most often with red maple, black and white oak, mockernut and shagbark hickory, sweet and yellow birch, white ash, American beech, and tuliptree.

Dry oak – heath forest: A fairly broadly defined community type, these forests occur on xeric to moderately dry, acidic sites, often on shallow or sandy soils and/or steep slopes. Typically, this forest type occurs on soils developed from sandstone, conglomerate and quartzite. Soils developed from red shales, schist and gneiss can also support this community type if the area has experienced heavy disturbance from repeated cutting and/or fire. The most characteristic tree species is chestnut oak, usually occurring with a mix of black, scarlet and/or white oak. Other tree species include sassafras, black-gum, sweet birch, red maple, pignut hickory, and pitch, Virginia, and eastern white pine. Total cover by conifers generally does not exceed 25% of the canopy.

Tuliptree – beech – maple forest: These forests occur on fairly deep, not strongly acidic soils, at a mid- to lower-slope position. Typically, this forest type occurs on soils developed from limestone, marble, diabase and some shales with higher calcium and magnesium content. The most consistent tree species for this often very mixed type are red maple and tuliptree. American beech is often present and, when present, is often codominant. In successional, lower slope situations, tuliptree may occur in nearly pure stands. The long list of possible associates includes various oaks, mostly red oak, as well as black-gum, sugar maple, mockernut and shagbark hickory, sweet birch, and eastern hemlock (less than 25% relative cover).

Red maple (terrestrial) forest: This is generally an early- to mid-successional type that is becoming increasingly common as red maple increases in Pennsylvania's forest. This type is seldom pure, but red maple dominates the tree stratum. Associate species include oaks, sweet birch, tuliptree, hickories, black cherry, ashes, and other hardwoods. This type is not well correlated with soil characteristics, but instead is a common result of release of a site from agriculture.

Examples of common palustrine communities in the region include:

Red maple – black-gum palustrine forest: The canopy of this community type is dominated red maple and/or black-gum. Other trees, e.g., yellow birch, eastern white pine, eastern hemlock, swamp white and pin oak, or black willow, may also occur.

Sycamore – box-elder floodplain forest: This community type occurs along floodplains of larger and mid-size river systems that receive periodic or seasonal flooding. Although this is typically a palustrine community type, there may be examples that are terrestrial. The most characteristic tree species of this type are sycamore and box-elder, often with red and silver maple, American and red elm, red ash, and black willow. River birch is a common component of these sites in eastern Pennsylvania.

Skunk cabbage – golden saxifrage forest seep: These are small communities (usually less than a quarter-acre) that occur where groundwater comes to the surface in a diffuse flow, saturating the soil for most of the growing season. The water chemistry ranges from acidic to strongly calcareous, with only minor accompanying shifts in species composition. These seeps most often occur in a forested context. Canopy cover ranges widely, and may be contributed by woody plants rooted within the seep, or by overhanging foliage from those in the surrounding uplands. The species composition is highly variable and includes skunk cabbage, golden saxifrage, cinnamon fern, sedge, goldthread, partridge-berry, jewelweed, fancy fern, Pennsylvania bitter-cress, clearweed, sweet-scented bedstraw, slender mannagrass, swamp saxifrage, New York fern, swamp aster, and sensitive fern.

Tussock sedge marsh: These are tussock sedge-dominated marshes. The majority of these systems are influenced by past impoundment. The substrate maybe peat, muck, or mineral soil. There is generally standing water between the tussocks for much of the year. Associated species include other sedges, rushes, bluejoint, tall meadow-rue, hairgrass, Joe-Pye weed, wool grass, water parsnip, marsh St.-John's-wort, scattered common cattail and small red maple. The invasive species common reed and purple loosestrife are frequently a major problem in these systems.

Herbaceous vernal pond: This community type is characterized by seasonally fluctuating water levels; it may dry out completely in the summer. Species composition is variable between sites, as well as annually and seasonally. Cover may be sparse, species composition is extremely variable, some typical representatives include three-way sedge, mannagrass, rice cut-grass, wool-grass, and a variety of sedges.

Wet meadow: These are open, usually grass-dominated meadows. They are typically flooded early in the growing season, but are generally dry for much of the year. Representative species include rice cut-grass, wool-grass, bugleweed, pale meadow grass and smartweeds.

More detailed descriptions of these and the many other plant communities found within the region and the state can be found in *Terrestrial and Palustrine Plant Communities of Pennsylvania* (Fike, 1996).

Wildlife Resources

Because our region has been so dissected and dominated by human use of the landscape, a good number of wildlife species no longer occur in this part of the state. Those wildlife species that remain are the ones more tolerant of human-dominated landscapes. Our backyard wildlife species—racoons, opossums, rabbits, voles, mice, robins, starlings, catbirds, mourning doves, blue jays, and white-tailed deer—abound under our suburban landscape conditions. In special situations, less tolerant wildlife still occur in the region. In some cases, these species have even moved back into the region in areas where land has been released from farming, but has still not been occupied by so many units of housing and commercial buildings that these species are excluded. Species in this category might include coyote, black bear, bobcat, mink, river otter, wood thrush, ovenbird, and various warblers. Typically, these more sensitive species occur in areas of larger, unbroken forest tracts of at least hundreds of acres.

Major Stewardship Issues

As noted above, the natural lands within southeastern Pennsylvania have been directly and indirectly impacted by human activities for many centuries. While humans have benefited from the products (fuel, food, and building materials) of agriculture and forestry, many natural lands are now suffering from the residual effects of exploitation and mismanagement. As we look more and more to natural lands to provide local environmental and ecological benefits and fulfill our recreational and aesthetic needs it is important to understand the various stewardship issues that should be addressed in any stewardship plan. Some issues (overabundant deer, invasives, hazards) are the result of past human activities; some issues (stormwater erosion, adverse uses) result from more recent activities on or near natural lands; others (dead wood management) are more generally related to the restoration and management of natural lands. This section will detail the stewardship issues that are commonly encountered and how they affect the stewardship of natural lands.

Deer Overabundance

The growing consensus among scientists and land managers is that the impact of browsing by overabundant deer populations is clearly the most detrimental factor in forest decline in Pennsylvania. Even though other factors (e.g., acid precipitation) may be contributing to the problem, the lack of tree, shrub, and herbaceous regeneration in forests results principally from an overabundance of white-tailed deer. (A detailed summary of this issue can be found in the 2005 report by the Deer Management Forum, titled *Managing White-tailed Deer in Forest Habitat From an Ecosystem Perspective*, available for viewing at **http://pa.audubon.org**) The simple reason for this is that while other factors mostly stress established

forest vegetation, deer, through their predominant consumption of seeds and seedlings, literally consume future forest components before they become sufficiently established. The removal of tree regeneration not only eliminates the defining component (canopy trees) of the future forest, it greatly amplifies the effects of other stressors by freeing up growing space to invasive plant species and physically creating the disturbed soil conditions to promote their spread. West Vincent Township is no exception, with most forested areas showing the telltale signs of a browse line at about 5' above the forest floor. Below this line many native shrubs, saplings, and herbaceous plant are missing and invasive plants and vines are becoming more common than in the recent past.

Forest fragmentation, the eradication of large predators, and cultural norms about hunting have resulted in the proliferation of one disturbance-adapted herbivorous animal, white-tailed deer, to unprecedented population densities. Researchers believe that our native forests evolved with deer densities of 5 to 10 per square mile (640 acres). At the beginning of the last century, white-tailed deer were nearly extirpated (regionally extinct) from Pennsylvania and other eastern states through over-harvesting and deforestation. By instituting game laws, state agencies had success in rebuilding the deer population. These hunting rules focused on providing a "maximum sustained yield" of game for hunters and the population consequently soared. Statewide, the deer population now averages almost 40 per forested square mile.

The perpetuation of any healthy forest community depends on the on-going establishment of tree seedlings and saplings (collectively known as "regeneration") in sufficient numbers to occupy the gaps that are created by periodic natural or human disturbance. A density of 20 deer per square mile is considered the maximum level to allow adequate tree and shrub regeneration; a level of 5 to 10 per square mile is needed to sustain a high diversity of native species, including native herbaceous plants. In forests such as those in West Vincent that have been subjected to over-browsing for many years, the density number will probably need to be lowered even further for a period of time to allow the forest to regenerate. The section on estimating deer impact under **Wildlife Management** provides guidelines developed by the Penn State University and the US Forest Service for visually assessing the degree of impact on a forest community and discusses methods for ascertaining the density of deer populations.

Deer overabundance dramatically curtails the survival of native flora and has led to the collapse of plant species diversity in the forest understory and the near cessation of tree reproduction in vast areas of Pennsylvania forests. Deer are browsers, which means their diet consists mainly of newly-grown twigs of woody plants, primarily trees and shrubs. When deer populations are high, they consume all of the established seedlings, as well as many tree seeds (particularly acorns) and herbaceous plants. It is believed that over 100 species of native wildflowers have been extirpated (become regionally extinct) in Pennsylvania partly as a result of overbrowsing by high deer populations. Some seedlings do manage to establish, especially following years of strong

acorn production, but they are usually eradicated in a year or less. In the best cases today, regeneration above browse height does occur in canopy gaps, but it is of a few species less preferred by deer and the number of seedlings is typically

Lack of regeneration from deer overbrowse

barely adequate to fill each gap, which leaves no margin for future adverse impacts. Regeneration of each gap will hinge on these few seedlings surviving a host of stresses (buck rubs, invasive vines, drought, insects, windthrow) on their way to the canopy.

The resulting lack of cover, food, and structural diversity within forests has undoubtedly reduced wildlife populations, particularly of small mammal and bird species. Native oaks, which are highly preferred food for deer, are not regenerating, which means that the wildlife-rich oak forests will cease to exist as adult trees age and die.

Part of the problem in communicating the forest health problem is that it is quite easy to see the "forest for the trees." Due to the lack of recent wide-scale wind events, most forests in our region still look healthy, with a canopy of large trees that have grown since the last extensive clearing of the forests at the turn of the 20th century. The spread of invasive introduced shrub and understory tree species into natural areas over the last few decades has filled in the vegetative layers vacated by native species as the result of high deer densities. Most forests appear a "healthy" green. Even those forests with an understory stripped of vegetation have a park-like structure (tall canopy trees with limited understory) that is aesthetically pleasing to many people.

The decision to restore any forest must start with the goal to maintain deer density at an appropriate level. Unless this goal is achieved first, the management of other stressors to perpetuate the forest becomes a short-term lesson in futility that ultimately ends with the demise of the current canopy trees—and by definition, the forest itself—through natural decline or the next major wind event.

Fragmentation and Edge Effects

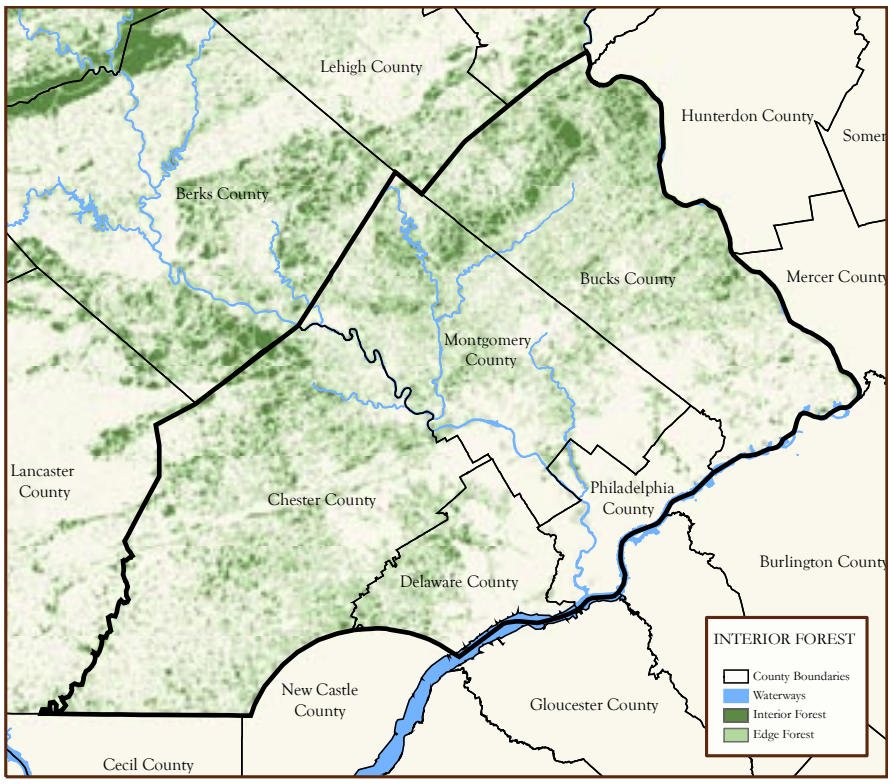
Historically, land use in the region was dominated by agriculture and logging. Those uses, coupled with recent residential and commercial development, have effectively removed or disturbed most of the native vegetation in the region and, through subdivision and clearing, added countless miles of edge to the fragments of forest that remain. Edge habitat can be defined as a habitat created by removal of the native vegetation, so that the transition zone (edge) is occupied more by light-loving plants. In southeastern Pennsylvania, as in many other settled places, these edges foster the proliferation of aggressive, invasive plants that crowd out the original native flora. The side lighting effect created at the transition or edge encourages edge-loving animals, which compete very effectively with interior-loving plants and animals, making the interior-loving species quite rare.

Fragmentation of our forests is second only to outright destruction and conversion of forestland to other uses as a cause of degradation of ecosystem function, habitat quality, and biodiversity. Forest fragmentation results in the local extinction of species and

can lead to far lower overall species diversity than would occur if the same total area of forest were to remain as a single contiguous block. For many animal species, the area of contiguous habitat in a forest fragment must be above some threshold size for a population to sustain its viability for more than a few individuals.

Minimum-area requirements vary greatly among species, but the total area of forest in a fragment is not all that matters. Many plants as well as animals are forest-interior specialists, unable to utilize the outermost zone of forest near the edge as habitat. The area inside a forest but near its edge is vulnerable to a host of detrimental outside influences, including increased wind, light, and heat, decreased humidity, and the influx of seeds of invasive introduced species. In general, fragmentation favors invasive species and works against native species.

Furthermore, the threshold size of a forest block required to sustain a population of a forest-interior species is larger with greater isolation from other forest blocks. Consequently a long-established population in a forest fragment may die out even if the habitat remains intact, if enough nearby forest fragments are further fragmented or destroyed. Put another way, in a neighborhood in which most of the forest is gone, the remaining forest fragment must be larger to sustain the same

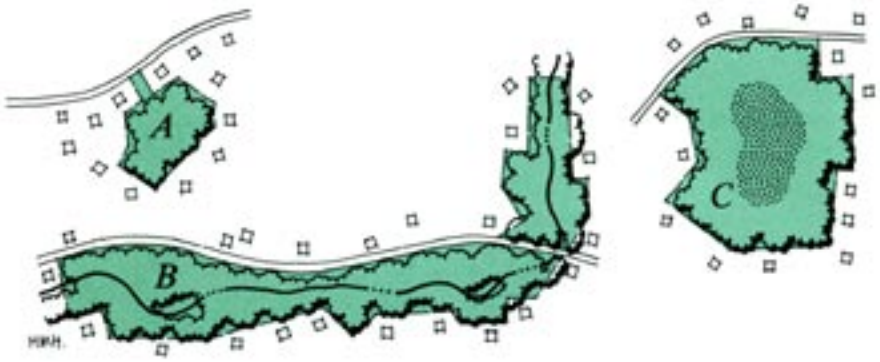


level of species diversity than if it were near other large forest blocks.

Fragmentation has at least four components:

- reduction in total forest area
- reduction in the area that functions as forest interior
- increase in the edge-to-area ratio
- increased isolation from the nearest large forest blocks

Conventionally, in temperate eastern North America the part of the forest that lies more than 100 meters (305') from



EDGE TO AREA RATIO
Preserve A is so small it is all edge. Preserve B is larger, but it is still all edge because of its shape. Preserve C is smaller than B, but because it is circular, it has an area of interior forest.

the closest edge is considered as functional forest interior for most species. It follows that, in two forest blocks with identical areas but different "footprints," the one with the higher edge-to-area ratio (i.e., more sinuous edge or narrower overall shape) is more fragmented. A circle is the two-dimensional shape with the lowest edge-to-area ratio and hypothetically the optimal shape for conserving forest diversity in a fragment, but smaller circles have higher edge-to-area ratios than larger circles. Any part of a forest block whose width is 200 meters (610') or less has no functional interior. Cutting a road or other linear non-forest feature through a forest fragment may not decrease total forest area by much, but the two fragments so created each has a much smaller maximum area, a much higher edge-to-area ratio, and far less (or no) functional interior.

The pattern of forest fragmentation in West Vincent Township is typical of northern Chester County, where forest cover only constitutes about one-third of the landscape and the largest contiguous forest blocks are 500 acres or less. Few forested areas are wider than 1,000', and a walker even in the middle of most forests can still see the open sky at the forest edge. The largest forested tracts in West Vincent generally follow ridges with steep slopes and ravines, such as those that characterize the northern section of the township close to French Creek. Interconnected networks of both upland and lowland forest found in this area are essential to the survival of many of the less common species of birds, reptiles, and amphibians in the township.

Often, the ownership pattern of large forest blocks in West Vincent is also fragmented, with large lots from 5 to 10 acres in size common. As homesites, driveways, and yards on these lots are cleared, graded, and developed, the pattern of fragmentation continues—even in the interior of the largest forests.

Aerial photograph of French Creek with fragmented forest network

Invasive Plant Species

One of the most serious problems encountered in the management of natural areas in the southeastern Pennsylvania region—and increasingly recognized as a threat worldwide—is the presence of invasive plant species. An invasive species is one that rapidly spreads and out-competes multiple native species, in all likelihood chiefly because of the absence of the predators, pathogens, and herbivores that keep it in check in its place of origin.

An invasive species is one that displays one or more of the following characteristics:

- fast germination
- high population growth
- early reproductive maturity
- vegetative as well as sexual reproduction
- generalized pollination
- wide tolerance to many habitat types
- high rate of biomass accumulation

- long-range seed dispersal capabilities
- fruit used by wildlife and humans
- few predators/diseases
- adaptation to disturbance

Nationally, their destructive impact on native biodiversity is exceeded only by direct habitat destruction. The misguided promotion of several exotic species for erosion and livestock control as well as horticultural plantings has given rise to virtually limitless seed sources, allowing many invasive species to sweep through the region's remnant natural habitats. There is a higher number of invasive species being used for various purposes than ever before and the rate of species introduction is higher than in the past. The increase of invasives is exponential, suggesting why invasives are so much more of a problem now than when the species were first introduced, or even as recently as thirty years ago.

Vines climbing trees and exotic shrubs that choke abandoned fields have the ability to displace native vegetation, halt the natural process of succession from field to forest, and homogenize the structural and food resources of a site, thereby reducing its habitat value for native fauna, particularly migratory songbirds. They can also alter nutrient cycling, local hydrology, fire regimes, geomorphological processes (such as dune formation), species and structural diversity, available wildlife resources, and prevent recruitment of native species due to competition for light, nutrients, and/or moisture.

Given the agricultural history of the region and its location near one of the world's horticultural centers (Philadelphia), West Vincent Township, and the rest of southeastern Pennsylvania are now home to numerous invasive species. The most problematic species at this time include:

Oriental bittersweet *(Celastrus orbiculatus)*: A woody vine that aggressively grows along any forest edge or in open meadows. Its seeds are dispersed by birds and human collectors (the bright orange seed capsules are used for fall decorations). By growing into the tree canopy, the vine raises the center of gravity of the tree making it vulnerable to windthrow.

Autumn olive *(Eleagnus umbellata)*: Along with its relative, Russian-olive *(Eleagnus angustifolia)*, this shrub can rapidly invade abandoned fields and open canopy forests to the exclusion of all other plants. Until recently it was promoted as a wildlife food although its fruits have limited nutritional value.

Japanese stiltgrass *(Microstegium vimineum)*: A warm-season grass dispersed by deer and human walkers that quickly spreads to the detriment of native herbs.

Multiflora rose *(Rosa multiflora)*: An upright shrub that was promoted as a "living fence," its supporters failed to understand its ability to spread rapidly via bird droppings.

Japanese honeysuckle *(Lonicera japonica)*: A perennial vine initially used for erosion control, its greatest impact is on forest tree seedlings and shrubs.

A more complete list of the invasive plants most impacting natural lands in the region can be found under **Invasive Vegetation Management**. Photos and detailed descriptions of individual plants are available at **www.nps.gov/plants/alien/index** and from other sources listed under **Resources**.

The presence of invasive plant species in the township complicates the goal of maintaining healthy native plant communities as invasives compete vigorously with preferred native species for "growing space," the major forces—light, water, inorganic nutrients, temperature, humidity, soil structure, and other factors—that support plant growth in that area. Given their rapid growth rates, prolific reproduction by seed or vegetative spread, and the absence of the specialist predators and pathogens that keep them in check in their native habitats, invasives are often able to out-compete native species. Most are particularly well adapted to colonize disturbed areas. Disturbance from human activities—agriculture, timber harvests, development—and

the high deer population has afforded several invasive species the opportunity to become well-established throughout the region.

The control of invasive plants will be a perpetual concern of land managers in West Vincent and the surrounding region. The extensive amount of edge area and seed sources in the region and the prolific nature of these plants guarantee that even with complete eradication on a given property, invasives can quickly reestablish themselves as a serious stewardship problem if not monitored and addressed on a regular basis. A strategy for coexisting with these plants is needed—one that will minimize their effects on the aesthetics and ecological stability of a property, with a minimum of management effort. **Invasive Vegetation Management** provides information on controlling invasive plants.

Water Resources

Our natural lands are directly influenced by the quality and quantity of water that constitutes the system of streams, wetlands, and groundwater in the region. The agricultural, suburban, and urban land-use pattern of the French and Pickering Creek watersheds has altered the natural balance of ground and surface water that defined the forested landscape prior to William Penn's arrival in 1682.

French Creek and forested floodplain

Almost the entire region has been cleared of forest, plowed and grazed for agriculture, bulldozed for development, planted in lawns, or paved. Each of these actions generates unnatural rates and amounts of stormwater runoff, particularly in the wettest periods of the year. Water that once infiltrated soil and recharged aquifers to gradually feed wetlands and streams during periods of drought is now lost downstream to the Delaware Bay and Atlantic Ocean. As a result, the frequency and extent of flooding is artificially high, and the water table that allows groundwater to feed wetlands and supply the base flow of streams is artificially reduced to unnaturally low levels during the driest periods of late summer.

Decreased groundwater levels are manifest in wetlands and small streams that become drier earlier in the year than they did in the past, and in resulting changes in the plant and wildlife populations. For example, invasive species such as Japanese honeysuckle and multiflora rose have become dominant in many former wetland areas, and salamander populations reliant on vernal pools (small areas of standing water, normal in springtime) for breeding have declined or disappeared for lack of habitat.

Ongoing threats to the quality and quantity of water represent potential threats to the natural lands in the region. With the advance of technology, humans have the ability to alter the landscape more rapidly and at a broader scale than ever before. The more we clear native vegetation, excavate and compact soil, and construct impervious surfaces such as rooftops and parking lots,

the more we "short-circuit" the natural hydrological cycle that recharges aquifers, regulates flooding, maintains diverse aquatic plant and animal communities, and feeds wetlands and streams with clean, plentiful water to support plant, animal, and human needs (including vital drinking water supplies). When we consider the root causes behind the degraded quality and diminishing quantity of water in the region and the severity of flooding and threats to life and property, all evidence points to urban and suburban development and lack of proper stormwater management as the major culprits.

The primary threats to water quality and quantity in the French and Pickering Creeks watersheds, as in all of southeastern Pennsylvania are: (1) **non-point source pollution**, which consists primarily of polluted stormwater runoff from urbanized areas and agricultural fields (in contrast to point-source pollution, which is discharged from pipes at industrial facilities or sewage treatment plants); (2) **flooding**; and (3) **groundwater depletion**.

Non-point Source Pollution

Streams in West Vincent are relatively healthy compared to other streams in southeast Pennsylvania. All attain water quality standards under the Pennsylvania Department of Environmental Protection's 305(b) list, and most are protected under state law as High Quality, with Birch Run ranking as Exceptional Value in the Chapter 93 list. Even with these high ratings, non-point source pollution is still a factor to be carefully monitored.

The following issues are associated with non-point source pollution facing streams in the region:

- **Loss and Degradation of Streamside Forested Areas and Wetlands**. Impacts of clearing, mowing, grazing, livestock, fertilizers, septic systems and stormwater runoff generate higher levels of Total Suspended Solids, nutrients, and bacteria.
- **Uncontrolled Stormwater Runoff**. Stream quality is negatively impacted by erosion, sedimentation and serious flooding associated with lack of effective stormwater management, and an increase in development of houses and roads near streams. Uncontrolled roadside runoff (which often contain oils and salt) from ditches and culverts is a region-wide problem. Severe erosion impacts are evident along certain stretches of headwaters streams in the township, particularly in certain agricultural settings where trees have been lacking for many years. Sediment is generated by storm runoff and associated soil erosion from farm fields, construction sites, roadways, parking lots, lawn areas, and eroding stream banks. Excessive sediment in streams can inhibit fish reproduction by smothering

Uncontrolled stormwater runoff often results in erosion along streams

eggs, and can harm other aquatic life, particularly bottom-dwelling species. Heavy sedimentation is evident in the large deposits of sandbars and islands in the lower Birch Run, Pickering Creek and French Creek.

- **Household Impacts**. Residences in local watersheds may contribute to high fecal coliform bacteria levels and nutrient levels through failing septic systems and use of phosphate-based detergents. Phosphorus is often contained in runoff from lawns and gardens using chemical fertilizers and can be found in household and commercial detergents, which enter creeks through wastewater systems. Phosphorus is the main nutrient responsible for eutrophication (nutrient enrichment, which causes algae blooms) in waterways. As algae decompose, they consume dissolved oxygen and diminish the ability of the creek to support healthy populations of fish and other aquatic life. Residences mowing along streams can facilitate streambank erosion and sedimentation.
- **Livestock in Streams and Wetlands**. The presence of cattle and horses in streams and wetlands at several locations in the Township is a problematic source of nutrients, sediment, and fecal coliform bacteria levels.
- **Canada Goose Populations**. Unnaturally high levels of fecal coliform bacteria and nutrients are evident in some locations downstream of ponds that attract large Canada goose populations.

It also should be noted that unnaturally warm water temperatures along some reaches of local streams may be a contributing factor that exacerbates the impact of non-point source pollution on the health of aquatic life. Warm water temperatures in the watershed are most likely attributable to a combination of factors, including stream segments lacking shade from riparian forest buffers, ponds discharging warm surface water, and direct runoff from heated pavement or lawn areas.

Flooding

Flooding is a natural process whereby streams overflow their banks during heavy precipitation events or snowmelts and spill into floodplains. When floodplains are kept naturally forested and with networks of wetlands, they serve to dissipate the velocity and disperse the volume of flood waters and reduce downstream hazards to human health and impacts to property.

Many of the agricultural areas in West Vincent and the region have been cleared of natural vegetation for centuries, allowing streams to cut deeply into their channels and reducing their ability to overflow their banks into the floodplain. More and more storms only produce "bankful" conditions where streams do not rise into the floodplain but simply gouge and erode their banks and deposit sediment downstream.

By clearing vegetation, grading soils, and paving more of the land, even with stormwater management systems, we alter the natural flooding process in a way that concentrates greater volumes of water in local streams over a shorter period of time. The cumulative effect is manifested in more frequent, damaging and hazardous floods in the lower sections of watersheds along larger streams and river and at points where streams converge. West Vincent Township has experienced flood problems in a number of locations, including at St. Matthews Road and Route 401, Flowing Springs Road at Birch Run, and Sheeders Mill Road.

The major cause of dangerous flooding is directly linked to urbanization, as we pave over watersheds and allow most of the stormwater runoff to head directly into streams rather than recharging into the soil as it would do naturally. The suburban land-use pattern favors seemingly benign single-family residential neighborhoods and shopping

centers rather than large industrial manufacturing facilities or hazardous waste facilities. However, the construction sites, roads and parking lots, lawns and sewage systems of this deceptively tame suburban landscape are responsible for the greatest threats to water quality and quantity in the watershed.

Groundwater Depletion

Nearly all residents in West Vincent Township rely on private wells drawing groundwater from underlying aquifers for their water supply. Most homeowners do not monitor their well levels or amount of water consumption other than during times of drought when County and State agencies issues water use restrictions.

Ground water depletion is a serious condition that can lead to drying of local wells, and loss of baseflow to wetlands and streams. The dense crystalline geology underlying West Vincent means that well yields are often low (less than 15 gallons per minute). Loss of natural groundwater recharge may result from a number of factors, including clearing of natural vegetation and replacement with lawn, grading and compaction of soils, and construction of impervious surfaces such as paved areas and rooftops. Depletion of groundwater is difficult to monitor, since it requires comparison of well data over time, and most local wells are private and well-drilling permits and data on well levels and yields has only been required by the Chester County Health Departments in recent years. When wells go dry, it is difficult to pinpoint the cause—it may be a combination of factors including drought, shallow well depth, increased demand from surrounding wells, and increased impervious surface coverage.

In sum, the quality and quantity of surface and groundwater and the ecological integrity of natural areas are closely interrelated. Increased surface runoff generated by poorly planned development results in increased flooding and erosion, diminished groundwater levels, increased pollution of ground and surface water, increased concentration of pollutants, and reduced diversity of native plants and wildlife. **Stormwater Management** provides general guidelines and innovative strategies for stormwater management for areas under development that will minimize the impact to on- and off-site land and water resources.

Riparian Areas

Under natural conditions, the areas adjoining rivers, streams, lakes, and ponds are protected by forested "riparian buffers." But decades of deforestation, agricultural expansion, and increasing development have drastically reduced the extent of water edge protected by forest. A riparian buffer made up of a mixture of native plant types—herbs, shrubs, and trees—filters out sediment and pollutants, stabilizes banks, mitigates stormwater flows, reduces water temperatures, and provides food for aquatic organisms. It also provides a protected habitat for wildlife to obtain water without being exposed to predators. Because these riparian areas are crucial to the protection and enhancement of water resources, a lack of riparian buffer has an adverse effect on the quality of water and aquatic habitats, and limits the overall wildlife benefits of a site.

The ideal riparian buffer recommended by the US Forest Service is a 95' strip along each side of a stream or water body consisting of three zones. The first zone is a 15' strip next to the stream or water body of an undisturbed forest that provides detritus and helps maintain lower water temperatures vital to fish. The second zone is a 60' strip of managed forest where filtration, deposition, plant uptake, anaerobic denitrification, and other natural processes remove sediment and nutrients from runoff and subsurface flows. The third zone is a 20' grass or grass and shrub strip providing runoff control where concentrated flows are

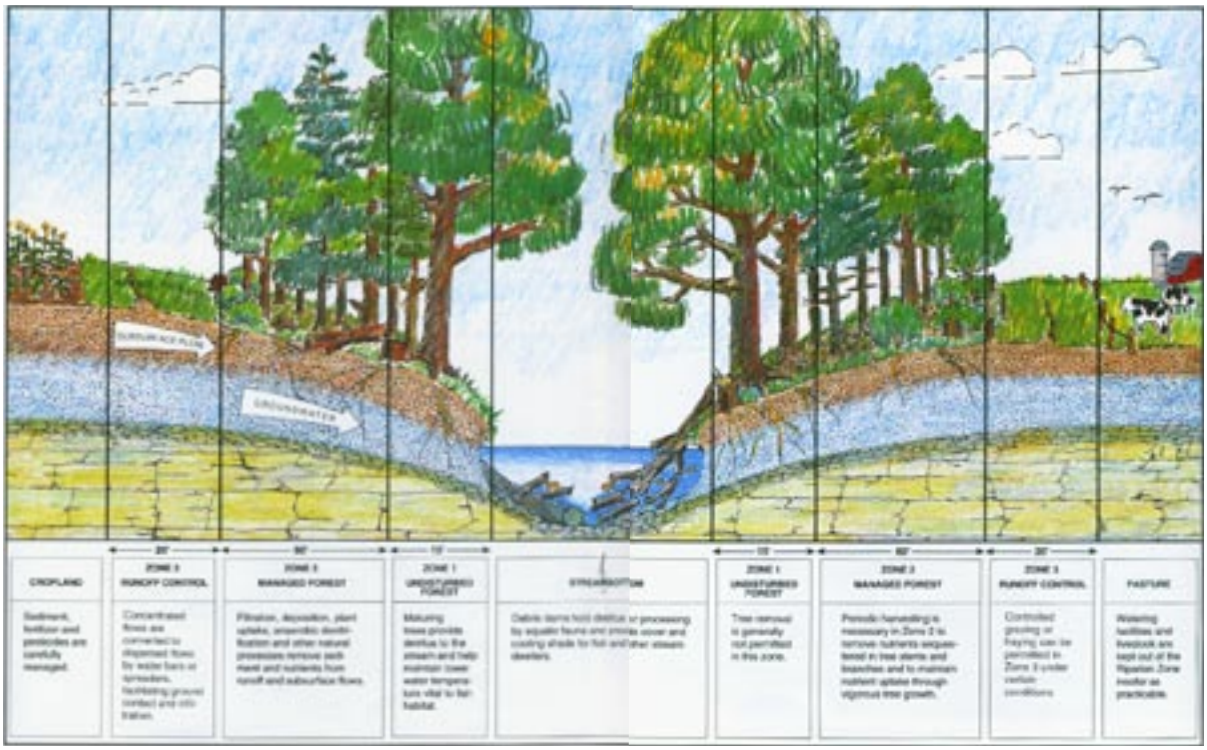
Lack of riparian buffer

converted to dispersed flows by water bars or spreaders, facilitating ground contact and infiltration. Narrower forest and shrub buffers, as well as properly designed grass buffers, also provide degrees of benefit.

Many streams in the northern portions of West Vincent Township benefit from full or partial riparian buffers, including numerous tributaries of Birch Run and French Creek that flow through forested headwaters areas. According to a *Riparian Buffer Assessment* prepared by the Heritage Conservancy, French Creek and its tributaries support the greatest concentration of stream miles in West Vincent that are fully or partially buffered by forest vegetation.

Recreational Use

As the amount of natural lands decrease across the region, the value of those remaining grows for both private landowners (as quiet retreats from today's overdrive world) and public landowners (as places for their constituents to recreate). Public landowners and private landowners allowing public access to natural lands are under increasing pressure to allow and facilitate more types of use by greater numbers of people. The 12.9-acre West Vincent Township Park at St. Matthews Road and Route 401 is a popular active recreation site with ballfields and trails, but no natural areas. The



The Streamside Forest Buffer *(USDA Forest Service, 1992)*

adjoining Township Building campus includes natural areas such as meadows and wetlands along a small headwaters tributary of Pickering Creek.

Natural lands can accommodate many types of recreational use if the type and level of use is tempered by the resiliency of the resources within the natural lands. Each type of use places different demands on site resources and each site has a different level of resiliency to each type of use depending on site characteristics, i.e., soils, slope, hydrology. Natural lands with well-drained soils, isolated wetlands, and no special plant or animal resources can tolerate a greater volume and more types of use than natural lands with extensive wetlands and species of special concern.

Each landowner must decide which uses will be allowed within the natural lands under their control. Sometimes this decision has already been made by a previous owner and conveyed through a restriction placed in a will, conservation easement, or deed restriction. If public money (state, county, municipal) is used to protect a property, there is often a requirement to allow some form of public access. In general, use of protected natural lands should be restricted to passive recreation such as hiking, birdwatching, and nature study. In some cases use by equestrians and mountain bikes is allowed. Motorized vehicles are usually only allowed for stewardship activities.

As part of developing a stewardship plan, the landowner should understand the inherent environmental conditions and determine what types of use can be allowed and the appropriate level and place for each use. It is important to make sure that recreational uses do not degrade the environmental and ecological benefits that made the natural lands worth protecting. To that end, it is a good rule to gradually add uses after the impacts of each use has been ascertained. Start with allowing the use that has the least impact—pedestrian use—and add new uses (or expand current use areas) if the natural lands have not been noticeably degraded. It is much easier to not allow a particular use from the start than to try to stop it after negative impacts are realized.

The following are a few issues and considerations related to public use of natural lands that should be addressed in a stewardship plan for natural lands that will be used for recreational purposes.

Meadows, wetlands, and a walking trail at the Township Building campus

Paved trail at Matthews Meadows

Trails

West Vincent Township supports an established and growing trail network used mainly for horseback riding, hiking, and cycling. The West Vincent Township Walk Way meanders for nearly one-half mile through the Township Park at St. Matthews Road and Route 401. Two regional trails pass through the township—the Horseshoe Trail, a 140-mile trail connecting Valley Forge and the Appalachian

Trail, and the French Creek Trail. New trails, such as those at Matthews Meadows and Weatherstone, are often required as a condition of approval for new residential subdivisions.

Trails are a feature that can both facilitate stewardship and recreational enjoyment of a property and compromise management efforts and wildlife habitat. On the one hand, trails provide easier access through a natural area for stewardship activities and opportunities for observation, contemplation, exploration, and learning by recreational users. On the other hand, they often serve as avenues for the spread of invasive plants such as stiltgrass *(Microstegium vimineum)* and mile-a-minute *(Polygonum perfoliatum)*. If sufficiently wide and heavily used, they can become both a barrier to the movement of some wildlife (mice, salamanders) and a "wedge of edge," resulting in a loss of interior forest habitat.

Trails are essential for proper stewardship and recreational enjoyment of natural lands, but if poorly designed or misused they can become stormwater channels that cut into hillsides and remove organic and inorganic soil resources. In severe cases, gully erosion can lower the water table and stress established vegetation. Users (hikers, equestrians, mountain bikers) of natural lands may create trails as the need or inspiration arises. This not only results in the formation of potential erosion channels, but also tramples vegetation and expands the amount of compacted soil. Compacted soil results in lower water percolation and soil gas exchange—both detriments to vegetation.

When recreational use of natural lands is a high priority, trails are the best way to direct that use. The main concerns with walking trails are (1) limiting the number of trails to minimize soil exposure, (2) properly routing trails to direct pedestrians to where they should go and away from where they should not go, and (3) minimizing soil erosion potential through proper construction and maintenance.

If a trail system already exists in the natural lands, it should be reviewed and modified with the goals of minimizing the number of trails (to limit maintenance needs, erosion potential, and soil compaction) and addressing current erosion and safety problems. In general, this will entail closing redundant trails, rerouting trails, and installing appropriate water control structures in unavoidable problem areas. Construction of any new trails should be kept to a minimum, particularly in forested areas, to prevent fragmentation. Unwarranted, ad hoc creation of new trails or inappropriate use of trails in publicly accessible natural lands should be addressed through education (signage, informational brochure, meetings with user groups) and enforcement. It is also recommended that the use of vehicles on trails be minimized, as heavy equipment can disturb and compact soil and, through transport on its tires, can deliver weed seeds to new areas.

Guidelines for design, construction, and maintenance of trails can be found in **Trail Design and Maintenance**.

Dogs

People walking leashed dogs can be a compatible use of natural lands if dog owners follow a few simple rules. First, dogs should be leashed at all times. Allowing a dog to run off-leash—except on the owner's property or for lawful hunting—is prohibited by state and (most) local community laws, as stated by the West Vincent Township Police Department on the township's website. West Vincent has appointed an Animal Control Officer with the power to fine owners whose dogs are not leashed in public or are allowed to run free. Unleashed dogs threaten the safety and recreational enjoyment of other users. Second, walking should be limited to an established trail system to prevent dogs from harassing or killing wildlife, disturbing understory vegetation and degrading streambanks. This damage may seem insignificant

or even unnoticeable to us, but to birds nesting in a meadow or native plants just peeking through the soil, the disturbances can be severe, even deadly. Finally, owners should clean up after their pets. Besides being a public nuisance, dog waste can degrade local water resources. Waste left in a natural area can be washed into streams or ponds during storm events and contribute disease-causing bacteria—including E.coli and fecal coliform bacteria—and excess nutrients to local water sources. The latter can lead to algal blooms that eventually decrease the oxygen level of the water body and adversely impact native aquatic organisms.

Horses

Southeastern Pennsylvania has a long tradition of equestrian use of natural lands, and West Vincent is home to a number of horses and equestrian trails. Equestrian use of natural lands can be compatible with other recreational uses and have minimal impacts on natural lands if trails are properly laid out and maintained and equestrians are responsible users. Potential conflicts with stewardship goals and other users exist if the latter is not achieved. Horses can damage trails if they are overused or used during inappropriate (wet) times. Using natural lands as a horse training or exercise facility is hazardous to pedestrians; horse excrement on trails is an unwelcome obstacle for pedestrians and another potential vector for weed seeds. Unless it is an existing use of the site, equestrian use should be added cautiously and only after other uses are established. Ideally, trails can be wide enough (or separate trails created) to minimize the potential conflict between pedestrians and riders.

Mountain Bikes

Mountain bikes can be relatively benign in natural lands under certain conditions (large area, low frequency, resilient resources); however, they are problematic if the activity is concentrated and in mixed-use situations. Repeated use of trails can accelerate trail erosion by funneling stormwater into narrow, continuous channels. Off-trail exploration disturbs understory plants and wildlife. Most importantly, bikes can threaten the safety and recreational enjoyment of pedestrians if the riders are irresponsible users. As with equestrian use, mountain bikes are best added after primary uses are established. Mountain bikers should be informed that use of natural lands is a privilege that will last as long as they respect the land and other visitors.

Hunting

Currently, the overabundance of white-tailed deer and Canada geese are stewardship issues that can significantly impact the plant and water resources of a site. While the impact of geese can often be addressed through eliminating the cover types that attract them (open water and lawn), reducing the impact of deer on natural lands is best achieved—at this point—through lethal removal. Under current Pennsylvania Game Laws, the most practical lethal removal option is hunting during established seasons. (See **Wildlife Management** for discussion of other lethal and non-lethal options.) Hunting can be compatible with other recreational activities if it is properly regulated and organized. Ideally, hunters should be screened and qualified by a proficiency test so that only responsible and skilled hunters are allowed on site. This will result in quick, clean kills and maximize safety for other users, including other hunters. Hunters should be informed that they are a vital part of the stewardship program for the site and not just involved in a recreational activity. See the description of Natural Lands Trust's deer management program under **Wildlife Management** as a model for a regulated hunting program.

Dead Wood

Although often viewed as unsightly waste material, dead wood is the foundation

of the forest food chain and also provides shelter to many animal species. In addition, fallen logs and limbs serve as a water reservoir in times of drought. They soak up water and can retain it for long periods of time, providing nursery sites for seedlings, especially during dry spells. Small animals like salamanders depend on large logs for needed moisture. Logs help control erosion by inhibiting surface water flow and by absorbing water in place. Mycorrhizal filaments reach up into fallen wood from tree roots to extract valuable nutrients. Individual standing dead trees—"snags"—are also important to leave, when they do not pose a hazard to humans or structures, because they are used as dens by many animal species and harbor insects and microorganisms that provide food for many birds and small mammals. These, in turn, are food for larger mammals and birds of prey.

Dead wood should be viewed as a valuable resource within natural areas. It should receive as little "processing" as possible. Hazard trees should, of course, be dropped to prevent injury to trail users, neighbors, or structures. Any tree downed by nature or chainsaw, however, should be left on the ground in as few pieces as needed to eliminate any trail obstruction, future hazard, or attractive nuisance. Care needs to be taken to avoid covering areas of special value such as dense stands of spring ephemeral wildflowers.

Organic Waste Disposal

Placing organic waste (grass clippings, pulled weeds, pruned branches, leaves, etc.) from landscaped areas in natural lands may appear to be a benign, perhaps even beneficial, means of disposal, but this practice can pose real threats. Such materials are often foreign to the ecosystem and behave very differently from the native accumulated materials. They often bear foreign seeds, insects, fungi, bacteria, and chemical properties, some of which can cause harm to native species. They are invariably placed in piles or thick layers and take much longer to decompose than the thin layers of material laid down naturally. These piles severely inhibit the establishment of native plant species from seed while typically providing favorable conditions for many introduced invasive species. Piles of branches created using native materials within a natural area can be beneficial to wildlife (see **Wildlife Management**).

Stockpiled and discarded organic waste is also unsightly, a potential hazard to humans and wildlife, and often becomes overgrown by invasive vegetation. These areas can then act as a source of seed and vegetative spread, fostering further invasion into nearby natural lands. Property boundaries need to be monitored on a regular basis to curtail dumping of lawn and garden waste by neighboring residents.

Stockpiled and discarded organic waste is unsightly and also a hazard to humans, wildlife, and the health of natural areas

Typical unsightly and hazardous structures and obstacles found on natural lands: old farm storage sheds, trees fallen across trails, and abandoned well heads

Aesthetics and Hazards

Residue from past human activities (agriculture, logging, partying) can still be found in natural lands. This can range from old structures (e.g., wells, foundations, fences) to scattered beer or oil cans to farm dumps filled with old fuels and pesticides. Natural lands are often used still as dumping sites for construction and landscape debris. This is not only unsightly, but potentially can introduce toxic material (asbestos, paint cans, painted wood, solvents, chemicals) or exotic vegetation into the area. To improve the aesthetic and recreational value of a property and to protect both humans and wildlife from harm, an effort should be made to catalog and remove unsightly and potentially harmful materials and structures from natural lands.

In addition to the removal of old debris and hazards, a regular monitoring program should be established to identify and address future issues as soon as possible to minimize their potential impacts. Periodically (as often as practical for the landowner or manager) walking the property boundary and any internal public roads is a good way to identify dump sites by motorists or neighbors. Of particular interest to every landowner with forested natural lands should be the monitoring and removal of "hazard" trees. Trees can become a hazard if they exist near an area or structure with high human use (residence, road, bench, picnic area) and they have a high potential to fall due to structural defects. Every landowner is responsible for injuries or damages that result from trees with obvious defects located on their property. All landowners have the obligation to make a reasonable effort to identify and remove hazard trees.

The level of scrutiny should be driven by the amount of human use and the presence of structures that could sustain damage in or adjacent to the natural lands. The monitoring program should focus on high use areas or areas with significant structures. An arborist, certified by the International Society of Arboriculture, should be hired to annually monitor high hazard areas (public and internal roads, off-site and on-site structures) and remove hazard trees. If possible, any cut portion of a tree in natural lands should be left on site as dead wood. Snags (dead, standing trees) in areas that are infrequently used are best retained for their wildlife benefits.

Ordinance Requirements

Creating a Legacy of Conservation Lands

Township Supervisors, staff, and advisory board members on the Planning Commission and Environmental Advisory Commission can use land use regulations to their advantage to achieve land stewardship goals. Two ordinances, Zoning, and Subdivision and Land Development, provide stewardship standards that should be evenly enforced as land is developed and used. The Pennsylvania Municipalities Planning Code authorizes Townships to adopt these ordinances and sets legal parameters for their content. Understanding regulations can help local officials "lighten the footprint" of new development. When new development requires greenway land, the emerging interconnected greenway network can be an asset for generations to follow.

Subdivision and Land Development Ordinance

The Subdivision and Land Development Ordinance (SLDO) standards determine how new development occurs, usually through subdividing an existing property into additional house lots, or by developing a single property into a multi-family or commercial use. A SLDO includes, among other standards, procedures for processing development applications, the content of the plans and documents that an applicant must provide to the Township and design standards such as those for streets, landscaping, and stormwater management. The first step in reviewing a new development application is to understand all of the applicable sections of Township regulations. Although not intended to be a thorough list of development requirements, Township officials can turn to the following when examining land stewardship issues.

SLDO Article IV – Plan Content Requirements

West Vincent Township encourages applicants to talk to the Township before filing an engineered Preliminary Plan. Dialogue early in the process, before huge sums are spent on engineering, holds advantages for the applicant, who can save on plan costs, and allows the Township to communicate conservation and development goals. For those applicants who choose not to participate in a voluntary Sketch Plan process, a mandatory Preliminary Plan still requires thorough natural resource consideration. A checklist of plan requirements, in SLDO Appendix A, facilitates Township review.

Township officials have the best chance of preserving and stewarding natural resources when they are documented on the plan and when open space is considered upfront

rather than as an afterthought. Fortunately for West Vincent Township residents, the plan review process requires consideration of natural areas first, before development is located. For more information, see the following SLDO sections:

- **Section 403 D. Existing Resources and Site Analysis Plan.** Requires a complete inventory of the natural and built environment.
- **Section 403 E. Preliminary Impact Analysis and Resource Conservation Plan.** Applicants must categorize areas as those of primary impact, secondary impact, and as protected areas. This section presents opportunities for the Township to ensure that natural resources are included within protected areas.
- **Section 403 F. Five Step Design Process.** One of the most effective ways to steward natural resources is to make sure that they are included in an interconnected greenway network. The Township requires that nearly all forms of development identify greenway land first, and then design the development *around, not over* natural, cultural, and historic resources.
- **Section 403 I. Stormwater Management Plan.** The Township requires that the Stormwater Management Plan address erosion and sedimentation control during construction. Without such a plan, wetlands, streams, and groundwater can be severely damaged during construction.
- **Section 403 J. Preliminary Greenway Ownership.** Applicants are required to submit a plan for the "Necessary and regular and periodic operation and maintenance responsibilities for the various forms of greenway land or open space (i.e., lawn, playing fields, meadow, pasture, cropland, woodlands, etc.), including mowing schedules, invasive plant control, etc.; and... regular yearly operating, maintenance and capital resources cost... changes to the maintenance plan shall be approved by the Board of Supervisors." This SLDO standard opens the door for discussion regarding greenway land stewardship—lawns versus forest, invasive plant removal, native species planting, etc.

SLDO Article VII – Resource Conservation and Greenway Delineation Standards

This article requires that "All subdivisions and land developments shall avoid or minimize adverse impacts on the Township's natural, cultural and historic resources, as defined below." The plans must demonstrate: natural infiltration and percolation of precipitation to the groundwater table; a non-negative water balance; designation of healthy woodlands as greenway areas; preservation of ground, shrub and canopy vegetation; and, non-disturbance limits on areas containing rare or endangered plants. In addition, Article VII sets standards for greenway land delineation and conservation during construction.

Zoning Ordinance

The Zoning Ordinance governs how all properties within the Township can be used, including the dimensions for improvements on individual lots. The Township is divided into a number of "zoning" districts each with its own use and dimensional standards. Nearly all of West Vincent Township is zoned for residential and mixed-use development and these districts encourage designation of open space ("greenway lands") whenever land is developed. Setting aside greenway land during the development process, ideally in conformance with the Township's "greenprint" or *Township-wide Potential Conservation Lands Map* (available from the Township), presents the most viable opportunity for conserving natural resources even as new development occurs.

Greenway Land

The following zoning districts require greenway land, usually 50% or more of the "buildable" land on the parcel in addition to floodplains, wetlands, and slopes steeper than 25%. Here's a quick guide to locating the greenway land requirements in Township zoning districts:

- **RC Rural Conservation (Article IV)** – see Section 405 for greenway land requirements in "Tiered" subdivisions.
- **R-3 Residential (Article V)** – see Section 505 for greenway land requirements in "Tiered" subdivisions.
- **R-2 Residential (Article VI)** – see Section 605 for greenway land requirements in "Tiered" subdivisions.
- **RM Residential Mix (Article VII)** – see Section 704 for Common Open Space.
- **VCC Village Center Commercial (XII)** – see Section 1204 for Open Space requirements.
- **VCR Village Center Residential (Article XIII)** – see Section 1304 for Open Space Requirements.

Overlay Districts

Floodplains and steep slopes are protected in "overlay districts" meaning that the regulations apply wherever these features appear. Articles XVI and XVII of the Zoning Ordinance should be consulted for specifics.

Zoning Article XIX – Design Standards for Site Planning and Greenway Lands Within Residential Development

These design standards are some of the most useful for achieving land stewardship goals within an interconnected Township greenway. Section 1905 C. Greenway Maintenance Standards, requires stewardship including "A Maintenance and Operations Plan... detailing the kinds of tasks that will need to be undertaken on a regular basis to control invasive species and to promote a varied habitat for plant and wildlife..."

Miscellaneous Sections Relating to Land Stewardship

Some zoning standards apply to individual properties, triggered when the property is extensively redeveloped, such as building a large addition. Other standards apply to specific situations, such as parking lot landscaping. Land stewardship is addressed in the following:

- **Section 2106. Landscaping and Screening of Parking Areas.** Although parking lots should not be built in sensitive natural areas, landscaping helps with stormwater infiltration and has microclimate benefits of cooling lots in the hot summer.
- **Section 2109. Village Design Standards.** The standards include, "the landscape shall be preserved in its natural state, insofar as practicable, by minimizing tree and soil removal."
- **Sections 2110 and 2206. Visual Resource Protection Standards and French Creek Scenic River Corridor.** These sections protect visual resources, not natural areas, per se, but in many instances, the two categories overlap.
- **Article XXIII. Water Resource Protection.** These standards apply to the most fragile soils in the Township. Protection of wetlands margins, special exceptions for high groundwater table uses, stream buffers, and special stormwater management requirements are contained in this section.
- **Appendix C. Selected Native Plant Species for Chester County.** Plans should be prepared by a landscape architect with experience in specifying native plant species. This list is an excellent guide for those reviewing the plans.

Landowner Education

Land use regulations empower local officials to hold development to high standards. However, a Township-wide greenway network will undoubtedly be a patchwork of privately owned and publicly owned lands, some protected from further development with conservation easements, and some privately held with few restrictions. Managing ecological systems such as wetlands and stream corridors, and maintaining community trails or neighborhood greens, will require the buy-in of residents who will be caring for segments of the greenway network. Whether a public trail or private marsh, community participation and buy-in will be as important as the enforcement capabilities of local officials.

Potential greenway lands on large lots managed as extensive lawn

Preparing a Stewardship Plan

Natural lands offer a broad menu of both stewardship challenges and opportunities for benefiting wildlife and human users. Successfully addressing the challenges and maximizing environmental, ecological, and recreational benefits requires a serious, on-going commitment to stewardship based upon a long-term perspective of protecting and enhancing the existing natural resources. Developing a stewardship plan is a good process for cataloging existing resources and issues and for developing and implementing stewardship goals.

The ultimate purpose of any stewardship plan is to provide direction for the landowner or manager to take a parcel of land from its current state to the desired state based on the landowner's present goals for the parcel. This might entail a significant change and a detailed plan or a simple plan that confirms or slightly modifies the stewardship activities already in place. By using the example of an existing healthy meadow you can see that if your present goal is to create a forest in this area to increase interior forest habitat, the plan would need to address many issues involved in converting the meadow to forest, including the types and number of trees to plant, when to plant them, and how to protect them from deer and invasive plants over several decades. On the other hand, if your goal is to continue to maintain the meadow for grassland bird habitat, the plan will codify the current stewardship regimen and address minor issues (e.g., spot spraying scattered invasives) to better protect on-site resources.

The process for developing a stewardship plan involves eight steps:

Step 1: Inventory existing natural resources to identify and better understand the natural resources within the property and current stewardship issues

Step 2: Delineate natural lands from remainder of the property

Step 3: Establish stewardship units to delineate areas with similar vegetation and past management

Step 4: Establish the conservation priority for the natural lands

Step 5: Establish the stewardship goals for the natural lands

Step 6: Determine appropriate strategies for each stewardship unit

Step 7: Prioritize and schedule tasks for each stewardship unit

Step 8: Establish a monitoring program to determine if goals are being met within each stewardship unit

An important point to remember is that because natural systems are continually evolving, land stewardship must similarly evolve over time as new stewardship issues are identified, land management knowledge and technology change, and stewardship goals are modified. Therefore, stewardship plans should be revisited on a regular basis (every 3–5 years) to make sure they are still appropriate in all respects. An annual review is ideal, especially following a significant change, such as new ownership or stewardship goals.

Step 1: Inventory Existing Natural Resources

The first step in developing a stewardship plan is to survey the property to identify the existing natural resources and document any issues that might impact the stewardship or use of the property through a process called site analysis. A site analysis will: (1) identify any legal restrictions on the property; (2) document the physical resources (geology, soils, hydrologic features, slopes) and vegetation (type, condition, and extent); and (3) note highlights, such as rare plants, scenic locations, trails, and large trees, as well as the presence of stewardship issues. This process should result in a thorough understanding of the property's environmental and ecological resources, the threats to the integrity of those resources, and the property's potentials—and limitations—for use.

Site analysis should include the creation of maps to visually display the site's resources *(see below)*. Usually, more than one map is needed to clearly show all the features of a property. A base map shows property boundaries, easements and rights-of-way, adjoining ownership, existing roads and structures, water features, forested and open areas, and any other relevant features. Maps that identify more detailed natural features—geology, soils, topography and slopes, hydrology, and vegetative cover—can then be mapped and overlaid on the base map separately or with other features.

Geology and soils will indicate what general type of plant communities (terrestrial or palustrine) would typically occur on the site. In some cases, the potential for uncommon plant communities (e.g., serpentine barrens) can be determined from an unusual geology. Hydrologic features include water features (ponds, streams, springs), wetlands, floodplains, and hydric soils. Moderate (15–25%) and

SITE ANALYSIS MAP

steep slopes (>25%) can be calculated from topographic contour lines.

The vegetation information gathered for a site analysis can range from simply identifying the plant communities present, to noting dominant native and invasive species, to undertaking a detailed inventory of the canopy, understory, shrub, vine, and herbaceous layers. Obviously, because stewardship largely involves manipulation of plant resources, the greater the detail the better. The level of detail, however, will depend on the available resources of the landowner. At a minimum, the location and description of existing cover types (i.e., forest, meadow, pond, stream, agricultural field, lawn, etc.) should be noted.

Highlights important to note include large trees, plant and animal species of special concern (rare, endangered, or threatened), patches of uncommon wildflowers (especially spring ephemerals), vernal pools, and wetlands. Issues that might be encountered include lack of native plant regeneration, invasive species, erosion (due to on- or off-site uses or problems), lack of adequate riparian buffer, old structures, hazard trees, and dumps.

INFORMATION SOURCE	TYPE OF INFORMATION PROVIDED	AVAILABLE FROM
Property deed	property line description, easements and rights-of-way, adjoining ownership	County
Tax map	property boundaries, easements and rights-of-way, adjoining ownership, roads	County and municipal offices
Survey	property boundaries, easements and rights-of-way, adjoining ownership, roads, structures, water features, wooded areas, topography, soils, wetlands, floodplain	owner, surveyor
Aerial photographs	roads, structures, water features, wooded and open areas	Delaware Valley Regional Planning Commission (DVRPC), Pennsylvania Spatial Data Access (PASDA), County
US Geological Survey (USGS) quadrangle maps	roads, structures, water features, topography	sporting goods stores, map stores/ dealers, library, Pennsylvania Spatial Data Access (PASDA)
Geology maps	geology	Atlas of Geologic Quadrangle Maps of Pennsylvania, library, Pennsylvania Spatial Data Access (PASDA)
County soil survey	soils, previous vegetation	Natural Resources Conservation Service (NRCS), Pennsylvania Spatial Data Access (PASDA)
National Wetlands Inventory maps	wetlands	US Fish and Wildlife Service, Pennsylvania Spatial Data Access (PASDA)
County Natural Areas Inventories	natural areas, species of special concern	County
Field surveys	site resources, stewardship issues	natural resource consultant

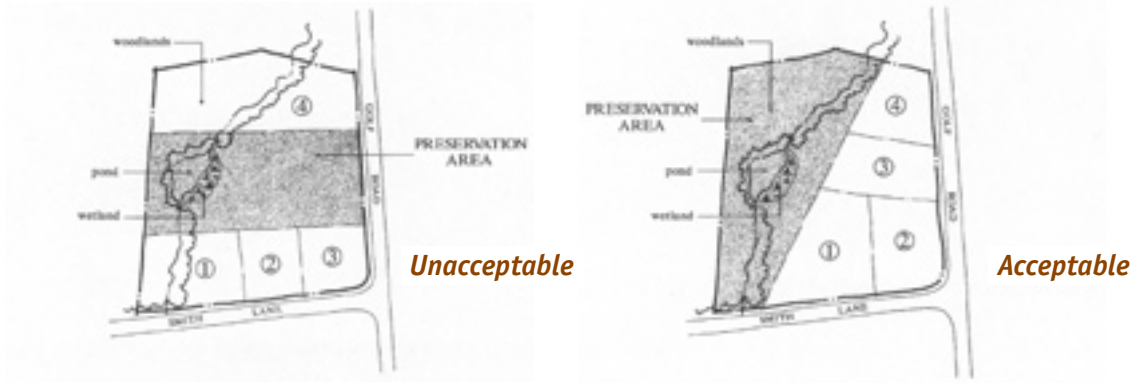
Step 2: Delineate Natural Lands

The next step in developing a stewardship plan is to use the information gathered through the site analysis to determine which areas of the property will be designated as natural lands and addressed under the plan. (For the purpose of the *Stewardship Guide*, we define natural lands as areas that are principally covered by plants that are native—or those that have become naturalized—to the southeastern Pennsylvania region. In general, natural lands do not receive or require ongoing, intensive management—as do agricultural or landscaped areas—to perpetuate.)

For most properties in this region, the general limits of the natural lands are fairly easy to establish. They are basically the areas outside of the landscaped and agricultural (cultivated fields, pasture, orchard) areas on the property. What will require some thought is: (1) whether any part of the current natural area will be used for other purposes in the future, such as the site for a house or playing field; or (2) if any of the current area in landscape plantings or agriculture can be converted to natural lands.

The following are simple guidelines to follow when refining the boundaries of the natural lands. These rules can be applied to private lands, including those instances where natural areas are being planned as part of a subdivision of a parcel, and public parklands. Following these guidelines will result in the design of better, more effective natural lands that meet the conservation goals of the landowner, maximize environmental and ecological benefits, and are easier to steward.

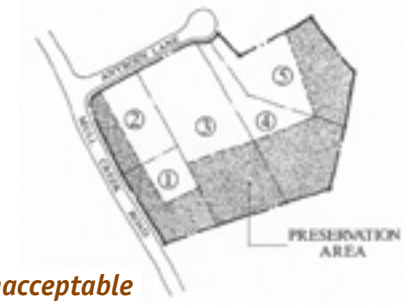
- **Natural lands should include the most sensitive resource area of a property.**



Unacceptable *Acceptable*

- **Natural lands should be designed as one, large block of land with logical, straightforward boundaries.**

~ *In the case of a planned subdivision with common open space, the natural lands should encompass as few ownerships as possible (preferably just one) to limit the difficulty and complexity of future monitoring and enforcement. If more than one ownership is absolutely unavoidable, then the natural lands should be configured so that one parcel contains all the sensitive natural area that is present, both to avoid fragmenting the natural system and to ease the burden of monitoring and enforcement.*



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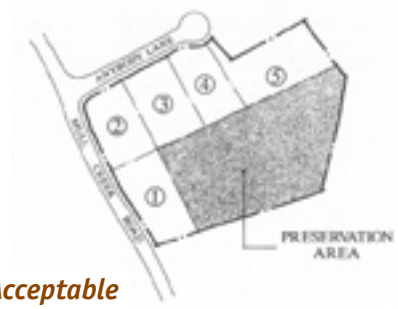

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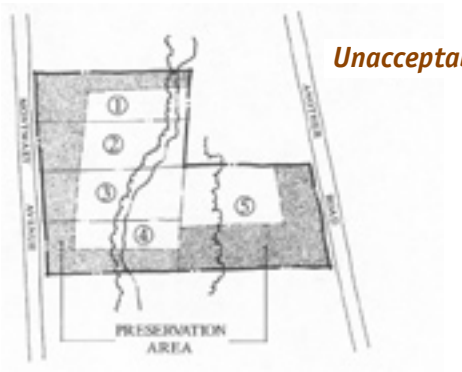
~ *Long, thin strips of land should be avoided as natural lands unless they are necessary to connect other significant lands or are designed to protect a linear resource that cannot otherwise be protected, e.g., a stream or trail.*



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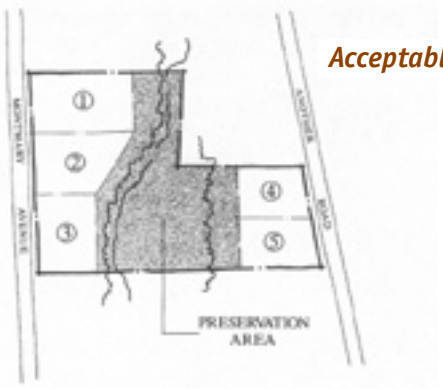
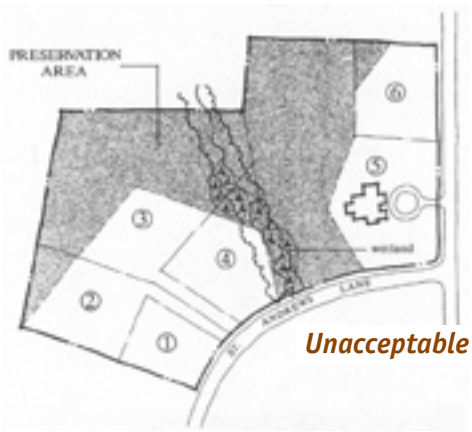


Acceptable

~ *Under no circumstances should a natural area extend into small corners of individual lots.*



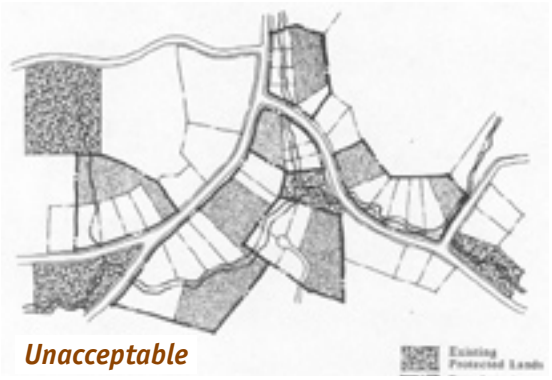
Unacceptable

Acceptable

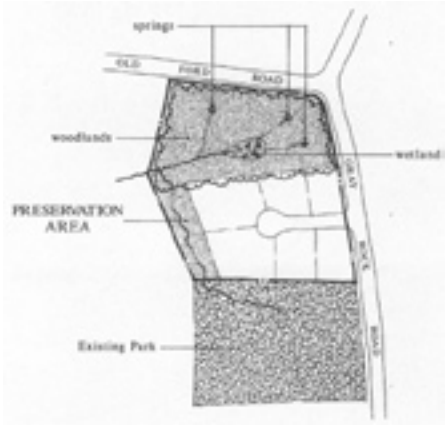
~ *The boundaries of natural lands should be designed to be as simple and straight as possible, so they can easily be found in the field and enforced. Where possible, natural boundaries or existing features of the land should be used.*

- **Natural lands should be designed as part of a larger continuous and integrated open space system. Maintaining or creating connections to natural lands on adjoining properties significantly increases the value of both areas.**

~ *If the natural lands are or will be legally protected, they should be designed to be contiguous to other protected areas on adjoining lands, if possible.*



~ *Where this is not possible, some connection to the other protected areas should be made.*



Step 3: Establish Stewardship Units

Unless the property is very small, its natural lands will usually consist of more than one cover type. Because stewardship goals, strategies, and tasks will often vary relative to the current cover type of an area it is helpful to distinguish areas with different cover types—or disconnected areas with the same cover type—into stewardship units. By delineating stewardship units on a map, it creates a common view and vocabulary for the property and allows you to discuss the current features and condition of each area of the property more clearly with family, consultants, and contractors.

STEWARDSHIP UNITS MAP

Step 4: Establish the Conservation Priority

Natural lands are conserved because they have some type of ***conservation value*** to current or former decision-makers. The decision-maker is the person(s) that placed a legal restriction (such as a conservation easement or deed restriction) on the property that runs with the property title or the person who currently holds legal title to the land. Examples of conservation values include:

- **Environmental** – high quality water resource, special geologic feature
- **Ecological** – important wildlife habitat, rare and endangered species
- **Recreational/Scenic** – natural environment for homeowner(s), passive use
- **Historical** – cultural features and use

- **Programmatic** – environmental education

If the landowner is trying to determine the conservation values of a site, the site analysis will identify the special features of the property that warrant conservation. The site analysis will, in most instances, identify more than one conservation value. Unfortunately, it is not always possible to steward natural lands in a manner that protects and enhances every conservation value of the site. The critical decision that must be made in developing a stewardship plan is which conservation value is most important, i.e., which is the ***conservation priority***. The conservation priority will be the engine that drives all future stewardship decisions for the natural lands. All stewardship decisions should focus on protecting and enhancing the conservation priority of the natural lands.

What or who determines the conservation priority of each site? While the relative importance of all conservation values should—and usually does—figure prominently in this decision, the conservation priority is ultimately determined by those with legal authority over the property. The following decision tree is designed to help you determine the conservation priority for the natural lands of any site.

1. **Do any legal documents, e.g., the will of the former owner, a conservation easement, a deed restriction, or the condition of subdivision approval, specifically dictate how the natural lands should be used or managed?** Examples could include: the site must remain in a particular condition (forest, meadow, agriculture); be managed for a specific species or group of animals (bog turtle, interior forest birds); or used for environmental education.

- *If the answer to this question is yes, the conservation priority is determined.*

- *If the answer to this question is no, proceed to Question 2.*

2. **Are there any features protected by federal regulations?** Plant and animal species listed on the federal Endangered Species List (e.g., bog turtle and bald eagle) are protected from activities that threaten the viability of the local population. Landowners with a listed species on their property should consult with the US Fish and Wildlife Service before undertaking any activity—you will be given an Incidental Take Permit if the activity will not harm the species—within the property. Although you do not violate any law by not consulting with USF&WS, if you proceed with an activity that does impact the species, you can be prosecuted under the Endangered Species Act.

- *If the answer to this question is yes, the conservation priority, at least for part of the natural lands, is determined.*

- *If the answer to this question is no (or yes, but it only impacts part of the natural lands), proceed to Question 3.*

3. **Does the current landowner have a specific conservation goal?** Without any specific legal restriction or federally regulated resource on the property, the current landowner has the authority to determine the stewardship of any property, within the guidelines of local ordinances. The landowner may have a specific goal for the natural lands such as habitat for interior forest or grassland birds, or timber production.

- *If the answer to this question is yes, the conservation priority is determined.*

- *If the answer to this question is no, proceed to Questions 4.*

4. **Can the property help protect or enhance a local, regional, or statewide conservation priority?** In many cases, the former or current decision-maker (landowner, township board of supervisors) did not or does not have a specific stewardship goal, but instead desires to see the property used to support a

general goal such as wildlife habitat, the protection of a high quality stream, or as a place for private or public recreation. While these goals will need to be addressed in the stewardship plan, their more general nature allows the conservation priority to be shaped by other conservation considerations and to change over time as the needs and concerns of the landowner or conservation community change.

In order to determine how best to use the property to fulfill general conservation goals, it is helpful to understand the conservation priorities of local, regional, or statewide organizations and agencies (see **Resources**) and to view the property as part of a larger landscape. Helping to address a larger conservation priority could help determine the conservation priority of the property. For example, there may be a plant species of special concern on or near the property that requires a forested environment to survive. Maximizing healthy forest on the property to protect the species of special concern could then become the conservation priority. On the other hand, if the property is part of a large, open landscape it may be able to help support threatened grassland bird species if it is maintained as a meadow. These two examples show that the same general conservation goals can result in very different conservation priorities and, in turn, very different stewardship plans for the same property.

Step 5: Establish the Stewardship Goals

Once you have determined the conservation priority for the natural lands, you are well on your way to establishing the stewardship goals, i.e., the desired future condition and use of the natural lands. The first stewardship goal should always be to protect and enhance the conservation priority of the property. There can be many other stewardship goals, but none should conflict with this primary goal. From the examples in Step 4 above, the stewardship goals could be as follows:

Primary goal

- Protect and enhance the forest species of special concern

Secondary goals

- Protect the water quality of the creek
- Provide recreational access for local residents

Step 6: Determine Appropriate Stewardship Strategies

Once goals are set for the entire natural lands of a property, stewardship strategies to achieve them can be established for each stewardship unit. Simply stated, the strategies lay out what will happen over the coming years in each unit within the natural lands to further the stewardship goals of the entire natural lands. Stewardship strategies should generally increase the environmental and ecological values of a unit while meeting a stewardship goal. The following are examples of common stewardship strategies.

Vegetation Management

~ Maintain current cover type

~ Convert to new cover type (discussed in detail in **Cover Type Options**)

~ Control invasive plants (physical removal, cutting, planting, herbicides, fire)

~ Establish mowing or burning regimen

Wildlife Management

~ Control pest species such as white-tailed deer and Canada geese

~ Enhance habitat by creating snags, leaving dead wood, installing nesting boxes and basking logs

Improve Aesthetics/ Eliminate Hazards

~ Remove trash

~ Discourage dumping

~ Remove or secure obsolete/ deteriorating structures

~ Remove hazard trees

Stormwater Management

~ Address active erosion

Establish and Maintain Trails

~ Construct and/or realign trails

~ Stabilize treadway (drainage, waterbars, bridges, etc,)

~ Establish mowing schedules

Step 7: Prioritize and Schedule Stewardship Tasks

The next step in creating a stewardship plan is determining what tasks need to be done and in what order to implement the stewardship strategies and achieve stewardship goals to protect and enhance the conservation priority for the natural lands.

Stewardship tasks are generally divided into restoration and routine tasks. Restoration tasks typically require a concentrated effort for a relatively short period of time. They often result from insufficient resources, interest, or knowledge to perform routine tasks (such as invasives control, deer management) in the past or from an unexpected disturbance to the natural lands, for example tree blowdowns from high winds, erosion from heavy rain, or illegal dumping. Routine tasks are ongoing (monitoring for unwarranted use or hazards, mowing trails, equipment maintenance) or cyclical (cutting vines in the winter, mowing or burning meadows in early spring, administering a controlled deer hunt) in nature.

Restoration and routine tasks will be generated largely by the stewardship strategies for the natural lands. Unless time or financial resources are unlimited, you will need to prioritize tasks in order to have the greatest impact with the available time and money.

The following are general guidelines for prioritizing restoration tasks.

- **Address hazards to humans and wildlife**, such as hazard trees, unsecured structures, or hazardous waste
- **Address issues actively degrading the conservation priority**, such as active soil erosion that is degrading high quality water resources

- **Remove unsightly debris** to not encourage additional dumping
- **Address issues impacting desired cover type**, such as invasive plants or deer

This should not be viewed as a list to be completed sequentially, but as a recommendation of the order in which issues should receive attention. In many cases restoration tasks will require contractors or volunteers, which can complicate the logistics of starting the work. Also, because project support is sometimes available from public agencies for restoration tasks (tree planting, erosion control) implementation can be delayed by required administrative tasks (e.g., applications, budget approvals).

The timing of routine tasks is generally dictated by the season *(see table at right)*. Routine monitoring of property boundaries, hazard trees and invasives is often best done during the winter months when access to and visibility within natural lands is easiest. Meadow mowing or burning has least impact on wildlife in early spring; trail mowing needs to occur throughout the growing season. Time available for deer management is restricted to the seasons set by the Pennsylvania Game Commission.

Step 8: Establish a Monitoring Program

To most efficiently and effectively meet the conservation goals established in a stewardship plan, environmental and ecological changes—those resulting both from management activities and from new influences on the property—should be tracked. With periodic feedback as to which stewardship activities are or are not working, together with increased knowledge and new technologies, those involved in management can continually adapt their stewardship of natural areas to meet established conservation goals. There should also be periodic (at least annual) monitoring to identify new disturbances (dumping, new invasive species, erosion) so they can be addressed as soon as possible.

The recommended approach for a practical monitoring program is to use the modern decision-support concept of "adaptive resource management" (ARM), which is a scientifically based way of "learning by doing." ARM has been termed "managing in the face of uncertainty, with a focus on its reduction." Implicit in this definition is that management can be improved if uncertainty is reduced. Summarized simply, ARM involves five basic steps, which are repeated cyclically:

1. Determine (or review and update) conservation priorities for the property.
2. Set and quantify a resource stewardship goal for each conservation priority.
3. Pick a set of stewardship strategies and tasks that are designed to move the system towards the goal.
4. Measure progress towards the goal at regular intervals (e.g., every three years) using indicator species and other environmental indicators.
5. Update the set of stewardship strategies and tasks based on the effectiveness of each action to move toward the goal.

QUARTER	TASK
1st Quarter (January – March)	**Monitor property boundaries for unwarranted use** 1. Repost as needed 2. Address unwarranted use as needed **Monitor for hazard trees** 1. Prune or remove as needed **Control invasive plants** 1. Cut vines in canopy trees 2. Cut/herbicide shrubs 3. Spray evergreen vines on days above 50˚ **Maintain meadows** 1. Mow prior to March 15th 2. Burn meadows if appropriate approvals and conditions exist **Mow/selectively cut shrublands if needed** **Perform winter maintenance on equipment and structures**
2nd Quarter (April – June)	**Prep and plant meadow prior to June 1st** **Water recently planted trees and shrubs as needed** **Maintain meadows** 1. Burn meadows if appropriate approvals and conditions exist **Control invasive plants** **Maintain trails** 1. Mow bi-weekly through growing season 2. Regrade and seed as needed 3. Install waterbars as needed **Perform equipment maintenance as needed**
3rd Quarter (July – September)	**Maintain trails** 1. Mow bi-weekly through growing season **Water recently planted trees and shrubs as needed** **Administer wildlife management programs if needed** **Control invasive plants** 1. Spray broadleaf weeds in grasslands **Perform equipment maintenance as needed**
4th Quarter (October – December)	**Administer wildlife management programs if needed** **Prep and plant meadow prior to November 15th** **Control invasive plants** 1. Cut vines in canopy trees 2. Cut/herbicide shrubs 3. Spray evergreen vines on days above 50˚ **Perform equipment maintenance as needed**

Stewardship Plan Summary

STEP	PURPOSE	LEVEL OF IMPACT
Step 1: Inventory existing natural resources	Catalog and map existing resources	Entire natural lands
Step 2: Delineate natural lands	Identify lands to be included in natural lands	Entire property
Step 3: Establish stewardship units	Outline areas with similar conditions for ease of planning and discussion	Entire natural lands
Step 4: Establish the conservation priority	Identify why the area is important to conserve and establish the most important conservation value	Entire natural lands
Step 5: Establish the stewardship goals	Establish the desired future condition and use of the natural lands	Entire natural lands
Step 6: Determine appropriate stewardship strategies	Determine what will be done to take natural lands from current condition to desired future condition	Stewardship units
Step 7: Prioritize and schedule stewardship tasks	Determine the order that tasks will be completed to implement stewardship strategies	Stewardship units
Step 8: Establish monitoring program	Create a means for determining the effectiveness of current stewardship strategies for achieving stewardship goals	Entire natural lands

Cover Type Options

Overview

Usually the greatest effect a land manager can have on achieving stewardship goals is through vegetation management. This can range from as little as removing a few invasive plants from a relatively pristine forest to converting an open field to forest through tree planting or converting a pond to meadow. Before you can make the decision to maintain the current cover type of a stewardship unit or convert a stewardship unit from one cover type to another, it is best to understand the characteristics of each cover type. Listed below are the major cover types that can be found in southeastern Pennsylvania, along with:

- a general description;
- the common expressions of this cover type in the region;
- its potential for addressing regional conservation priorities; and
- the current stewardship issues generally associated with the cover type.

This information and the site analysis will be used to develop the cover type strategy for each stewardship unit. Generally this is the most important stewardship strategy to develop in order to protect and enhance the conservation priority. The **Stewardship Matrix** below and guidelines within each cover type section are designed to provide direction for the development of the cover type strategy for natural lands within the region. Under the heading *Existing Cover Type* in the matrix are listed the various cover types common to southeastern Pennsylvania and found in West Vincent Township. For each cover type the options that are viewed as acceptable (because they provide significant environmental and ecological benefits) for natural lands are highlighted in green; options considered unacceptable are gray. Cover types such as landscaped and agricultural areas are not considered natural lands—although agricultural lands can provide many wildlife benefits (food, habitat)—due to the frequent disturbance and use of biocides and fertilizers that are characteristic of most management regimens for these cover types. Assistance for developing stewardship plans for these cover types can be obtained from the Pennsylvania Agricultural Extension Service (see **Resources** for contact information).

The determination of which cover type option is best for a given stewardship unit will be influenced by numerous considerations. These include site conditions, existing resources on adjacent properties, the historical use of the site, and the amount of financial commitment that can be given to the stewardship of the natural lands. All factors must be weighed in determining which avenue to pursue. In the case of sites that require fairly severe and expensive restorative measures, the best approach may be to plan for a slow, long-term restoration that spreads the cost over many years. In this situation, the cost of restoration is

Stewardship Matrix

	ACCEPTABLE OPTIONS					
EXISTING COVER TYPE	*preserve as is/enhance (healthy)*	*restore (degraded)*	*convert to forest*	*convert to shrubland*	*convert to meadow*	*convert to wetland*
healthy forest						
degraded forest						
hedgerow						
shrubland						
meadow						
pasture/cropland						
wetland						
stream/riparian area						
pond						
lawn/landscaped area						
traditional stormwater management area						

likely to be similar or less than that for maintenance of a lawn or formal landscape. It is recommended that the stewardship plan be a practical compromise between protecting the environmental, ecological, and historical resources of the property and providing recreational opportunities for the current and future property owners.

An overview and general stewardship guidelines for each option are provided under the referenced section below. The existing cover types are broadly divided into forested and open areas. The forested section is further segregated into healthy and degraded. For the purpose of this *Stewardship Guide* the term "healthy" refers to a resource that has not been significantly degraded by the natural or human issues noted above.

Forested Areas

Overview

A forest is an area dominated by trees that are greater than 15' tall and have a canopy cover of at least 60%. (Areas dominated by trees with 10 to 60% canopy coverage are termed woodlands. In this region woodlands rarely occur naturally.) Forested areas can exist as unbroken blocks, hundreds of acres in size, or as thin hedgerows along farm fields. Because most existing forests started in areas subject to clearcutting within the past 150 years or on abandoned agricultural fields, they are mostly even-aged forests, with most canopy trees of the same age. Uneven-aged stands will become more common—assuming no major wind event or the widespread use of clearcutting within the region again—as old canopy trees die and a new generation of canopy trees mixes with the old.

In addition to being described by community type (see **Major Plant Communities**), forests are often described by their relative age. Even-aged forests have four broad age categories through which they progress as they age. The wildlife and recreational benefits of the forest vary with each stage. A ***young*** forest is dominated by trees less than a foot in diameter. They are typically dense stands with few shrub or herbs. Within a ***maturing*** forest, numerous small snags (dead standing trees) represent the losing trees in the race to the canopy. As more light enters the forest floor, shrubs and forest wildflowers start to proliferate. In southeastern Pennsylvania this is typically the stage when the forest is colonized by invasive shrubs and vines which, if left uncontrolled, will rapidly degrade the forest and prevent it from reaching maturity.

In general, ***mature*** forests are the most common forest age class in the region. A healthy mature forest is commonly described as one that, as a whole, has age and structural diversity (well-defined canopy, understory, shrub, and herbaceous layers) and a variety of native plant species in all layers. (Because of these characteristics, a mature forest is probably the most aesthetically pleasing of the age classes, as well.) This creates a habitat that is beneficial to a wide variety of wildlife species, all of which use different areas within this three-dimensional mosaic to meet their food and cover needs.

Forests that survive environmental stresses and clearing for an extended period

Even-aged forests progress through four broad age categories, from top to bottom: young, maturing, mature, and old growth

of time eventually become ***old-growth*** forest. Although age (some define it as early as 150 years old) is one factor that determines whether a forest is "old growth," it also requires the stand to have high structural complexity and species diversity, a heavy accumulation of down woody debris, and a large number of snags.

The forests commonly found in West Vincent Township are in the 50- to 75-year old range, with older stands (100+ years) of oaks and beeches found in areas that were historically maintained as woodlots for local farms. These forests are generally located on land that proved less suitable for tilling, such as steep slopes, ridgetops, rocky soils, and wetlands. The majority of the French Creek, Birch Run, and Pickering Creek and their tributaries in West Vincent benefit from at least partial riparian forest cover along streambanks and floodplains.

Each age category provides different wildlife and recreational benefits and stewardship challenges. Wildlife habitat value is further enhanced for any age forest by the availability of water resources (streams, seeps, ephemeral pools), evergreen plant species, and "dead wood," both standing trees (snags) and fallen branches and logs.

Benefits to regional conservation priorities

- **Interior forests**—those areas over 100 meters (305') from an edge—are increasingly rare in the region due to fragmentation from development. They support many migratory songbird species that are declining along with the loss of this habitat.
- **Riparian forests** provide the greatest benefits to adjacent water bodies, particularly small streams. They help to maintain water temperatures through canopy shading, absorb pollutants and accumulate sediments from agricultural and residential runoff, stabilize streambanks, and add leaves and woody debris to the stream that furnishes food and shelter for aquatic organisms.

Current stewardship issues

- **White-tailed deer** are a major issue impacting forests throughout the region and state. The current overabundance of deer makes both the perpetuation of existing forests and the establishment of new forested areas problematic. Maintaining forest as a cover type (which should be the strategy for all but the most degraded sites) requires that measures are taken to reduce deer access to forest resources, particularly seeds and seedlings.
- **Invasive plants** degrade forests in a number of ways. Invasive vines (oriental bittersweet, Japanese honeysuckle, grape, porcelainberry, five-leafed akebia, mile-a-minute) precipitate windthrow of large canopy trees and smother shrubs and small trees. Invasive trees (Norway maple, ailanthus) and shrubs (multiflora rose, shrub honeysuckle, autumn olive) can create a forest that is much less diverse in vertical structure and wildlife food than a native forest. The result is a decline in native wildlife populations, particularly migratory songbirds.
- **Fragmentation and edge effects** exacerbate the impacts of deer and invasive plants by providing the habitat that is most attractive to them. Fragmentation also lowers the habitat value of forest by reducing interior forest. If consistent with the conservation priority of the site, stewardship cover types should be modified to minimize edge and fill in forest gaps.

Overall, the forest cover type provides the greatest number of environmental, ecological, and recreational benefits. Unless the stewardship unit is highly degraded and the conservation priority would benefit from additional open cover, every

effort—within the practical limits of the landowner's resources—should be made to maintain the unit as forest. Cover type options for forests in different forest conditions (healthy, degraded) are addressed below. Hedgerows are a special variety of forest that is addressed separately.

Landowner Input

Forest can be one of the least intensive cover types to manage or one of the most intensive, depending on the current condition of the forest and the specific stewardship goals of the landowner *(see tables below and following page)*. If the forest is already in a healthy condition the landowner (either themselves or through a hired manager) will only need to monitor the property to identify future stewardship issues (over-browsing by deer, invasive plants) that can threaten forest health. On the other hand, if the forest is highly degraded and one of the stewardship goals is timber production favoring oak species, a larger commitment will be required to steward the forest. Below is a table that shows the basic tools and considerations that will be required of the landowner if they chose to steward this cover type under different stewardship scenarios, along with the available assistance from public agencies and private organizations and consultants (see **Resources** for contact information).

CONDITION	STEWARDSHIP GOAL	
Healthy Forest	*General Wildlife / Recreation / Scenic / Biodiversity*	*Timber Production*
Assistance	PA Audubon, PA Bureau of Forestry, PA Game Commission, Penn State Extension, private consultants (foresters, wildlife biologists, botanists)	PA Bureau of Forestry, private consulting foresters
Tools	1. Monitoring: Plant ID books, Deer Impact Guidelines 2. Invasives control: pruners, pruning saw, chainsaw, herbicide	1. Monitoring: Plant ID books, Deer Impact Guidelines 2. Invasives control: pruners, pruning saw, chainsaw, herbicide
Considerations	1. Monitor for invasives at least annually and control as quickly as possible 2. Monitor deer population and maintain at appropriate level (5-10 per square mile) 3. Determine types of use; develop facilities (trails, bridges, benches, signage), as needed, to accommodate	1. Monitor for invasives at least semi-annually and control as quickly as possible 2. Monitor deer population and maintain at appropriate level (10–20 per square mile)

CONDITION	STEWARDSHIP GOAL	
Degraded Forest	*General Wildlife / Recreation / Scenic / Biodiversity*	*Timber Production*
Assistance	1. Stewardship Information: Available from PA Audubon, PA Game Commission, Penn State Extension 2. Contractor/volunteers to address invasives 3. Wildlife management consultant to develop deer management program	1. Timber Management: Engage a private consulting forester 2. Contractor/volunteers to address invasives 3. Wildlife management consultant to develop deer management program
Tools/Materials	1. Monitoring: Plant ID books 2. Invasives control: pruners, pruning saw, chainsaw, herbicide, heavy equipment 3. Tree planting: adding seedlings to forest gaps	1. Monitoring: Plant ID books 2. Invasives control: pruners, pruning saw, chainsaw, herbicide, heavy equipment 3. Tree planting: adding seedlings to forest gaps
Considerations	1. Prioritize invasives control tasks 2. Determine appropriate deer control method 3. Determine types of use; develop facilities (trails, bridges, benches, signage) to accommodate	1. Prioritize invasives control tasks 2. Determine appropriate deer control method 3. Determine types of use; develop facilities (trails, bridges, benches, signage) to accommodate

Cover Type 1: Healthy Native Forest

Overview

There are undoubtedly few forested areas in southeastern Pennsylvania or West Vincent Township that remain in an ecologically healthy condition. To qualify as such would require the site to be well stocked with native trees relative to its age and site conditions, be free of invasive plants, and not be overbrowsed by deer. This could include a variety of "looks," from a dense stand of young tuliptree that has reclaimed an old field to a steep hillside dominated by a relatively open beech forest. A hedgerow would also qualify if it meets the criteria above. Any area of this type would be rare and would provide important environmental (air and water purification, erosion control), ecological (habitat for native wildlife), and recreational benefits.

Cover type option and guidelines

1a. Preserve As Is

The preferred stewardship option for natural lands with this cover type should be to preserve it in its current condition. In order to achieve this goal every effort should be made to minimize disturbance to the area—both from natural and human sources. Interior trails are compatible with the resource although they should be minimized since they often act as avenues for other disturbance factors such as

Healthy native forest

invasive plants and dumping. Most importantly, the site should be monitored on a regular basis for the presence of invasive vegetation, reduced levels of regeneration due to over browsing by herbivores (particularly white-tailed deer), or changes in environmental conditions (air or water pollution) that may adversely impact existing vegetation. If any of these conditions arise within the forest, the landowner/manager should consult **Section 2: Degraded Forest** and/or contact a qualified resource manager for an appropriate management solution. The Pennsylvania Bureau of Forestry can provide you with general information on forest stewardship and financial assistance programs, and a list of consulting foresters that you can contact for further assistance.

Severely degraded forest

Cover Type 2: Degraded Forest

Overview

The majority of forests in our region and in West Vincent Township exist in a more or less degraded condition. This usually results from the presence of invasive vegetation or a lack of advanced tree and shrub regeneration due to over-browsing by deer. Forests also are degraded by dumping and soil erosion.

The amount of degradation by invasive vegetation on any given property will vary relative to the age of the forest, the degree of fragmentation, the availability of seed, and the aspect of the site. In general, the vitality and impact of invasive plants increases directly with available light (an exception to this rule is Norway maple, a tree that is well adapted to growing in dense shade). Consequently, forests usually are degraded most severely along their edges (particularly those with southern or eastern exposure) and within interior gaps.

Cover type options and guidelines

There are two preferred cover type options for degraded forest. Which option or options is (are) chosen will depend on the degree of degradation, site conditions, available management budget, and the environmental, ecological, and recreational benefits of the resource. In general, options 2b and 2c should only be considered for sites that have been severely impacted by invasive plants.

2a. Restore to Healthy State

Because of the many environmental, ecological, and recreational benefits of forests the preferred option is to restore the degraded resource to its original state. Use the following guidelines in developing restoration and maintenance plans for degraded forests.

(1) Address the source of degradation as soon as possible to minimize restoration costs.

(2) Use the Deer Impact Index (see **Wildlife Management**) to determine whether degradation is due to an overabundance of white-tailed deer. If so, develop a strategy for reducing deer access to forest vegetation either by physical barriers or a reduction in the deer population.

(3) It will often require many years of treatment to successfully control invasives plants due to budgetary constraints and/or the vitality and persistence of invasive plants. See **Invasive Vegetation Management** for recommendations on how to prioritize invasive management tasks.

(4) To promote native tree and shrub regeneration within forest gaps protect existing seedlings with fencing, tree shelters, or flexible tree guards. If there is insufficient natural regeneration, plant native trees appropriate to light and moisture conditions. Trees should be planted on 10' x 10' spacings and protected from deer damage with measures such as fencing, tree shelters, or flexible tree guards. This should continue on an as-needed basis to assure that sufficient regeneration is available to replace canopy trees as they die.

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

(6) Remove any trash and dispose of according to current municipal and PA Department of Environmental Protection regulations.

(7) Correct soil erosion by rerouting trails along the contour and/or controlling water source. Fill gullies and plant with an annual rye and/or oats and native trees and shrubs. Do not use standard conservation seed mixes—they may introduce exotic species into the forest.

(8) Monitor the forest annually and address degradation as needed.

2b. Convert to Shrubland

This would be the preferred option if the conservation priority is to protect threatened shrubland birds and the landowner has the resources to complete necessary stewardship tasks. The landowner can either follow the guidelines under 2a to establish tree seedlings (using "short" species) across the area, or, if adequate tree and shrub regeneration is present, maintain through periodic mowing or selective cutting to prevent canopy tree species from dominating the site. Once shrublands are established, use the following guidelines to maintain them.

(1) Determine the limits of available mowing technology (i.e., how large of a tree or shrub can be cut) to set mowing frequency. In southeastern Pennsylvania, the mowing frequency will usually need to be between three and ten years to maintain a shrubland cover type. In most cases, it will be advisable to engage a contractor with specialized equipment to perform this work.

(2) An alternative method to maintain shrubland is to selectively remove, through cutting or herbicide, seedlings and saplings of tree species that typically grow to above 25' in height while leaving tree species (dogwood, redbud, hawthorn, blue beech) that typically do not exceed this height and native shrubs.

(3) Monitor annually for invasive species and control as needed.

2c. Convert to Meadow

A forest or hedgerow sometimes becomes so degraded by invasive plants that it is better to remove part or all of it with heavy equipment. This is most obvious when the majority (>75%) of the canopy trees have been killed or drastically deformed by vines; or when an undesirable species (e.g., Norway maple or ailanthus) is the dominant species. Creating a grass and wildflower meadow is one option other than reforestation that will provide many of the environmental benefits of forest and help to diversify the ecological

communities within the region. This option would be most appropriate if the forest is relatively small and adjacent to existing meadow. Use the following guidelines (and information in **Meadow Management**) for converting degraded forest or hedgerow to grass and wildflower meadow. For information more specific to your site contact the Natural Resource Conservation Service or Conservation District representative in your area.

(1) Prepare the area for seeding by eliminating all existing vegetation. Remove 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) Monitor the meadow for intrusion by invasive plants. Spot spray as needed to prevent re-establishment of invasives. For recommendations see **Invasive Vegetation Management**.

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

Cover Type 3: Hedgerow

Overview

Hedgerows are areas, now dominated by trees, which were left uncultivated between agricultural fields as windbreaks and disposal sites for rocks and other debris. Unless they are periodically cut back, hedgerows tend to widen over time as shrubs and tree seedlings creep into the open field. Due to the relatively high availability of sunlight, they are dominated typically by shade-intolerant or intermediate-intolerant tree species common to the area. They are a ubiquitous remnant of the agricultural legacy of the region, inhabiting remaining farmland, parks, nature

Degraded hedgerow severely impacted by vines

preserves, and subdivisions. Extensive networks of hedgerows commonly mark old property lines and fencerows in the Pickering Creek portion of the township, south of St. Matthews Road.

Benefits to regional conservation priorities

- Traditionally, hedgerows were seen as important ***corridors*** for wildlife movement, providing cover for small mammals and birds.
- Hedgerows can also be valuable as ***seed sources*** for afforestation projects on adjacent agricultural fields that are under conversion to forest.

Current stewardship issues

- ***Invasive plants*** are often prolific within hedgerows due to the high availability of sunlight. Hedgerows can act as bountiful reservoirs of invasives seeds that can be transported into nearby forests by wind and birds.
- Ground ***predators of threatened meadow bird species*** (fox, raccoon, coyote, feral cats) use hedgerows as cover and as travel corridors. In turn, avian predators use the canopy trees as perch sites from which to hunt these same birds. Hedgerows essentially fragment meadow like open gaps fragment forest and eliminate viable nesting habitat within 150' of the hedgerow edge. This risk can be reduced by keeping low cover to a minimum (cutting lower limbs/branches so that the hedgerow is open beneath).
- ***Hazard trees*** can be a potential problem if the hedgerow is part of a trail system with benches or observation points. Hedgerow trees are more exposed to environmental stresses than forest trees. High use areas near hedgerows should receive regular monitoring for hazard trees.

Cover type options and guidelines

Hedgerows are a remnant cover type whose value is diminishing as new conservation priorities are identified in the region. Whether or not to maintain a stewardship unit in this cover type will depend upon the conservation priority of the natural lands.

3a. Preserve As Is

If the hedgerow will eventually be part of a larger forest to enhance the conservation priority, then it should be stewarded along with the other forest resources within the natural lands following guidelines under 1a above.

3b. Convert to Shrubland

This would be the preferred option if the conservation priority is to protect threatened shrubland birds and the landowner has the resources to complete necessary stewardship tasks. The landowner can either follow the guidelines under 2a to establish tree seedlings (using "short" species) across the area, or, if adequate tree and shrub regeneration is present, maintain through periodic mowing or selective cutting to prevent tall-growing tree

species from dominating the site. Once shrublands are established, use the following guidelines to maintain them.

(1) Determine the limits of available mowing technology (i.e., how large of a tree or shrub can be cut) to set mowing frequency. In southeastern Pennsylvania, the mowing frequency will usually need to be between three and ten years to maintain a shrubland cover type. In most cases, it will be advisable to engage a contractor with specialized equipment to perform this work.

(2) An alternative method to maintain shrubland is to selectively cut remove, through cutting or herbicide, seedlings and saplings of tall-growing tree species while leaving tree species (dogwood, redbud, hawthorn, blue beech) that typically do not exceed 15' in height and native shrubs.

(3) Monitor annually for invasive species and control as needed.

3c. Convert to Meadow

If the conservation priority calls for maximizing open meadow habitat, the removal of the hedgerow could be warranted if it significantly reduces the fragmentation of meadow habitat. Follow guidelines under 2c to convert hedgerow to meadow.

Open Areas

Overview

The natural tendency for most sites within our region is to exist as forest. Maintaining areas as agricultural fields, meadows, pasture, or lawn essentially freezes the process of ecological succession that moves a site from domination by herbaceous plants (grass and forbs), to an intermediate stage dominated by shrubs and small trees, and then finally to forest. When these activities stop succession proceeds.

Trees—and therefore forests—gain dominance of the landscape by developing structural components (woody trunk and branches) that place their photosynthetic (food-producing) surface (leaves) above the leaves of other types of plants. This elevated position, however, exposes trees to numerous environmental stresses, including high winds (hurricane, tornadoes), ice, and drought. These stresses, along with tree pests and pathogens, have regularly over the centuries, disrupted the forest canopy by toppling isolated trees or hundreds of acres at a time. This has allowed non-tree or open cover types to persist in the region albeit in a mostly migratory pattern in response to random forest disturbances.

Human activities added to these ambient disturbances over the past 10,000 years. In particular, the extensive use of fire and, more recently, agricultural practices (forest clearing and subsequent abandonment of marginal fields as fertility or markets decline) by Native Americans and European settlers helped to maintain enough of these cover types to support wildlife species adapted to their conditions. As populations grow within the region and more land is more or less permanently disturbed (converted to houses, roads, shopping malls, etc.) and the amount of forest and agricultural lands decreases, the amount of these cover types is rapidly declining to the detriment of specialist species dependent on these particular habitats. Maintaining natural lands in these cover types can help support declining wildlife populations and perpetuate an historic component of the regional landscape.

West Vincent Township's landscape is generally a mix of forested, agricultural, and residential areas, with few areas of meadow that are in

	COVER TYPE	
	Shrubland	*Meadow*
Assistance	PA Audubon, PA Game Commission, Penn State Extension	PA Audubon, PA Game Commission, Penn State Extension
Tools	1. Monitoring: Plant ID books 2. Vegetation control: pruners, pruning saw, chainsaw, herbicide, heavy-duty field mower/brush cutter	1. Monitoring: Plant ID books 2. Vegetation control: field mower, herbicide
Considerations	1. Monitor for invasives at least annually and control as quickly as possible 2. Monitor deer population and maintain at appropriate level (5–10 per square mile) 3. Determine type and frequency of cutting	1. Monitor for invasives at least annually and control as quickly as possible 2. Monitor deer population and maintain at appropriate level (5-10 per square mile) 3. Determine types of use; develop facilities (trails, bridges, benches, signage), as needed, to accommodate 4. Determine whether it will be grasslands or grasses and forbs

the early stages of succession. Numerous hayfields in the area have meadow characteristics, particularly those where hay is harvested infrequently.

Landowner input

Stewardship of open areas presents challenges similar to forest stewardship. Like forests, the amount of landowner input will depend upon the current condition of the area. Use of these cover types is somewhat less complicated than forest because there are fewer options for stewardship goals to complicate stewardship decisions.

Because open lands have the natural tendency to succeed to forest, stewardship of these cover types can be more challenging requiring larger, more expensive equipment. Above is a table that shows the basic tools and considerations that will be required of the landowner who choses to steward the two major open cover types, along with the available assistance from public agencies and private organizations and consultants (see **Resources** for contact information).

Cover Type 4: Shrubland

Overview

Shrublands are open sites that have moved to the intermediate shrub/small tree stage of succession. They provide many of the environmental benefits of forest and unique ecological benefits (threatened wildlife habitat). Because they are used by species of birds uncommon to this area (chestnut-sided warbler, blue grosbeak, indigo bunting, yellow-breasted chat, American woodcock, grouse, northern bobwhite quail) they provide unique recreational (birdwatching and hunting) opportunities.

Benefits to regional conservation priorities

- Over the past century there has been a relative abundance of shrubland as forests resprouted from clearcutting and marginal farmland was gradually abandoned across the region. This abundance

Shrubland

has rapidly declined as forests have matured and houses have consumed more recently abandoned farmland. This has resulted in the decline of birds that prefer this cover type.

Current stewardship issues

- The perpetuation of shrublands requires the use of heavy mowing equipment to clear it periodically or the intensive "weeding" of tall-growing tree species.
- Their relatively open character makes shrublands ideal sites for invasive plants to become established, adding to the stewardship time commitment.

Cover type options and guidelines

There are three options for shrublands: preserve as is, convert to meadow, or convert to forest. Which option or options is (are) chosen will depend on the degree of succession and degradation, site conditions, available management budget, and the relative environmental, ecological, and recreational benefits of the resource. The difficulty of maintaining shrublands, and their potential to be reservoirs for invasive plants if not properly maintained, dictates that it is not a practical cover type to perpetuate for the typical landowner. However, if the conservation priority is threatened bird species, the site lends itself to dominance by shrubs and small trees (i.e., is wet or dry much of the year), or the landowner has the resources to undertake the required stewardship tasks, it is a very valuable cover type for wildlife.

4a. Preserve As Is

Shrublands are maintained in a healthy state through periodic mowing or selective cutting to prevent tall-growing canopy tree species from dominating the site. Use the following guidelines to maintain shrublands.

(1) Determine the limits of available mowing technology (i.e., how large of a tree or shrub can be cut) to set mowing frequency. In southeastern Pennsylvania, the mowing frequency will usually need to be between three and ten years to maintain a shrubland cover type. In most cases, it will be advisable to engage a contractor with specialized equipment to perform this work.

(2) An alternative method to maintain shrubland is to selectively remove, through cutting or herbicide application, seedlings and saplings of tall-growing tree species while leaving tree species (dogwood, redbud, hawthorn, blue beech) that typically do not exceed 15' in height and native shrubs.

(3) Monitor annually for invasive species and control as needed.

4b. Restore to Healthy State

This would be the preferred option for a mildly degraded site. Use the following

guidelines for restoring a degraded shrubland to a healthy state.

(1) Assess invasive plants and address by using recommendations in **Invasive Vegetation Management**.

(2) Use guidelines under 2a (using appropriate shrubland species) to fill in any shrubland gaps.

4c. Convert to Forest

This option can be either the easiest or hardest road to take depending on the status of succession (i.e., the number of native trees established) and the level of degradation by invasive plants. It will be the least costly if native trees are about to dominate the site and the amount of invasive plant material is small. It will be the most difficult option if native trees are sparse and invasive plants are prominent. Use the following guidelines to convert shrubland to forest.

(1) Identify native trees and release them from competition with invasive plants by cutting or wick application of herbicide. *(Note: native trees can usually out-compete invasive shrubs, but not invasive vines and trees.)*

(2) If necessary, augment natural tree regeneration by planting native tree seedlings. This will require a spacing of between 10' x 10' and 20' x 20'.

(3) Use protective measures such as fencing, tree shelters, and flexible tree guards to minimize deer damage to natural or planted seedlings.

(4) Reduce vegetative competition through selective herbicide use around base of tree (once or twice annually) or mowing (at least four times) during the growing season until the canopy has closed. After closure monitor for invasive plants and control as needed.

(5) Monitor annually for invasives and treat as necessary.

4d. Convert to Meadow

This option would be best if the site is heavily impacted by invasive plants. Creating a grass and wildflower meadow will provide many environmental and recreational benefits and help to diversify the ecological communities within our region. Use the guidelines under 2c (and information in **Meadow Management**) to convert shrubland to grass and wildflower meadows.

Cover Type 5: Meadow/Grassland

Overview

Meadows are open areas dominated by grass species (grasslands) or grass and wildflower species (meadows). They provide many environmental (erosion control, stream buffer), ecological (wildlife habitat), and recreational (walking and equestrian trails) benefits, and can be an attractive part of the landscape.

Historically, grasslands and meadows occurred as breaks in the eastern deciduous forest resulting from disturbances such as fire, periodic flooding, insect infestation, and clearing by humans—first by American Indians and later by European settlers. Most grasslands and meadows in eastern North America are short-lived ecosystems. Without repeated disturbance, trees and other forest plants seed in rapidly and reestablish the forest.

Since the first European settlement, native grasslands and meadows have steadily declined. These plant communities were once composed of hundreds of native plant species that, for millions of years, provided the highest quality food and habitat for native meadow wildlife. The typical grassland or meadow today is an abandoned field invaded by a few introduced species—multiflora rose, autumn-olive, Japanese honeysuckle, Amur honeysuckle, Canada thistle, mile-a-minute and Japanese stilt-grass are examples—that crowd out most native plants and degrade the habitat for many native animal species. Most grasslands and meadows in Pennsylvania have an agricultural past (old hayfields

Grassland

Meadow

or pasture) and are dominated by exotic cool-season grasses such as fescue, ryegrass, bluegrass, orchard grass, and timothy. However, the native meadow grasses that grow most abundantly in our region are warm-season grasses, including little bluestem, big bluestem, Indian grass, broomsedge, and switchgrass. Because they have lived here for millions of years (with interruptions during ice ages), native 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'–15', where possible.

Declines in populations of neotropical migrant birds that breed in the forests of eastern North America have received much attention, but grassland birds in the region are in even greater peril. Analysis of breeding bird survey data show that 16 of the 19 species that breed in grasslands in the East have shown declining trends and 12 of them have declined significantly. Populations of grassland nesting birds such as bobolink, eastern meadowlark, grasshopper sparrow, savanna sparrow, vesper sparrow, upland sandpiper, and northern bobwhite have declined drastically in recent years due to the loss of habitat and the fragmentation of remaining habitat into pieces that are too small to meet their needs. Most of this loss is from residential and commercial development and from changes in farming practices, such as earlier mowing times and the widespread cultivation of cool-season grasses.

Many butterfly species also have co-evolved relationships with particular species of 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. Little is known about the effects of declining native grassland habitat to other kinds of wildlife in Pennsylvania, including small mammals, snakes, lizards, turtles, insects and other arthropods, and various animals that live in the soil. But we can get some idea of the probable magnitude of the problem from surveys of one of the few groups that has been studied—moths—in the native grasslands of the State Line Serpentine Barrens along the southern borders of Chester and Lancaster Counties. These grassland remnants harbor, according to discoveries so far, at least three dozen moth species listed as endangered, threatened, or rare in Pennsylvania.

Benefits to regional conservation priorities

- Preserving habitat for grassland dependent species,

including several species of ***grassland birds*** (grasshopper sparrow, meadowlark, northern bobwhite, savannah sparrow) that are threatened due to the decline in this cover type. Maintaining this cover type, particularly in large blocks (greater than 50 acres) or as part of a larger, open landscape would provide habitat for these species.

Current issues

- Meadows and grasslands within our region are often impacted by ***invasive plants***, particularly vines (oriental bittersweet, Japanese honeysuckle), shrubs (multiflora rose, autumn olive, shrub honeysuckle), and herbaceous perennials (Canada thistle). They also can suffer from human disturbances such as soil erosion and dumping.

Cover type options and guidelines

There are four appropriate cover type options for meadows: preserve as is, restore to healthy conditions, convert to forest, and convert to wetlands. Which option or options is (are) chosen will depend on the conservation priority, the degree of degradation, site conditions, available stewardship budget, and the relative environmental, ecological, and recreational benefits of the resource.

5a. Preserve As Is

Because they are uncommon in our region, the preferred cover type option for healthy meadows and grasslands (those that have not been degraded by natural or human factors) is to undertake appropriate stewardship tasks to maintain them in a healthy condition. Meadows are kept in a healthy condition by following or mimicking the stewardship practices that have kept them healthy. In most cases this means they are periodically mowed, burned, or grazed to prevent colonization by woody plant species. Use the following guidelines to preserve established healthy meadows.

(1) Mow meadow once or twice a year at a height of 4"– 6" to prevent intrusion by woody vegetation or invasive vegetation. Recommended dates (to maximize ecological benefits) 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.

(2) 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.

(3) Monitor the meadow for intrusion by invasive plants. Consult **Invasive Vegetation Management** for recommendations on addressing any problems.

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

5b. Restore to Healthy State

This would be the preferred option for a mildly degraded site and would be one of the least costly of the four options to establish and maintain. Use the following guidelines for restoring a degraded meadow to a healthy state.

(1) Regrade and seed any eroded areas following guidelines under 2c.

(2) Remove and dispose of any trash according to current municipal and PA Department of Environmental Protection regulations.

(3) Eliminate invasives through spraying or wick application of appropriate herbicide or manual or mechanical removal. Use only herbicides approved for aquatic use for spray applications within 100' of water resources. *(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.)* Areas that are disturbed by manual or mechanical removal should be seeded with native wildflowers and grasses mixed with an annual grass (Canada wild-rye, Virginia wild-rye, or oats) to hinder reestablishment of invasives.

(4) Mow meadow once or twice a year at a height of 4"– 6" to prevent intrusion by woody and invasive vegetation. Recommended dates (to maximize ecological benefits) 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.

(5) 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.

(6) Monitor the meadow for intrusion by invasive plants. Consult **Invasive Vegetation Management** for recommendations on addressing invasives.

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

5c. Convert to Forest

This option would be most appropriate if the area is relatively small (less than 10 acres) and conversion would augment an adjacent forested area (and result in reduced edge or increased interior forest habitat), connect two existing forested areas, or provide a natural screen to improve aesthetics of the site. Although there are many environmental and ecological benefits to be realized from this strategy, it is also a strategy that requires significant time and resources to accomplish due to the overabundance of white-tailed deer and invasive plants in the region. Implementing this strategy will take many years of intensive stewardship to minimize the impact of these factors. Use the following guidelines to convert meadow to forest. These guidelines assume that conditions common to the area, specifically overabundant deer and invasive species, exist on the site. If native tree seedlings are already established in the meadow or the land manager believes that an adequate number of trees will become established naturally, you can start the process at step (3). In the rare instance of adequate native regeneration and low deer and invasives pressure, you can begin at step (5).

(1) Plantings should be spaced to allow for control of competing vegetation with available mowing equipment, but close enough for the canopy to close quickly. For forest and wide hedgerows this will require a spacing between 10' x 10' and 20' x 20'. Narrow hedgerows that principally serve as screens should have at least

20' spacings in staggered rows to allow for full development of each tree.

(2) Select native species that are appropriate for site conditions.

(3) Use protective measures such as fencing, tree shelters, and flexible tree guards to minimize deer damage.

(4) Reduce vegetative competition through selective herbicide use around base of trees (once or twice annually) or mowing (at least four times) during the growing season until the canopy has closed. After canopy closure, monitor for invasive plants and control as needed.

5d. Convert to Shrubland
This would be the preferred option if the conservation priority is threatened shrubland birds and the landowner has the resources to complete necessary stewardship tasks. Use guidelines under 3b to convert meadow to shrubland.

5e. Convert to Wetland
This would be the preferred option for a meadow that is relatively small, is adjacent to existing wetlands, and has topography that would lend itself to conversion to wetlands with minimal site work (e.g., light grading, construction of a low berm to capture surface water flow). On former agricultural fields this can sometimes be accomplished by breaking the drainage tiles that were installed to make the site suitable for agriculture. This option and the specific tasks required to implement this strategy, along with potential funding opportunities, should be explored with representatives of the Natural Resources Conservation Service, Conservation District, PA Department of Environmental Protection, or US Fish and Wildlife Service.

Cover Type 6: Pasture/Cropland

Overview

Pastures are open areas of short grass and forbs that are used for livestock grazing. Cropland is used to grow annual plants (e.g., grains, beans) and hay for consumption by humans and domesticated animals. A well-managed pasture or cropland has minimal impacts on adjacent natural lands and can be part of a landscape that supports threatened grassland birds such as bobolinks and meadow larks (see **Meadow/Grassland** above). Poor stewardship (the area is overgrazed, has exposed soil, or is full of weeds) can cause soil erosion (through increased surface runoff) on adjacent natural lands, degrade nearby water resources (through inputs of sediment and animal excrement), or act as a reservoir for invasive plant species. If the area is no longer needed for agricultural purposes, it can be added to the natural lands of the property. This would be particularly beneficial if the pasture or cropland is currently located in an area that is often wet. Pasture is an increasingly common agricultural use of land in West Vincent Township, particularly as the number of small horse farms grows.

Cover type options and guidelines

There are four cover type options for converting an existing pasture to natural lands: convert to forest, convert to shrubland, convert to meadow, or convert to wetland. Which option or options is (are) chosen will depend on the conservation priority, site conditions, and the available stewardship budget.

6a. Convert to Forest
This option would be appropriate if the planted area would augment an adjacent forested area (and result in reduced edge or increased interior forest habitat), connect two existing forested areas, or provide a natural screen to improve aesthetics of the site. Although there are many environmental and ecological benefits to be realized from this strategy, it is also a strategy that requires significant time and resources

to accomplish due to the overabundance of white-tailed deer and invasive plants in the region. Implementing this strategy will take many years of intensive stewardship to minimize the impact of these factors. Use the following guidelines to convert pasture to forest. These guidelines assume that conditions common to the area, specifically overabundant deer and invasive species, exist on the site. If native tree seedlings are already established in the pasture or the land manager believes that an adequate number of trees will become established naturally, you can start the process at step (3). In the rare instance of adequate native regeneration and low deer and invasives pressure, you can begin at step (5).

(1) Planting design should be spaced to allow for control of competing vegetation with available mowing equipment, but close enough for the canopy to close quickly. For forest this will require a spacing of between 10' x 10' and 20' x 20'. Narrow hedgerows that principally serve as screens should have at least 20' spacings in staggered rows to allow for full development of each tree.

(2) Select native species that are appropriate for site conditions.

(3) Use protective measures such as fencing, tree shelters, and flexible tree guards to minimize deer damage.

(4) Reduce vegetative competition through selective herbicide use around base of trees (once or twice annually) or mowing (at least four times) during the growing season until the canopy has closed.

(5) After canopy closure monitor for invasive plants and control as needed.

6b. Convert to Shrubland
This would be the preferred option if the conservation priority is threatened shrubland birds and the landowner has the resources to complete necessary stewardship tasks. Use guidelines under 3b to convert pasture to shrubland.

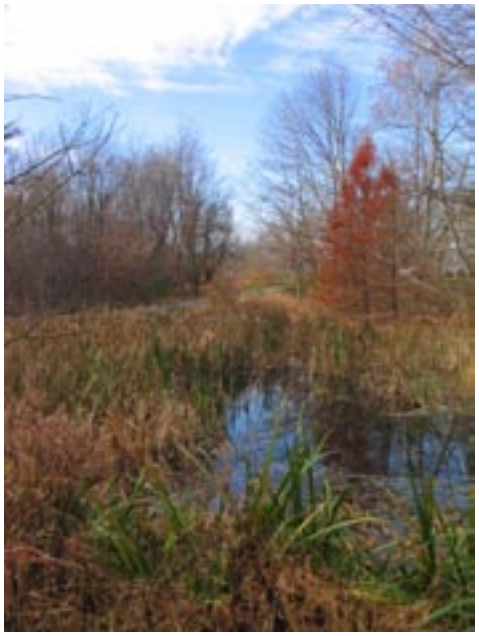
6c. Convert to Meadow
Meadows provide more environmental and ecological benefits than pasture and cropland and are less costly to maintain. This would be a preferred option if the area was no longer needed for animal grazing and it would augment an adjacent meadow. Use the guidelines under 5b to convert pasture to meadow.

6d. Convert to Wetland
This would be the preferred option for a pasture or cropland that was formerly wetlands (i.e., was previously drained for agriculture) or a pasture or cropland that is relatively small, is adjacent to existing wetlands, and has topography that would lend itself to conversion to wetlands with minimal site work (e.g., light grading, construction of a low berm to capture surface water flow). On former agricultural fields this can sometimes be accomplished by breaking the drainage tiles that were installed to make the site suitable for agriculture. This option and the specific tasks required to implement this strategy, along with potential funding opportunities, should be explored with representatives of the Natural Resources Conservation Service, Conservation District, PA Department of Environmental Protection, or US Fish and Wildlife Service.

Cover Type 7: Wetland

Overview

Wetlands are defined as areas which satisfy any one of the following parameters: (1) they support hydrophytic (water-loving plants), (2) they contain hydric soils, or (3) their hydrology is such that there is permanent or periodic inundation, or soil saturation for seven days or more during the growing season. Although historically maligned as wasteland, wetlands (particularly forested wetlands) are finally receiving proper recognition for the many important ecological and environment benefits



Wetlands

they provide. Because the stewardship of wetlands is covered by federal and state regulations that are periodically modified it is prudent to contact the Natural Resources Conservation Service, PA Department of Environmental Protection, or the Conservation District before conducting any stewardship activity in or near a wetland area.

Wetlands in West Vincent Township are generally confined to narrower seeps and springs in headwaters areas, along streams, and at the bases of slopes. Numerous ponds in the township have been constructed on sites formerly supporting wetlands.

Benefits to regional conservation priorities

- These include ***stormwater control***, ***stream buffers*** against pollution from soil erosion and chemical herbicides and fertilizers, and ***wildlife habitat***. For these reasons management activities within wetlands are highly regulated at the federal, state, and local level.
- Increase in overall availability of this cover type in the region.

Current issues

- There are three species of invasive plants that can be problematic in wetlands in the region. Purple loosestrife *(Lythrum salicaria)*, reed canary grass *(Phalaris arundinacea)*, and phragmites *(Phragmites australis)* can monopolize wetlands and reduce their ecological value.

Cover type options and guidelines

There are five options for wetland areas: preserve as is, restore to healthy state, convert to forest, convert to shrubland, or convert to meadow. Which option or options is (are) chosen will depend on the conservation priority, site conditions, and the available stewardship budget. Any permitted stewardship work within wetlands is best undertaken when the ground is frozen or dry (to minimize the impact to the resource) and after consultation with a representative of the Conservation District, PA Department of Environmental Protection, or Natural Resources Conservation Service.

7a. Preserve As Is

This would be a preferred option if the existing cover type is forest or meadow in a healthy condition. Consult Cover Types 1, 4a, and 5a for stewardship guidelines for maintaining healthy forest, shrubland, and meadow, respectively.

7b. Restore to Healthy State

This would be a preferred option if the existing cover type is forest or meadow in a degraded condition. See 2a, 4b, and 5b for management guidelines for restoring degraded forest, shrubland, and meadow, respectively.

7c. Convert to Forest

This would be a preferred option if the existing cover type is shrubland, meadow, pasture, or lawn. See 4c, 5c, 6a, or 10a, respectively, for guidelines to convert shrubland, meadow, pasture, or lawn to forest.

7d. Convert to Shrubland

This would be the preferred option if the conservation priority is threatened shrubland birds, the landowner has the resources to complete necessary stewardship tasks, and existing cover type is degraded forest, meadow, pasture, or lawn. Follow guidelines under 2b, 3b, 6b, or 10b, respectively,

to convert degraded forest, meadow, pasture, or lawn to shrublands.

7e. Convert to Meadow
This would be the preferred option if the existing resource is pasture or lawn/landscaped area. This would not be a preferred option if the existing resource is forest. Follow guidelines under 6c and 10c, respectively, to convert pasture or lawn/landscaped area to meadow.

Forested riparian area

Cover Type 8: Stream/Riparian Area

Overview

Riparian areas are land areas immediately adjacent to streams or ponds and typically include floodplains, alluvial soils, and stream related wetlands. Riparian areas can provide many environmental (as silt and chemical buffers for associated streams), ecological (wildlife habitat), and recreational (fishing) benefits and can be an attractive part of a property. Given their critical position adjacent to water resources it is recommended that all riparian areas be maintained as forest or meadow to maximize their buffering role. The width of the buffer needed to protect the stream resources and provide environmental and ecological benefits will vary relative to soils and slope. In general the buffer should be no less than 25' (ideally 95' or more) on either side of the stream and may need to be more to include sensitive areas such as wetlands. The exact extent of the protected stream corridor should be made on a case-by-case basis.

Benefits to regional conservation priorities

- Protect water resources through uptake of agricultural and residential chemicals, provide food for aquatic macroinvertebrates.

Current issues

- The stewardship of riparian buffers adjacent to or within developments can be compromised due the proximity of residences and their owners who complicate/eliminate deer management, use the area as dump sites, or prune understory vegetation to improve the view of the water body.

Cover type options and guidelines

As stated above, riparian areas should consist of forest, shrubland, or meadow to buffer the adjacent water resource. Therefore, regardless of the existing resource, the goal should be to maintain the corridor as healthy forest, shrubland, or meadow, or to move the existing resource to healthy forest or meadow. Use the **Stewardship Matrix** to reference the appropriate section for guidelines to achieve this goal.

Cover Type 9: Pond

Overview

Ponds are open bodies of water formed by damming a stream or through excavation. Although they are not a natural component of southeastern Pennsylvania (as they are in the glaciated areas of northern

Pond

Pennsylvania), ponds are common in the region due to their former use on farms (irrigation, fire control), for water supplies, or for flood control. Although they can provide environmental (as silt traps for associated streams), ecological (habitat for aquatic plants and animals, and waterfowl), and recreational (fishing, boating) benefits and can be an attractive part of the landscape, they are seen currently as having largely negative impacts on the water quality of any associated stream. They elevate water temperatures, block the migration of aquatic organisms, and, if surrounded by lawn, attract large numbers of Canada geese which further degrade the water through fecal deposition. From a basic stewardship perspective they also can require specialized maintenance (periodic dredging and dam repairs) that is potentially very costly and they are a liability concern. In this *Stewardship Guide*, we will address only ponds that are relatively small and part of larger existing or potential natural lands.

Benefits to regional conservation priorities

- Water source for wildlife

Current issues

- Thermal pollution of associate streams
- Attractive cover type for Canada geese. This leads to degradation of pond and associate streams.

Cover type options and guidelines

There are six cover type options for ponds: preserve as is, restore to healthy state, convert to forest, convert to shrubland, convert to meadow, or convert to wetlands. Which option or options is (are) chosen will depend on the conservation priority, site conditions, and the available stewardship budget. For further information on pond maintenance (or prior to any conversion of the existing resource) contact the Natural Resource Conservation Service (NRCS), the PA Department of Environmental Protection (DEP), or the County Conservation District.

9a. Preserve As Is

This would be the preferred option if the pond is in sound condition and there are sufficient funds to maintain the resource. It is recommended that the pond be buffered by forest, shrubland, or meadow. Consult the Stewardship Matrix above to reference the appropriate section for converting the existing buffer to forest, shrubland, or meadow. The buffer should ideally have a width of at least 75' to provide sufficient environmental and ecological benefits.

9b. Restore to Healthy State

This would be a preferred option if the conservation priority (e.g. environmental education) would be enhanced by perpetuating a pond and there are sufficient funds to both restore it to a sound condition and for long-term maintenance. Contact Natural

Resource Conservation Service (NRCS) and Pennsylvania Department of Environmental Protection (DEP) to make sure all current regulations are followed when undertaking pond restoration and to learn of any potential funding sources for the project. It is recommended that the pond be buffered by forest, shrubland, or meadow. Consult the **Stewardship Matrix** to reference the appropriate section for converting the existing buffer to forest, shrubland, or meadow. The buffer should ideally have a width of at least 75' to provide sufficient environmental and ecological benefits.

9c. Convert to Forest
This would be a preferred option if there is no desire to preserve the pond and approval was obtained from DEP for filling in the pond, or alternatively, breaching the dam. Use the following guidelines in implementing the strategy to convert a pond to forest. These guidelines start with the assumption that conditions common to the area, specifically overabundant deer and invasive species, exist on the site. If the land manager believes that an adequate number of native trees will become established naturally, you can skip steps (3) and (4). In the rare instance of adequate native regeneration and low deer and invasives pressure, you can begin at step (7).

(1) Follow DEP or NRCS recommendations for draining, removing structures, and filling. Regrade as needed to restore the natural topography of the site.

(2) Seed exposed ground with a combination of annual rye or oats to stabilize the exposed soil.

(3) Planting design should be spaced to allow for control of competing vegetation with available mowing equipment, but close enough for the canopy to close quickly. This will typically require a spacing of between 10' x 10' and 20' x 20'.

(4) Select native species that are appropriate for the site, which in this case are likely to be wetland conditions. For best survival trees should be 1"– 2" in caliper for hardwoods and 6'– 8' feet in height for conifers.

(5) Use protective measures such as fencing, tree shelters, and flexible tree guards to minimize deer damage.

(6) Reduce vegetative competition through selective herbicide use around base of tree (once or twice annually) or mowing (at least four times) during the growing season until the canopy has closed. After closure monitor for invasive plants and control as needed.

(7) Monitor annually for invasives and treat as necessary.

9d. Convert to Shrubland
This would be the preferred option if the conservation priority is threatened shrubland birds, the landowner has the resources to complete necessary stewardship tasks, and approval was obtained from PA DEP for filling the pond or breaching the dam. After filling and restoring the area to its natural topography according to DEP recommendations, follow the guidelines under 3b to convert a pond to shrublands.

9e. Convert to Meadow
This would be a preferred option if there is no desire to preserve the pond and approval was obtained from DEP for filling the pond or breaching the dam. After filling and restoring the area to its natural topography according to DEP recommendations, follow the guidelines under 2c to convert a pond to meadow.

9f. Convert to Wetland
This would be a preferred option if there is no desire to preserve the pond and approval was obtained from DEP for filling the pond or breaching the dam. This option and the specific tasks required to implement this strategy, along with potential funding opportunities, should be explored with representatives

of the Natural Resources Conservation Service, Conservation District, PA Department of Environmental Protection, or US Fish and Wildlife Service.

Cover Type 10: Lawn/Landscaped Areas

Overview

Lawn and landscaped areas are open areas that are formally landscaped and maintained principally for recreational and aesthetic benefits. Because they afford the least environmental and ecological benefits (indeed they can create environmental problems if not managed properly) and usually require the most financial commitment to maintain, their extent should be minimized. Adding part of this area to natural lands is a good way to increase environmental and ecological benefits and reduce overall stewardship costs for a property.

Benefits to regional conservation priorities

- None

Current issues

- The increase in suburban development has led to the proliferation of this cover type. The use of chemical biocides to maintain this cover type adds insult to injury by polluting the remaining natural resources nearby. Using natural lawn care and developing a tolerance for "weeds" can help to minimize the ongoing impact of this environmentally and ecologically worthless cover type.

Cover type options and guidelines

There are four options for lawn/landscaped areas: convert to forest, convert to shrubland, convert to meadow, and convert to wetlands. Which option or options is (are) chosen will depend on the conservation priority, site conditions, and the available stewardship budget.

10a. Convert to Forest

This option would be appropriate if the planted area would augment an adjacent forested area (and result in reduced edge or increased interior forest habitat), connect two existing forested areas, or provide a natural screen to improve aesthetics of the site. Although there are many environmental and ecological benefits to be realized from this strategy, it is also a strategy that requires significant time and resources to accomplish due to the overabundance of white-tailed deer and invasive plants in the region. Implementing this strategy will take many years of intensive stewardship to minimize the impact of these factors. Use the guidelines under 6a to convert lawn/landscaped area to forest.

10b. Convert to Shrublands

This would be the preferred option if the conservation priority is threatened shrubland birds and the landowner has the resources to complete necessary stewardship tasks. Use guidelines under 3b to convert lawn/landscaped area to shrubland.

10c. Convert to Meadow

Converting lawn/landscaped areas to meadow would increase the environmental and ecological benefits of the site, especially if it augmented an existing meadow, buffered a stream corridor, or was located on a wet or steep (>15%) site. Meadow can be "created" from lawn areas simply by reducing the mowing frequency to once or twice annually or through eliminating the existing vegetation and planting native meadow species. The latter option is preferable in that it allows the landowner to introduce desired species and to eliminate undesirable grasses (e.g., tall fescue and perennial rye) or invasives that compete with desirable species. The former option, however, may be more appropriate on wet or steep areas where meadow establishment procedures would be more difficult and could create environmental problems. Any plan that calls for the elimination of existing vegetation to establish meadow on wet or steep (>15%) areas should follow Soil Conservation Service

recommendations to minimize environmental impacts. Use the guidelines under 5b to convert lawn and landscaped areas to meadow.

10d. Convert to Wetland
This would be the preferred option for lawn/landscaped area that was formerly wetlands (i.e., was previously drained for agriculture), is relatively small, is adjacent to existing wetlands, and has topography that would lend itself to conversion to wetlands with minimal site work (e.g., light grading, construction of a low berm to capture surface water flow). This option and the specific tasks required to implement this strategy, along with potential funding opportunities, should be explored with representatives of the Natural Resources Conservation Service, Conservation District, PA Department of Environmental Protection, or US Fish and Wildlife Service.

Cover Type 11: Stormwater Control Structures

Overview

While natural lands are rarely the source of stormwater problems, they often suffer from poor stormwater management on properties upslope or upstream. Managing stormwater runoff from impervious surfaces is an essential aspect of land and water stewardship. If designed with careful attention to the ecology and hydrology of each site and each watershed, and with the use of innovative Best Management Practices (BMPs), projects can reach or exceed the predevelopment condition. More importantly—greenway lands within new subdivisions provide excellent opportunities to work "on-contour" with broader systems of berms, swales, and vegetated filter strips and better utilization of natural soils and vegetation than more concentrated development sites.

Unfortunately, many existing stormwater basins are maintained as lawn, which provides no wildlife benefits except for Canada geese. There are several options for converting to an alternative cover type to improve this condition and make stormwater structures a beneficial part of the property's natural lands.

Benefits to regional conservation priorities

- Stormwater basins maintained as lawn have no benefits as natural lands.

Current issues

- Conventional stormwater systems provide virtually no means of filtration for contaminants found in stormwater runoff, other than by allowing suspended solids to settle out in detention or retention basins.
- Stormwater basins maintained as lawn attract Canada geese.

Cover type options and guidelines

There number of options for stormwater control basins varies according to the professional to whom you speak. Engineers are usually opposed to planting woody vegetation within stormwater basins—particularly on the berms—because of concerns that the tree or shrub roots will undermine berms and any liners or recharge beds that may be associated with the bottom of the basin and that woody detritus can clog outflow structures. Ecological designers believe that woody vegetation will anchor soils on berms (like on streambanks) and promote recharge in basin beds (any clogging of outfall structures simply requires seasonal maintenance as an alternative to weekly mowing). In the least, stormwater basins can be converted to meadow to increase ecological benefits and eliminate the basin as an attraction to Canada geese.

11a. Convert to Forest
Follow guidelines under 10a.

11b. Convert to Shrublands
Follow guidelines under 10b.

11c. Convert to Meadow
Follow guidelines under 10c.

Historic Resources

Overview

Southeastern Pennsylvania is brimming with historic resources, many of which contribute to community character and can be categorized as follows: (1) built resources incorporating residences, barns, commercial buildings, houses of worship, civic structures, etc., (2) archeological resources encompassing artifacts and relics of past human cultures, and (3) cultural resources including combinations of built and natural resources, such as trees, streams, bridges, walls, spring houses, corn cribs, railroad tracks, and cemetery markers.

Many township historical commissions and review boards have inventoried local historic resources. Because historic resources provide area residents and visitors with a critical link to the past, it is recommended that you contact your local historical commission directly for advice if your natural lands contain built, archaeological, or cultural resources.

Cover type options and guidelines

There are two preferred management options for historic resources: preserve as is and restore to a healthy state. The option selected will depend upon the condition and integrity of the resource, the available management budget, and the interpretive value of the resource. A local historical review board will likely consider a resource to have a high degree of integrity if it possesses one of the following: (1) an authentic, remnant historic or architectural identity evident through surviving or physical characteristics such as location, setting, design, materials, and/or workmanship; (2) the documented potential of possessing retrievable or surviving characteristics; or (3) documented association with an historical event or person, accompanied by surviving relevance to the setting of the event or person. It is recommended that you contact your local historical commission directly for assistance in determining the integrity and interpretive value of your historic resource(s). If required, the commission will also help you identify potential sources of preservation funding.

12a. Preserve As Is

If a resource has a high degree of integrity and interpretive value, measures should be taken, at the very least, to sustain the existing form, integrity, and material of the resource. Preservation may include either initial stabilization or ongoing maintenance. Because of the varied nature of historic resources, it is recommended that an expert in the type of resource present be retained to advise on the most appropriate methods for preservation, i.e., an architect specializing in historic architecture, an archeologist, or landscape historian. In the case of simple vernacular structures such as springhouses, any sensitive, competent design professional is probably qualified.

12b. Restore to a Healthy State

If a resource, which has a high degree of integrity and interpretive value, exists in a state of disrepair, every effort should be made (funds permitting) to restore the resource to its form and condition at an appropriate point in history. If restoration is not feasible for financial or other reasons, the goal should be to stabilize the resource in order to prevent further damage. Consultation with your local historical commission will help determine the appropriate point in history.

Stewardship Techniques and Procedures

The **Major Stewardship Issues** section highlighted the major stewardship issues that are currently impacting natural lands in southeastern Pennsylvania. This section will provide an overview of the stewardship techniques and procedures that may help landowners in the region to address these issue on their property. As mentioned in the *Stewardship Guide*'s **Introduction**, new information and methods for addressing stewardship issues will come over time. The land manager should keep current on these issues to become aware of new options. The land manager should also be aware of what works on his or her property and share this information to hopefully improve the reigning recommendations.

Wildlife Management

Two wildlife related issues—overabundant goose and deer populations—were highlighted under **Major Stewardship Issues**. The impact of deer overabundance and its impacts to native forests was noted as the most significant factor impacting native Pennsylvania forests. The following is a discussion of the methods currently available and their applicability to reducing the impact of overabundant deer populations in southeastern Pennsylvania. It will be followed by a much briefer—an indication of much less impact—discussion on Canada geese.

Deer Management Options

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 begins with the assumption that human intervention is required to meet the desired management goals of a property (i.e., ambient controls within the landscape are insufficient to maintain the population at an acceptable level) and that human understanding of the issue and knowledge of management tools is sufficient to implement appropriate measures to achieve the desired management goals. The desire to change from passive management to active management of the deer

population must stem from the belief that human intervention is required to reduce deer access to forest resources in order to perpetuate healthy forest communities within the property.

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.

A good example of the ultimate fate of a forest under passive management is the 3,400-acre Florence Jones Reineman Sanctuary in Landisburg, northwest of Carlisle, PA. This property, managed by Natural Lands Trust, has suffered from extreme deer overabundance (densities up to 400 per square mile) since the late 1960's when hunting was prohibited by the donor's will. The deer population has remained high—despite the total lack of understory vegetation—through the consumption of the annual mast crop (from the existing canopy trees) and agricultural crops on adjacent farm fields. Studies of forest gaps—the traditional site of dense regeneration—by Dickinson College showed a total lack of tree seedlings. Computer models confirm the obvious: in the best case scenario, i.e., one without a major wind event or forest pathogen, the forest will degrade into a savannah community by the end of the current canopy trees' lifespan.

Based on the current understanding of deer ecology and results from properties under passive management in other 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') 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. Below are the current tools used to actively modify the impact of white-tailed deer.

Barriers

Barriers physically restrict deer from interacting with vegetation in the treated area. Tactics under this method include tree shelters, netting, and deer fencing. Tree shelters and netting protect individual trees or shrubs; fencing excludes deer from all the vegetation in a specific area. Physical barriers have proven to be effective in protecting forest vegetation although they can be expensive if used over a large area.

Tree shelters are useful to protect seedlings in open areas (forest gaps and edges) until they reach five feet in height and are above browsing by most deer. Results of using shelters for understory plantings are mixed. If artificial regeneration is the main source of regeneration, the per-acre cost would run approximately $2,000 per acre for materials (seedlings, tree shelters, stakes) plus installation. Tree shelters require periodic monitoring and maintenance as they are attractive to deer as rubs and are sometimes targets of vandals.

Tree shelters

Deer fencing is typically 8' high and constructed of box wire, plastic mesh, or electrified wire. Bowman's Hill Wildflower Preserve in Buck's County, Pennsylvania fenced 80 of its 100 acres with the latter in the early 1990's and effectively protected its wildflower collection. Tyler Arboretum, near Media, Delaware County, in 2000 installed a 12' tall, 2-mile-long deer fence around 105 acres of its collection at a cost of $350,000 (including more than $50,000 to provide the means for vehicular access). In addition to its high initial cost, fencing requires constant monitoring to quickly repair any breaks caused by falling limbs or vandals and restricts not only deer movement, but also the movement of several other animal species. Cost estimates for large scale fencing projects would be about $8–$10 per running foot of fence, including installation.

Barriers are potential components to an active deer management program on properties in the region. Tree shelters could be used to protect natural or artificial regeneration in forest gaps with sufficient sunlight or to connect or enlarge established forest parcels. However, given their cost and maintenance requirements tree shelters would have limited application.

Deer fencing holds more promise as a deer management tool, but it would involve significant up-front expense and frequent monitoring to ensure the integrity of the fence. Costs and monitoring are complicated by internal roads, paths, or streams, requiring gates and stream crossing devices. One option that minimizes the cost is to fence large (quarter to half the forested area) sections on a rotating basis to protect vital forest regeneration from deer browsing while still maintaining most of the forest accessible for management and recreation. However, once tree regeneration is established and the fence is moved, the previously fenced areas would likely be degraded again by deer browsing.

Fencing can also be used as an instructional and monitoring tool. At a relatively low cost (approximately $300 per exclosure), the landowner could use deer fencing to create small (30' square) deer exclosures that could be monitored and compared to the existing forest. These study areas would provide a picture of the forest's potential when browsing impacts from deer are removed. It will also provide an alternate and perhaps more understandable barometer of deer overabundance than deer

density. The state of the forest within the exclosure can guide deer management outside.

Repellents

Repellents create unpleasant sensory experiences that discourage deer from physically interacting with vegetation in the treated area. Repellents include periodic loud sounds, bright lights, or foul-tasting foliar sprays. Repellents can be effective in small areas where the goal is to reduce browsing damage to tolerable limits.

The main drawbacks to repellents are cost (approximately $150 per acre, plus application) and their short-term effectiveness. Deer, particularly those in dense populations, quickly adapt to these tactics. The manager must be committed to continually monitoring application needs and experimenting with new products as deer adapt. Although foliar sprays may be useful for landscape and other special plantings, deterrents are usually impractical on the scale needed for natural lands.

Contraceptives

Contraceptives are available to prevent pregnancy in deer. They can be administered to deer (a permit from the Pennsylvania Game Commission would be required) by remote delivery through darts or bait, or through sub-cutaneous implants. The two major types of contraceptives are immuno-contraceptives and hormonal contraceptives.

Immuno-contraceptives "vaccinate" an animal against egg proteins. When an ovary releases an egg, the deer's immune system views the egg as a foreign body and rejects it before it can implant itself within the uterus. Although very expensive and labor-intensive, immuno-contraceptives have proven effective in arresting deer population growth under certain circumstances, such as on islands or within fenced parks or zoos where deer are confined to a relatively small area by natural or human-constructed boundaries.

At present, the cheapest and most common method for administering immuno-contraceptives is through the use of dart guns—close-range arms that are accurate to about 40 yards. Most population biologists feel that in order to stop herd growth in deer, i.e., prevent pregnancy in 90% of the female population, immuno-contraceptives have to be administered at least twice each breeding season.

Hormonal contraceptives work primarily by preventing ovulation in does. The most effective method for administering this type of contraceptive is through sub-cutaneous implants. Although one treatment can be effective for multiple years there are logistical and health related issues associated with the use of hormonal contraceptives in natural areas on free-ranging deer. The first is the need to immobilize each deer to apply the treatment. Potentially more problematic is the unknown consequences of introducing these hormones into the food supply.

Currently, there are no contraceptives for free-ranging deer that are approved by the FDA or any other governing body. Also, the effects of deer contraceptives on other animals (including humans) have not been studied. Because deer in southeastern Pennsylvania are free ranging, there is a high probability of human consumption of treated animals. It is even more likely that hormonal contraceptives will enter the food chain when treated deer die and are consumed by other animals, e.g., raccoons, chickadees, turtles. Introducing hormonal contraceptives into the environment and food chain could have unknown and far-reaching effects.

The use of contraceptives to manage the deer population within natural lands in southeastern Pennsylvania is problematic at this time due to the high cost (over $1,000 per doe annually for immuno–contraceptives), the potential health risks of hormonal contraceptives, and the high mobility of the local deer herd. The fact that deer are free-ranging (entering and leaving

properties at will) throughout the region makes treating enough of the right animals almost impossible.

Trap and Transfer

Trapping or darting deer (requiring a permit from the Pennsylvania Game Commission) and moving them to another location is the most expensive, difficult, and ineffective deer control method. It is an option fraught with problems, the biggest of which is finding a location willing to accept more deer. Attracting well-fed deer into baited traps is the next challenge. Finally, survival rates of transported deer have been low. For these reasons trap and transfer is not an option for natural lands within the region.

Lethal Removal

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.

Summary of Active Deer Management Options

METHOD	COMMENTS
Tree Shelters	High cost and maintenance requirements
Deer Fencing	Significant up-front cost, frequent monitoring
Repellents	Impractical in natural areas
Contraceptives	High cost, permit/license
Trap and Transfer	Expensive, difficult, location, permit/license
Lethal Removal	Currently most effective, safety concerns

Estimating Deer Impact

Monitoring vegetation indicators is a practical way to assess the effect of deer on natural lands. Vegetation can be assessed by two methods: (1) comparing the overall influence of deer browsing on existing vegetation to an established index or (2) quantitative sampling. The US Forest Service and Penn State University have developed a five-level deer impact index to visually assess the level of deer influence on forest health:

Deer Impact Index 1
Very low: Occurs only within a well-maintained deer exclosure.

Deer Impact Index 2
Low: Species composition and height of regeneration is determined mainly by available light, nutrients and seed source. There is a well-developed shrub layer and native wildflowers are abundant and grow to their full size.

Deer Impact Index 3
Moderate: Evidence of browsing is common with a greater reduction in height and abundance of the most-preferred species than of the least-preferred species.

Deer Impact Index 4
High: Preferred species are sparse or absent and all plants are nearly the same height as a result of browsing. Vegetation in the shrub layer is sparse except for the least-preferred

species (e.g., spicebush, American beech).

Deer Impact Index 5
Very high: A pronounced browse line is evident with virtually no vegetation below the browse line except for two rhizomatous fern species, hay-scented fern and New York fern.

The deer impact index is a qualitative measure; its utility for detecting change over intervals as short as one or two years is weak and its usefulness depends heavily on the level of experience and knowledge of the evaluator on food-plant preferences of deer, expected maximum sizes of various plant species under a variety of habitat conditions, and how to distinguish signs of deer browsing from plant damage by other animals and causes other than herbivory. Quantitative sampling is more time-consuming but its interpretation involves less judgment and specialized expertise. A quantitative approach could include periodic surveys along a transect or cataloging vegetation change within fixed plots. The latter could be used in conjunction with the construction of deer exclosures. Methods need to be scientifically rigorous if the results are to be sufficiently credible to serve as the basis for labor-intensive and potentially costly deer management procedures. For example, the protocol should include:

- stratified random selection of areas to be sampled,
- large enough sampling plots or transects or wide enough dispersion of smaller subsampling plots within each exclosure or control area to cover the range of spatial heterogeneity,
- true replication with interspersion of treatment (exclosure) and control areas across the landscape, and
- sufficient replication for reasonably high statistical power, to increase the likelihood of early detection of relatively subtle differences.

The data gathered within sampling plots or along transects may include:

- percent cover of each plant species below 6' above ground surface (maximum height of deer browse),
- number of seedlings and saplings of each tree species, and
- special measures of indicator species (forest-floor species known to be vulnerable to deer but somewhat tolerant of moderate levels of browsing, e.g., Canada mayflower, Indian cucumber-root, and several trillium species); measures may include height of tallest plant or length of longest leaf in the plot, and number of flowering/fruiting individuals versus number of non-flowering/fruiting individuals of each indicator species in the plot.

Estimating Deer Abundance

The primary concern about deer overabundance is the associated impact on ecosystems and biodiversity, however, it is still important to monitor deer abundance to make certain that management actions intended to reduce or maintain deer populations actually do so. It is nearly impossible to make a full count of any animal species in the wild, but several methods have been developed to estimate the abundance of white-tailed deer.

Survey methods can be classified into two general types: indirect methods based on monitoring deer signs (e.g., tracks or fecal pellets) and direct methods that require capturing or observing deer. Direct methods may deliver more accurate and precise population estimates but they tend to be prohibitively expensive.

Direct methods include the aerial survey, which has the advantage of covering large areas quickly and easily, although hiring pilots and renting aircraft are expensive. The main problem with using aerial surveys for white-tailed deer in this region is visual obstruction by vegetation. In a predominantly deciduous

forest, aerial surveys are performed only in winter but evergreen trees and shrubs, topographic features, and the dense cover of trees' and shrubs' trunks, limbs, and twigs still obscure a large percentage of deer from aerial view. Researchers have shown that thermal imagery—flying at night using infrared-sensitive instruments—is far more effective than daytime aerial survey methods using visible light.

Another direct approach is the mark-recapture method, which involves marking individual deer and comparing the proportion of marked deer recaptured or killed in a subsequent roundup or hunt. This method is expensive because a large number of deer need to be marked—at least 45% of the deer if the population is small (less than 200). In addition, the method is based on the assumptions that marks are never lost and deer do not emigrate from the study area. The mark-recapture method has been shown to overestimate deer populations because of unknown mortality of marked deer and emigration from study areas. Accurate monitoring of mortality and emigration requires the use of radio-collars in place of marks. Another problem with this method is that every deer is assumed to have the same probability of being recaptured or taken by hunters, which is likely to be violated owing to differences between older and younger deer in wariness, ability to evade pursuers, and hunter preference.

Most indirect methods do not provide estimates of absolute abundance, but are intended to provide an index of relative abundance that can be used to detect changes over time within a particular area. For example, counts of the abundance of deer trails, tracks, deer sightings per kilometer walked on foot, intensity of browsing, abundance of fecal pellet groups, and number of deer killed on roads have all been used as indices of abundance. All of the index methods assume that potential sources of variability in the index (e.g., deer defecation rates, hunter effort, or movement by deer across the landscape) are constant over time so that the changes in the index over time reflect changes in population size alone.

Counting fecal pellet groups is the most widely applied means of indirectly estimating deer density. A typical method would be to visit a large sample of uniform-sized plots across the study area and eradicate all existing pellet groups on each plot, then return to those plots several weeks or months later and count the newly deposited pellet groups. Deer density can be estimated by assuming a daily defecation rate per individual deer. The assumptions of this method are that a random sample of plots has been selected, the defecation rate is known and remains constant among deer and surveys, and pellet groups are counted accurately on the plots. (In practice, the pellet group technique has often been applied somewhat differently. Surveys are usually performed in winter and the number of days is taken to be the time since leaf drop. This removes the labor requirement of first eliminating all existing pellet groups on plots, but results are distorted by the precarious assumptions that all pellet groups deposited prior to leaf fall have been covered by leaves and that leaf drop occurred on a specific day.)

Although widely used, pellet group counts are subject to many sources of error, which may be minimized by careful design and execution of the specific protocol. They include observer skill and fatigue in detecting pellet groups, choice of plot shape, habitat (vegetation) influences on detection of pellet groups, and decay rate of pellets. The most sophisticated surveys apply the technique of "distance sampling" to account for differential detection among habitats, factor in the decay rates of pellet groups, and use a statistically based sampling design. However, even the most careful surveys are based on a number of questionable assumptions, including a constant defecation rate and no variation in decay rates among habitat types. Research on defecation rates indicates that they vary among seasons

(presumably because of dietary changes) and among age and sex classes and that pellet decomposition rates differ according to habitat type. Despite their limitations, however, pellet group counts may be the most practical means of monitoring changes over time in deer densities in natural areas.

Natural Lands Trust's Deer Management Program

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 at right). 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

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" paper plate at 45 yards. No buckshot allowed. Shooting from a treestand 10' 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.

continued...

NATURAL LANDS TRUST REGULATED HUNTING PROGRAM
Rules and Regulations

continued...

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.

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.

Goose Management Options

Canada geese are attracted to open water—particularly open water bordered by short grass that provides them clear view of potential predators. Under natural conditions, they are generally restricted to areas adjacent to larger streams. They have become a problem over the past decade due to the proliferation of their ideal habitat in the form of golf courses with water hazards, and residential subdivisions with stormwater basins or old farm ponds that are now included in landscaped areas.

As with deer management, the landowner or manager has the option to employ passive or active management of goose populations. Because geese are highly selective in their habitat requirements, passive management works on most properties by the simple lack of this habitat. On those properties with attractive goose habitat, the landowner will need to consider active management to prevent degradation of on-site and off-site water quality from coliform bacteria and nutrient input from fecal matter. In cases where goose density is very high, they can also strip vegetation from stream or pond banks and facilitate bank erosion and sedimentation of the water body. Excessive goose "droppings" and sometime belligerent behavior during nesting season can also discourage recreational use of these areas.

Active Management

Habitat Management

The most effective way to decrease goose impact is to change the area into habitat that is less attractive to them, i.e., one that would qualify as natural lands. Establishing a strip of natural lands (trees, shrubs, meadow) at least 20' wide around the water will deter geese from wandering into the mowed areas beyond. It may even keep geese off of the pond/lake. This method reinforces the general recommendation to establish and maintain riparian buffers along any water body.

While habitat management is the best long-term method for reducing goose impacts in natural lands, it may be necessary to implement other

Canada geese and their "droppings"

active management techniques to further discourage geese, particularly while the new, more natural habitat is getting established. Other techniques include the following.

Fencing

A single strand of wire placed about 6"–10" above the ground will help deter geese from walking from the pond and into the adjacent planted areas. Mark the wire with flagging that flutters in a breeze. The

flagging will protect humans from tripping over the wire and the fluttering will make geese nervous. While they can easily fly over the wire, and sometimes will, in most cases it will keep them confined to the water. It does not need to be electrified, but if geese are pushing through the wire, electrifying temporarily, may be necessary.

Repellents

Repellents are available to spray on vegetation to make it unpalatable to geese. Some use hot pepper, some use other agents. They are expensive, but in theory will only need to be used for a short period.

Harassment

Several options are used to harass geese and discourage them from using a property, including dogs, "scarecrows," or loud noises. Dogs are very effective in harassing geese. The landowner could use his own dog or use a professional goose management service which uses specially trained dogs for this purpose. These services, which use small herding dogs or sometimes hunting breeds, are contracted to periodically visit a site to chase the geese.

Loud noises can also be used to harass geese. This method uses fire crackers, or shells that explode after being fired from a shotgun. There are also propane-fueled cannons that make loud booms to scare animals away. It is pretty labor intensive, but has been successful in driving off geese in many places. This method requires prior permission from the Pennsylvania Game Commission.

"Scarecrows" are a more passive form of harassment that uses balloons or alligators and owl decoys to deter geese from using areas. These are very short-term solutions, at best. In most cases, geese quickly learn that they aren't a threat and ignore them.

Lethal Removal

Lethal removal is usually an effective way to dissuade geese from accessing the property. It usually only requires the removal of a few geese to make the remaining geese leave the area. Landowners can kill geese either by obtaining a depredation permit (obtained after substantial paperwork through the Pennsylvania Game Commission) or during legal hunting season. Although most hunting seasons don't coincide with the time (spring) that landowners want to discourage geese from their property, over time and combined with other deterrents, it could provide enough time for a natural riparian buffer to become established.

Egg Tampering

Geese can be discouraged from using a property through egg tampering which prevents offspring from nesting geese. Geese often abandon areas after nesting unsuccessfully. This method, which includes oiling and addling, requires permission from the local Wildlife Conservation Officer of the Pennsylvania Game Commission. These techniques should be done shortly after geese have finished laying eggs and are beginning to sit on the nest. Addling eggs is shaking them violently to kill the embryo. In oiling, one uses a cloth saturated with cooking oil, to completely wipe the egg shell. This keeps air from passing through the shell wall and essentially smothers the embryo. The key is not to visibly destroy the eggs or nest, as this will encourage the geese to build another nest and lay additional eggs.

Habitat Improvements

Wildlife management is more than just addressing pest species. In addition to generally improving the health of natural plant communities, there are many activities

Nesting box

that can be undertaken to encourage particular species to use the property. Typically they supply some component of the habitat requirements of these species. Below are examples of improvements that can be effective in southeastern Pennsylvania. The Pennsylvania Game Commission can provide you with additional recommendations.

Nesting Boxes

Many birds use natural cavities in trees as nest sites. Nesting boxes provide a suitable alternative that can attract particular species to a property. The box should be constructed to fit the size of the bird and be located in the appropriate plant community and at the proper height and orientation to the sun and prevailing winds. Species that commonly use nesting boxes in the region include eastern bluebird, wood duck, purple martins, owls, American kestrel, and swallows. The Pennsylvania Audubon Society, Pennsylvania Game Commission, and Pennsylvania DCNR Bureau of Forestry can provide you with plans for constructing and locating nesting boxes for each species.

Vernal Ponds

Areas that periodically hold water provide valuable habitat for amphibians, aquatic insects, and migratory waterfowl. They are rare in the region due to past draining for agriculture and development. Often they can be recreated through relatively minor earth moving (by hand or machine) or the destruction of existing drainage tiles in agricultural fields. Other methods include the construction of ponds with water control structures and dynamiting holes in isolated areas. The Natural Resource Conservation Service can provide you with information on creating vernal ponds on your property.

Brush Piles

Brush piles are piles of woody debris, most commonly the branches of trees and large shrubs, that are assembled to provide resting and escape cover, nesting sites, and den sites for wildlife. Typically, the largest materials are placed at the bottom, with increasingly smaller material added in layers that alternate direction. Brush piles provide the greatest benefit if they are located in places, such as forest openings or edge, where cover is lacking. Species that benefit from brush piles include the cottontail rabbit, squirrels, chipmunks, skunk, raccoon, and fox, along with some amphibians and reptiles.

Forest Management

Reducing Forest Fragmentation and "Edge Effect"

Decreasing the edge-to-area ratio and increasing the area of functional forest interior can be accomplished by reforesting selected "peninsulas" and "islands" of non-forested land that presently intrude into the main body of a contiguous forest.

Edge effects are conditions in and near the forest-nonforest transition zone that weaken or kill native plants, foster the growth of invasive plants, provide access for nest predators (e.g., raccoon) and parasites (e.g., brown-headed cowbird), and repel forest-interior animal species. Dense, healthy mid-canopy and shrub layers at the forest edge minimize edge effects. A forest edge that has existed for many decades often already has a well-developed wall of leaves and branches extending from near the ground to the upper leaf canopy. Remediation is required at more recent edges, where trees have been cut down within 20 years, and at edges where landscape maintenance practices restrict new growth. Such edges are said to have high permeability.

Native trees and shrubs of species appropriate to specific site conditions should be planted along forest edges with high permeability. Mixtures of evergreen and deciduous species should be used where the natural community would include evergreens, in order to enhance impermeability in all seasons. Construction and maintenance practices should be avoided that would damage understory and mid-canopy vegetation at the forest edge and increase its permeability to sunlight, air movement, and the influx of seeds.

Adjacent forested parcels enhance the ecological and environmental conditions of forested areas within natural areas. They provide buffers from edge effects and create a larger unfragmented forest. Protection and coordinated management of these resources would provide the greatest environmental and ecological benefits.

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).

Brush Brute removing 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'–6' steel frame with 18" "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 vines

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

Planting trees

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.

Restoring a serpentine woodlands with fire

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.

Fire

Fire has played an important part in shaping local plant and animal communities for thousands of years. Fire was a frequent occurrence within forests, following major disturbances such as windfalls or insect defoliation, and on the open grasslands, shrublands, and barrens scattered throughout the region. In addition, Native Americans living in the region used fire for thousands of years for numerous reasons, for example, to drive game and to rejuvenate food resources such as berry patches and pasture for game species. Fire suppression over the last century has modified the plant composition

of forest communities. Many eastern forests are now in transition from an oak- and hickory-dominated canopy to a fire-sensitive red maple-dominated canopy.

The use of fire to control invasives by giving an advantage to desirable native species is an exciting new application for an old management tool. The difficulty in utilizing this tool is the obvious destructive power that can arise from its misuse or improper application. Local governments and fire companies are often not receptive to the use of fire to restore and maintain native biodiversity and ecosystem function. If you plan to use fire to manage natural lands, you will need to prove to these authorities that you are properly trained and equipment (see **Prescribed Fire**) to undertake this activity.

As with herbicides, only properly trained individuals should utilize fire as a management tool. To be effective and safe, weather and fuel conditions must meet narrow parameters (the "burn prescription"). In this region it is usually best to burn in early spring—mid March to mid April for herbaceous invasives, late April to early May for woody invasives—a time when many natural fuels reach a peak of flammability but weather conditions typically make containment simpler. Furthermore, invasives usually sprout earlier than native species, making them vulnerable to fire at a time when many natives are highly fire-tolerant. Before undertaking a burn it is also crucial to acquire any necessary permits, notify neighbors, and coordinate with local and state authorities and, of course, the local fire company.

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' 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" 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" diameter) and straight (>8' 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") 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' 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' high and 6' 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'–6' 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' x 10' 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

Planting forest gaps

and cambium layer (girdling) of young trees caused by antler rubbing. The wraps should cover the trunk from 1' to 5' 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' tall (above ground level). Shrubs should be a minimum of 18"–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"–3" inches thick over the planting area, but no closer than 2" 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" 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 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

continued...

Invasive Introduced Species of Plants, currently associated with the greatest harm to native biodiversity in southeastern Pennsylvania

...continued

COMMON NAME	SCIENTIFIC NAME	DESCRIPTION
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, Japanese/Chinese	*Wisteria frutescens/sinensis*	liana (woody vine)

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 (new leaves emerge in late winter or early spring and they generally flower and set fruit in spring or early summer) such as fescue, ryegrass, bluegrass, orchard grass, and timothy. 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 (emergence is often delayed until spring or early summer and they generally flower and set fruit in late summer or fall), 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'–15'.

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 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.

Meadow establishment through spraying *(top)* **and then planting with a no-till drill** *(bottom)*

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' 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).

In certain, select cases it may be wise to try to promote a mixture of warm season and cool season meadows to encourage certain plant and bird species, particularly bobolinks and meadowlarks. These two species are area sensitive and will require at

least 25 acres of meadow that are managed to minimize edge effects.

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 esthetic 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"–8" inches during the growing season and 4"–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.

Meadows with trails encourage exploration

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.

Prescribed Fire

The use of prescribed fire for resource management purposes is gaining general acceptance within the scientific and natural resource management communities. It is viewed as a way to perpetuate an historical influence on the local ecology in a manner that minimizes and often reduces threats to persons or property. The goal of a fire management program is to utilize prescribed fire in a manner that perpetuates and enhances desired plant communities within natural lands.

Fire has played an important part in shaping local plant and animal communities for thousands of years. Fire was a frequent occurrence within forests (following major perturbations such as wind events or insect defoliation) and on the open barrens (serpentine, pine) scattered throughout the region. In addition, Native American use of fire for numerous reasons, including to drive game and to rejuvenate food resources such as berry patches and pasture (for game species), frequently augmented these natural occurrences.

Fire suppression over the last century has modified the plant composition of both forest and barren communities. Eastern forests are now in transition from an oak-hickory dominated canopy to a fire-sensitive maple canopy. On the barrens, the lack of fire has resulted in the buildup of organic duff and invasion by woody vegetation. These conditions decrease the viability of plant species adapted to the mineral soil and full sunlight conditions maintained by periodic fires. At the same time, maintaining abandoned agricultural land as meadow (artificially maintained representatives of ephemeral forest openings) has become very problematic due to the growing presence of exotic, invasive vegetation. Left unchecked, invasives such as thistle, multiflora rose, and Japanese honeysuckle usurp the native grasses and wildflowers that can tolerate periodic fires. Through displacement of native vegetation, invasives homogenize the structural and food resources of the site, thereby reducing the habitat value for native fauna.

There are two issues that face the greater use of prescribed fire in our region. The first is to continue to develop and implement programs that both safely and effectively apply this powerful tool. Use of this management tool will require the support of both the general public and local authorities, particularly fire management personnel. Careful use and clear communication between owners of natural lands and neighbors and local authorities will be essential in addressing this issue.

The second issue is the need for better understanding of the biological and ecological effects of fire in this region in order to intelligently guide

its use to achieve natural resource management goals. To date, most research has been undertaken in the western states, which contain different plant species (both native and undesirable exotics) and site conditions. Detailed knowledge of plant responses to different fire regimes (frequency, season of application) is needed to make the best use of this stewardship tool.

A prescribed fire is defined as fire applied in a knowledgeable manner to fuels on a specific land area under selected weather conditions, to accomplish predetermined, well-defined, management objectives. Safely fulfilling this definition requires extensive preparation, proper training, and specialized equipment. The following are critical components of a successful prescribed fire program.

Program Organization

Required guidelines should be established for all burns and include the following:

Ecological justification and research

- Development of an ecological justification for each burn unit
- Development of a Site Fire Management Plan for all preserves including standard operating procedures for all prescribed burns
- Listing of expected effects

Natural Lands Trust's Fire Management Equipment

QUANTITY	EQUIPMENT	USAGE
3	Drip Torches (w/brackets)	Fire Ignition
3	Collapsible Backpack Pump	Fire Suppression
3	Indian Backpack Pump	Fire Suppression
12	Nomex Jumpsuits	Personal Protection
12	Helmets	Personal Protection
12	Plastic Face Shields or Goggles	Personal Protection
12	Nomex Neck and Face Guards	Personal Protection
12	Fire Shelter	Personal Protection
12	Leather Gloves	Personal Protection
1	Fire Weather Kit	Monitor Weather
12	Radio Harness	Communication
12	Portable Radios	Communication
1	Mobile Ritron Radio	Communication
1	Radio Organizer	Communication
1	Radio Cloning Cable	Communication
3	Wire Rakes	Fire Control/Prepare
3	Council Rake	Fire Control/Prepare
1	Turbo Meter (annometer)	Monitor Weather
1	Tool Box	Repair/Parts
9	PPE Bags	Gear Bags
1	Radio Gang Charger	Communication
9	1½" x 100' Hose	Fire Control
11	1" x 100' Hotline Hose	Fire Control
18	⅝" x 50' Mop Up Hose	Fire Control
6	1" x 1" x 1" Gated Wyes	Fire Control
3	1½" x 1½" x 1½" Gated Wyes	Fire Control
7	1" Nozzle	Fire Control
3	¾" Nozzle	Fire Control
2	2" Suction Hose, 10' each	Water Supply
1	500-gallon Portable Tank	Water Supply
1	75-gallon Relay Tank	Water Supply
1	Firefighter Portable Pump	Water Pump

continued...

Natural Lands Trust's Fire Management Equipment

...continued

QUANTITY	EQUIPMENT	USAGE
1	Mini-striker Portable Pump	Water Pump
1	200-gallon Slip-on Unit	Fire Control
1	2" foot Value	Water Supply
4	1½" x 8' Suction Hose	Water Supply
13	1" to ⅝" Reducers	Water Supply
13	1½" to 1" Reducers	Water Supply
2	2" to 2½" Increaser	Water Supply
1	2" to 1½" Reducer	Water Supply
6	1", 1½" & 2½" Double Male & Female	Water Supply
12	Headlamps	Safety
7	Hotshields and Bags	Safety
3	Practice Fire Shelters	Safety
2	Replacement Goggle Lens	Safety
1	Case of Fusee	Ignition
2	Fusee Holders	Safety
1	Extra Fuel Can 5-gallon	Ignition
1	1991 Fire Trailer	Haul Equipment
2	Work Lights	Fire Control at Night
1	Window Protector	Mount on Light
1	Brush Bar System	Safety
1	Warn Trans4mer Winch System	Safety
1	5-gallon Pail of Class A Foam	Fire Control
1	Foam Inductor and Nozzle	Fire Control
1	Spool of Pea Cord	Safety

- Listing of threatened or endangered species
- Photodocumentation
- Conducting appropriate research

Pre-burn fire / Stewardship staff activities and public relations

- Development of a burn prescription
- Establishment of burn plots and creation of firebreaks
- Coordination of burn activities with appropriate fire and police groups, local and state government officials, and state and federal environmental organizations
- Notification of affected neighbors

Training and equipment

- Designation of a fire leader with advanced training
- Increase in the general level of training and fire experience for all participants
- Obtaining all necessary fire fighting personal gear, tools, and equipment

Organizational commitment

- Commitment of staff time, equipment, and resources necessary for a quality program

Equipment

Safe application of prescribed fire requires proper equipment to protect both participants and the property of preserve neighbors. On the previous page and at left is the current inventory of Natural Lands Trust's specialized equipment for our 12-person fire management team.

Training

Prescribe fire should only be used by trained staff or contactors. Training is

currently available from:

- DCNR, Bureau of Forestry District 17, 610-582-9660
- New York Wildfire and Incident Management Academy, 631-444-0276, cthamilt@gw.dec.state.ny.us
- Eastern Area Training: Partners in Wildlife Management, www.nationalfiretraining.net/ea/

Minimum requirements for all participants (always check for updated requirements) in a prescribed fire program should be:

- S-130 and/or PA 130 (Firefighter Training)
- S-190 (Introduction to Wildland Fire Behavior)

The fire leader should have extensive training including:

- S-290 (Intermediate Fire Behavior)
- S-390 (Introduction to Fire Behavior Calculations)
- RX-300 (Federal Prescribed Fire Burn Boss)

In addition, all participants in a prescribed fire program should meet the federal standard for physical fitness. Participants should be tested annually prior to the burn season and pass the most current standard. At the time the *Guide* was published the standard is for all participants to walk 2 miles with a 25 lb. backpack within 30 minutes.

Photodocumentation

It is often helpful to establish fixed points from which to periodically take photographs to monitor and help evaluate the relative success of the fire management program. Ideally, photos should be taken before and after burns and in the middle of the growing season.

Stormwater Management

Managing stormwater runoff from impervious surfaces is an essential aspect of land and water stewardship. To assist in measuring the "ecological footprint" of a given project, one can ask: "How close to the pre-development condition are its runoff quality and quantity?" It is important not to consider each project individually, but as a series of developed sites contributing cumulatively to the flooding, erosion, sedimentation, water pollution, and drought effects in each watershed. If designed with careful attention to the ecology and hydrology of each site and each watershed, and with the use of innovative Best Management Practices (BMPs), projects in West Vincent can reach or exceed the predevelopment condition. More importantly—natural/greenway lands within new subdivisions provide excellent opportunities to work "on-contour" with broader systems of berms, swales, and vegetated filter strips and better utilization of natural soils and vegetation than more concentrated development sites.

Natural lands typically retain far greater volumes of stormwater than agricultural or developed areas. This translates to fewer and less severe floods and more consistent stream baseflows during drought periods in areas dominated by natural lands. Innovative stormwater systems are designed to recreate this natural hydrology by retaining stormwater runoff on-site during storm events, and discharging less of it over time. Innovative stormwater practices help to maintain natural stream hydrology with fewer and less severe floods and more consistent stream flows during droughts. By reducing unnecessary clearing, grading, and impervious coverage, and by promoting groundwater recharge, each project can reduce its watershed impacts. In addition, the technique of handling runoff in many small systems close to where

it is generated on the site is a major improvement over concentrating runoff in a few large systems at the lowest areas of the site (often with the poorest soils for recharging groundwater). All of these techniques are fundamental steps toward guaranteeing that private and community wells continue to provide clean, plentiful drinking water to local residents, even as new development requires more groundwater while potentially reducing groundwater recharge.

The need to manage stormwater runoff on each site provides numerous opportunities to address some of the major water quality and quantity issues facing local watersheds. Conventional stormwater systems provide virtually no means of filtration for contaminants found in stormwater runoff, other than by allowing suspended solids to settle out in detention or retention basins. One of the most critical distinctions between old and new stormwater BMPs is the new approach to filtration of runoff to improve water quality. Simply recharging runoff into soil rather than discharging it to wetlands and streams provides a critical filtration system by allowing the soil and vegetation to process nutrients, chemicals, sediments, and salts from paved areas, rooftops, and lawns. If carefully designed, these systems will not contaminate wells with non-point source pollutants. With the addition of innovative techniques such as vegetated filter strips, level-spreader berms, grassed swales, sediment forebays, and constructed wetlands, the filtration effects for runoff from each site are significantly enhanced.

The stormwater planning and design strategies proposed here are comprehensive and include evaluating the entire plan from a stormwater perspective, taking into consideration such factors as:

- amount and location of vegetation clearing and soil grading,
- amount and location of impervious cover to be constructed,
- integrating stormwater management systems throughout the site and early in the design process,
- type and location of stormwater best management practices (BMPs) employed on the site, and
- amount, location, and type of vegetation to be planted as part of the landscaping plan.

When compared to conventional stormwater management systems, plans designed using this approach can reduce runoff volume and velocity reaching streams, increase recharge of groundwater aquifers, and improve the quality of runoff water. If designed properly, the result is less downstream flooding and erosion, cleaner water, healthier aquatic life, and more baseflow for streams and wetlands during droughts. The techniques proposed here are also generally consistent with the pending National Pollution Discharge Elimination System (NPDES) Phase II requirements, and the River Conservation Plans for both the French and Pickering Creeks and the Brandywine Creek watersheds.

Vegetation Clearing and Soil Grading

- Evaluate the grading plan to minimize unnecessary clearing, cutting, and filling.
- Retain the natural soil mantel and vegetation wherever possible to reduce the amount of stormwater runoff that must be controlled.
- Carefully delineate limits of disturbance in woodlands, around specimen trees, and open areas that could be converted to meadow or reforestation.
- Avoid clearing vegetation anywhere within 100' of streams to construct stormwater basins, lawn areas, roads, ball fields, or other improvements.

Impervious Cover

- Evaluate the building program to minimize the amount of unnecessary paved area and rooftop.
- Minimize road widths and utilize localized parking pull-offs instead of full on-street parking.
- For lower-traffic areas, overflow parking, and walkways utilize porous paving, gravel, or paving blocks.
- Evaluate the potential for utilizing green roofs on flat-roof structures such as pavilions, sheds, garages, and commercial or institutional structures. Roofscapes, one of the leading developers of green roof systems is based in Philadelphia.

Stormwater Management Systems

- Integrate stormwater systems throughout the site and early in the design process, and avoid shoe-horning them into the open space as a final step.
- Avoid collecting, piping, and rapidly sending untreated stormwater to the lowest areas of the site.
- Instead, disconnect, disperse, and slow down stormwater runoff, managing it with localized BMPs to maximize recharge within each micro-watershed, close to the impervious cover source where it is generated.
- Utilize non-structural, vegetative-based BMPs wherever possible.
- Merge landscaping plan and natural lands/greenway lands management with stormwater management systems wherever possible.
- Recommended BMP'S:

~ ***Recharge gardens*** can be incorporated into site plans within median strips, cul-de-sac islands, road shoulders, adjacent to parking lots, and in front lawns to handle roof and driveway runoff. Recharge gardens are small infiltration beds, depressed slightly below grade, and planted with wet-tolerant native trees, shrubs and plants to serve multiple functions: landscape features, biofilters to improve water quality, promote recharge, and provide habitat for plants and wildlife.

~ ***Grassed swales and infiltration trenches*** can be included along road shoulders to disperse and recharge sheet flow from roads. This technique would require certain sections of road to be designed without curbs, or with periodic curb cuts. Road shoulders can be planted with native warm season ornamental grasses and wetland shrubs to serve as natural check dams to reduce velocities and promote recharge.

~ ***Roof drains*** can be added to direct roof runoff from downspouts into subsurface infiltration beds, including recharge gardens.

~ ***Level spreader berms and infiltration trenches*** can be designed to handle runoff at the rear lot lines, and in protected open space. Runoff can be directed to these areas with carefully designed berms and swales, then recharged with an overflow allowing for dispersed sheetflow into open space.

~ ***Constructed wetlands*** and ponds can be incorporated as landscape features and planted with native wetland vegetation to serve as living filters for runoff, areas of visual interest for residents, and provide habitat for aquatic life. These should be designed with sediment forebays.

Landscaping Plan

- Incorporate vegetative stormwater BMPs into the overall landscaping plan for each site, rather than treating them separately. Pay careful attention to the use of native trees, shrubs, and plants to blend the function and aesthetics of the site and its stormwater systems

into any adjoining or nearby natural areas and open spaces.

- Go beyond typical street tree plantings and maximize planting of native canopy trees throughout the site that will mature over time to recreate a forest canopy that reduces runoff volumes and velocities, contributes to regional air quality enhancements, and reduces energy costs for home heating and cooling.
- Reduce the amount of turfgrass throughout the site and maximize the amount of reforestation, wildflower meadow, and native plants gardens. Encourage homeowners to use natural landscaping practices as alternatives to lawn.

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

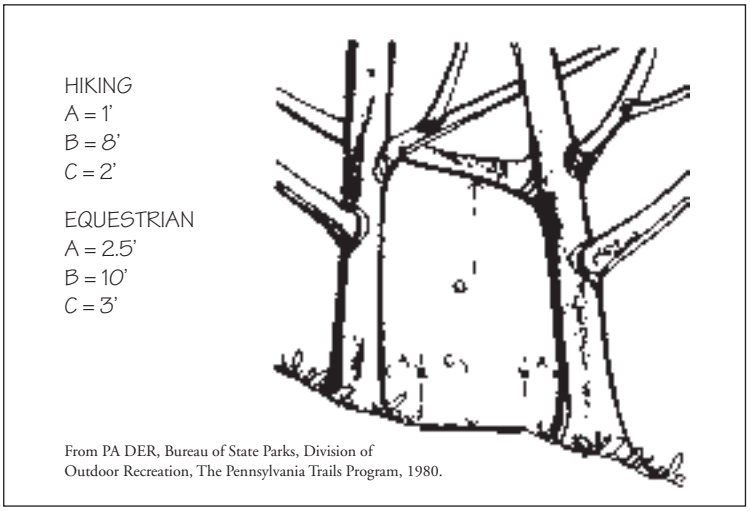
Constructing good, easily maintained trails and their associated structures is somewhat complicated. The basic concepts are described below, but please refer to **Additional Information Sources** for detailed reference manuals on the subject.

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.

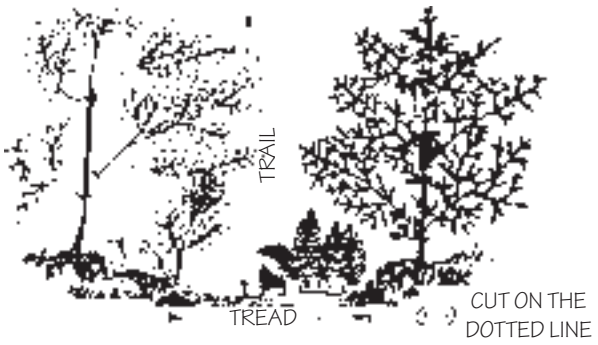
After the precise location of the trail is determined, the treadway should be cleared. For hiking trails, a 2' treadway should be cleared with all projecting limbs cleared an additional 1' for a total horizontal width of 4'. For equestrian trails, a 3' treadway

Trail Clearing Dimensions



From PA DER, Bureau of State Parks, Division of Outdoor Recreation, The Pennsylvania Trails Program, 1980.

Trail Vegetation Removal



From Proudman, Robert D. and Reuben Rajala, 1981.

Blowdowns

From Proudman, Robert D. and Reuben Rajala, 1981.

should be cleared with all projecting limbs cleared an additional 2½' 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

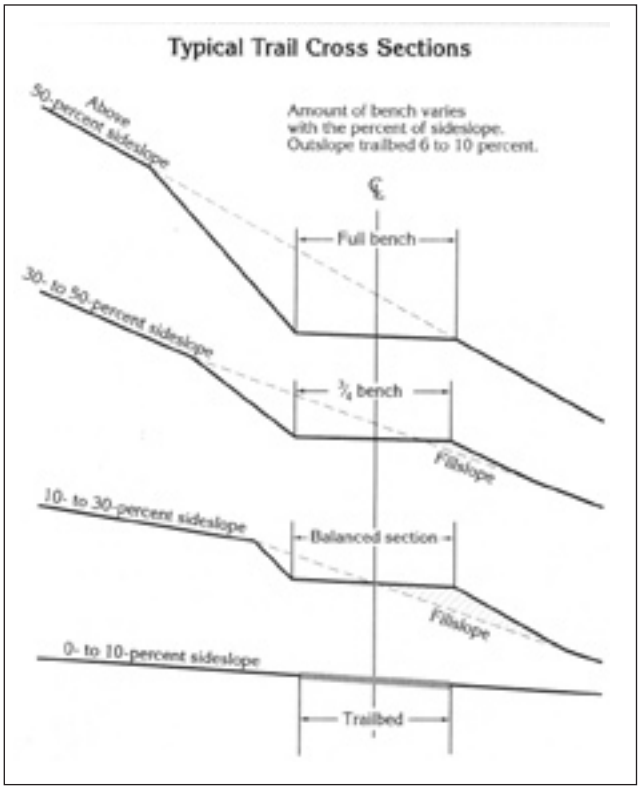
The type of tread surface on trails will ultimately be determined by the rate of use and the terrain through which the trails pass. Initially, once a trail has been cleared, it should be surveyed to ascertain where special measures should be taken to stabilize the treadway. These special measures will 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.

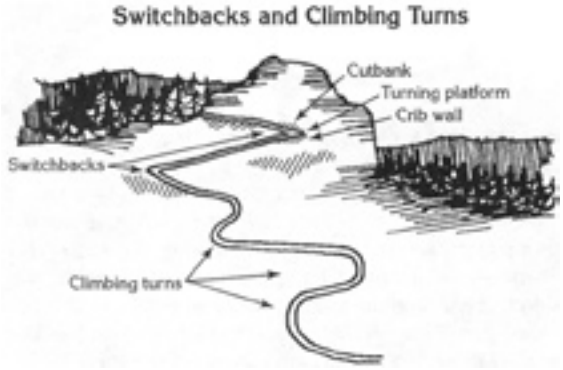
In most areas there will be no need for actual trail construction, as careful trail design should have selected stabilized areas. In existing stable areas with slopes of less than 10%, the exact alignment of the treadway can be located by sweeping herbaceous and trailing plants and leaf litter off the 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.





Climbing turns can be built on gentler slopes, usually not more then 15–20%. Switchbacks are needed on steeper slopes.

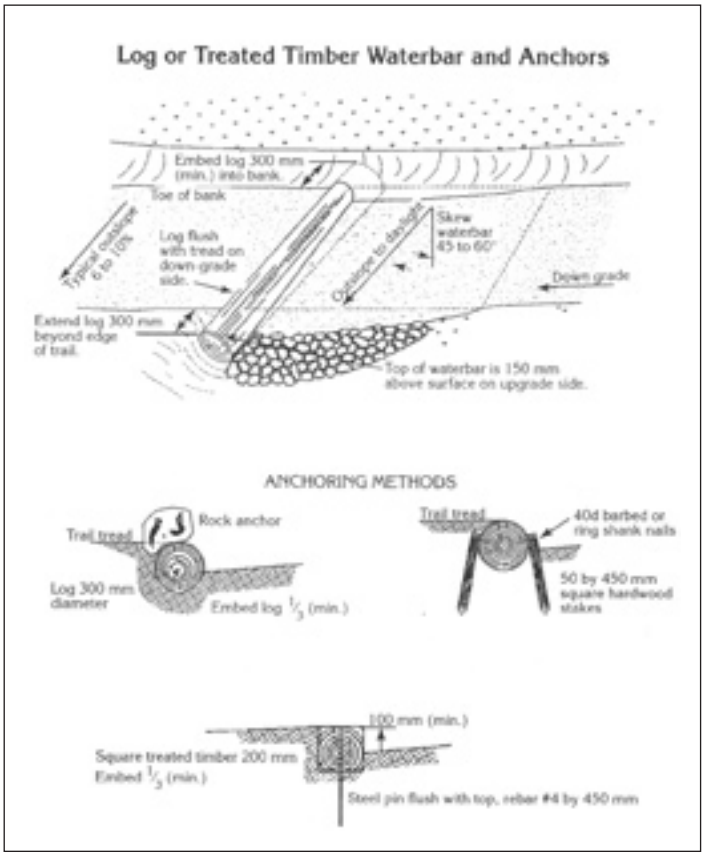
Both switchbacks and climbing turns take skill to locate and are relatively expensive to construct and maintain, therefore, every effort should be made to minimize their use when designing a trail.

Surface Water Control

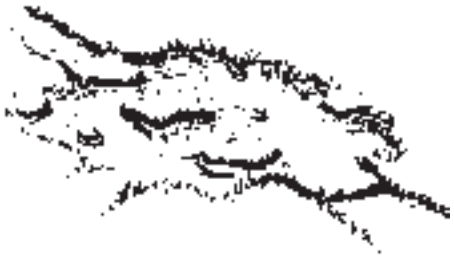
Diverting surface water off the trail is one of the first priorities in designing and maintaining trails. Running water erodes the treadway and support structures and can even lead to loss of the trail itself. The first choice to address surface water is to enhance the natural drainage by outsloping 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

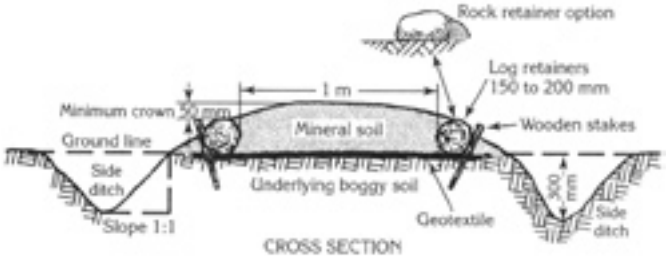


Stepping Stones



From Birchard, William and Robert D. Proudman, 1981.

Turnpike



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.

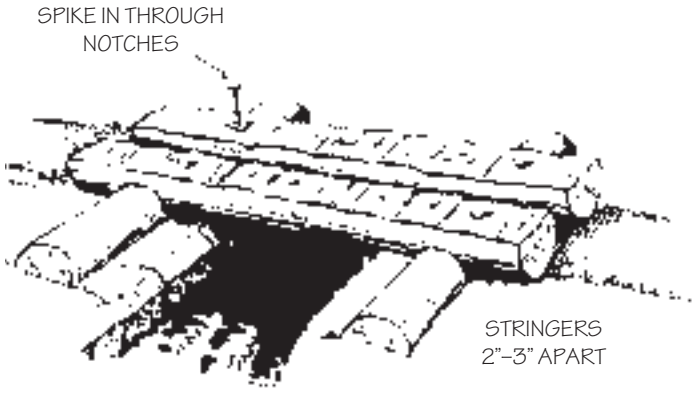
Puncheon

From Birchard, William and Robert D. Proudman, 1981.

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.

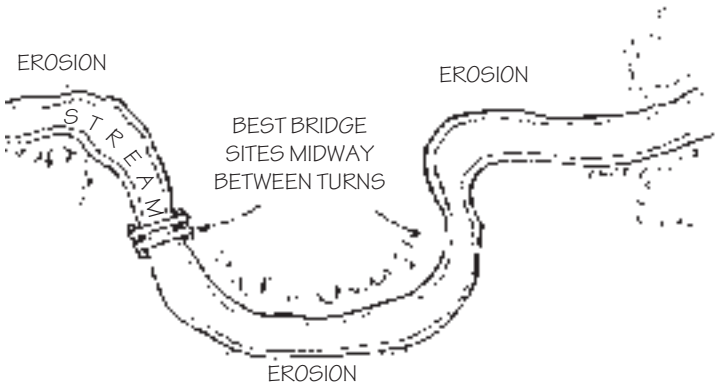
A puncheon, or bog bridge, is a wooden walkway used to cross muddy areas. See ***Puncheon***. It can be used

Stringer Bridge



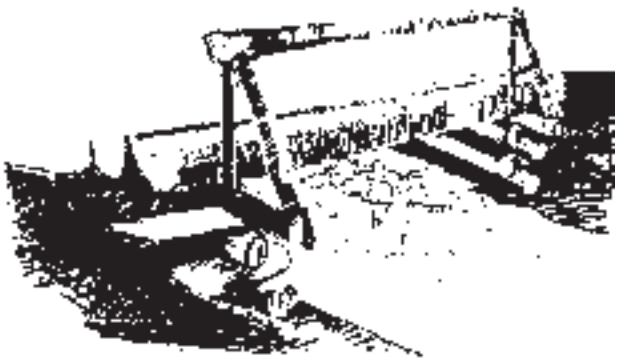
From Birchard, William and Robert D. Proudman, 1981.

Bridge Siting



From Birchard, William and Robert D. Proudman, 1981.

Two Stringer Bridge with Handrail



From Birchard, William and Robert D. Proudman, 1981.

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 Wwales, 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*** previously.

As an alternative to stepping stones, a simple bridge could be constructed of a single or double stringer with two base logs similar to the

puncheon described above. See also ***Stringer Bridge***. The base logs should be placed on each bank above the flood level on a flat stone or ledge, secured with pins if possible. The stringer(s) should be secured to the base log on each end using 10" or 12" spikes or large bolts. Both the base logs and the stringers should be of rot-resistant wood, such as locust or white oak, from which all the bark has been removed. To facilitate construction, crossing sites for bridges should be selected where the banks are the same height and midway between turns. See ***Bridge Siting***. A handrail would be needed for safety only if the top of the stringer is more than 3' above the stream. See ***Two Stringer Bridge with Handrail***. The stringer surface should be randomly scored to provide safer footing when wet.

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 US 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 trails. 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" (1-800-242-1776) 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 that 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 ¾"–1½" 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" x 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° 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.

A hazard tree situation

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 within the public right-of-way (for this purpose it is the base of the tree that matters) 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 tree; 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

NATURAL LANDS TRUST 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.

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.

Native Plant Materials

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.
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 in deep, rich, moist, slightly acid soils, however, often found on rocky, drier sites. Flowers are catkins, 2"–3" long. Yellow leaves in fall are best among birches.	See river birch.

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
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.
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.
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.

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
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.
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	Piedmont 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.

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE 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.
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.
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.

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
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.
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.
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.

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
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	Piedmont 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.
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

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
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.
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 WET MEADOW 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

Natural Landscapes
354 North Jennersville Road
West Grove, PA 19380
610-869-3788

North Creek Nurseries, Inc.
388 North Creek Road
Landenberg, PA 19350
877-ECO-PLUG
www.northcreeknurseries.com

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.redbudnativeplantnursery.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 ¾"–1½" 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

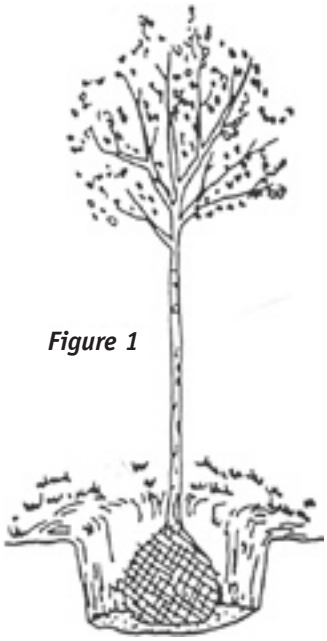
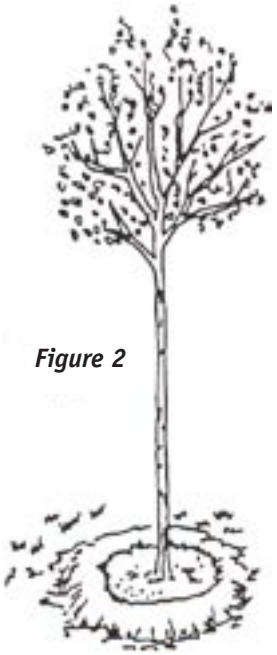


Figure 1



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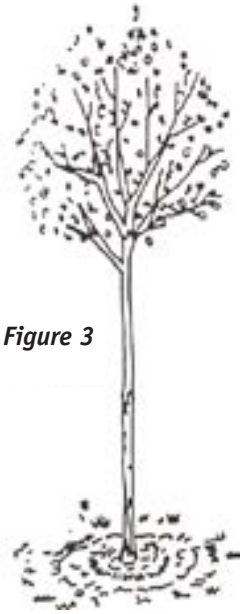


Figure 3

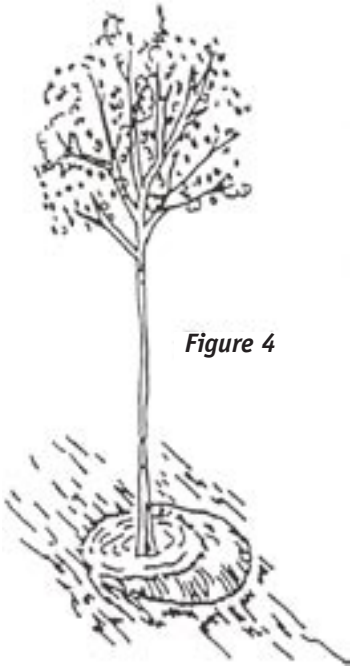


Figure 4

root ball. Use two stakes for trees smaller than 2½"–3½" 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 ¾" 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.

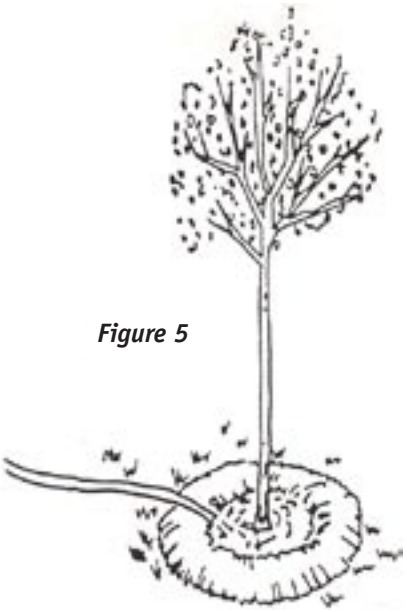


Figure 5

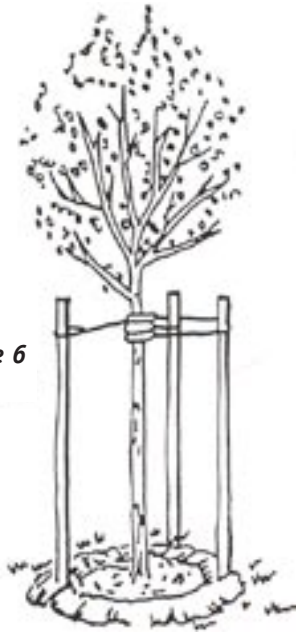
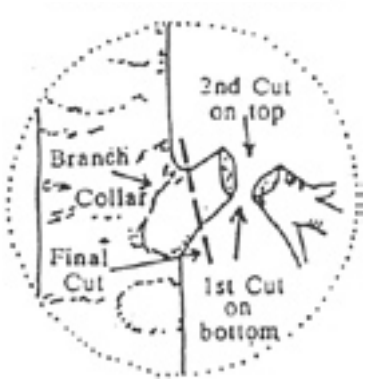


Figure 6

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.

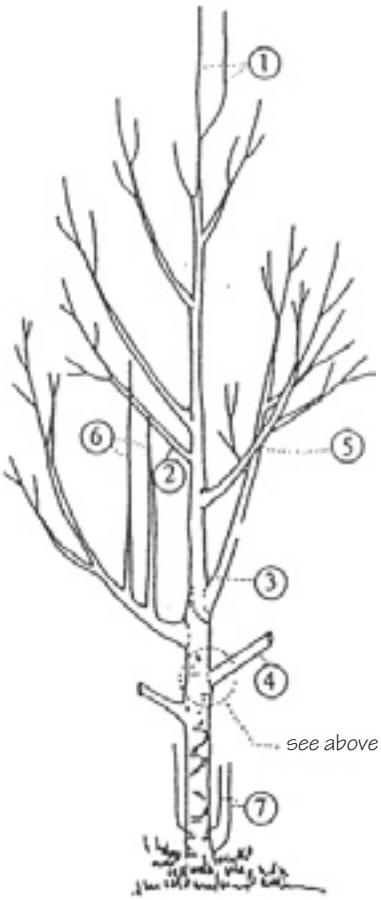
How to Cut a Branch



- 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.

What to Look For

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.



Glossary

Acidic – Describes soil or water with a pH lower than 5.5.

Afforestation – The establishment of forest trees by planting or seeding in an area not previously forested.

Barrens – Woodland or shrubland communities where tree establishment or growth is suppressed by environmental conditions and/or disturbance regime. Most often associated with thin or excessively drained soils.

Baseflow – The water that percolates to the groundwater and reaches the stream slowly over long periods of time. Because it sustains streamflow during rainless periods it is also called dry-weather flow.

Bedrock – The solid rock that is exposed at the surface or underlies the soil or other unconsolidated material at the surface.

Best Management Practices (BMPs) – The current, most generally-accepted way to perform a given management task. Examples include: How to establish a native meadow; How to plant a tree; How to harvest timber near water resources; and How to manage stormwater.

Biocide – A poisonous chemical substance that can kill living organisms, especially microorganisms.

Biodiversity – Biological diversity; the variety of plants and animals, the communities they form, and the ecological functions they perform at the genetic, stand, landscape, and regional levels.

Blowdown – Tree that has fallen down across a trail.

Calcareous – Describes soil, groundwater, or surface water with high calcium concentrations, often derived from limestone or calcium-rich glacial deposits.

Canopy – The upper level of a forest, consisting of branches and leaves of taller trees. A canopy is complete (or has 100% cover) if the ground is completely hidden when viewed from above the canopy during the growing season.

Cavity tree – A tree with cavities in which birds, mammals, or insects such as bees may nest (also called a den tree).

Clear cut – A harvesting and regeneration technique that removes all the trees, regardless of size, on an area in one operation. Clearcutting is most often used with species like aspen or black cherry, which require full sunlight to reproduce and grow well, or to create specific habitat for certain wildlife species. Clearcutting produces an even-aged stand.

Codominant – A species with relatively high abundance or percent cover; two or more species providing roughly equal cover, abundance, or influence in a community or stratum.

Community – An assemblage of plants and/or animal populations sharing a common environment and interacting with each other and with the physical environment.

Conifer, coniferous – Any of a large group of cone-bearing trees and shrubs, mostly evergreens such as the pine, spruce, fir, cedar, yew, etc. These species do not lose their leaves (needles) at the end of the growing season but retain them through the year. In

forestry they are often called softwoods.

Conservation – The wise use and management of natural resources.

Conservation easement – A legally-binding agreement between a landowner and a qualified conservation organization, such as a land trust, or government agency, such as a township, which ensures that the conditions of the easement are met over time. The easement permanently limits a property's use and binds all present and future owners of the land. The property remains in private ownership and does not need to be opened to the public. Tax benefits may apply to the donor.

Cover – The percentage of the ground surface that is covered or shaded by the leaves or stems of a plant species or a group of plant species during the growing season

Deciduous – Losing or shedding leaves at the end of the growing season, remaining leafless throughout the winter, and sprouting new leaves the following spring.

Deed restriction – A written stipulation contained within a deed that restricts certain future uses of the property generally inserted at the time of transfer. A deed restriction may include restrictions similar to those contained within a conservation easement. However, enforcement may only be carried out by the prior owner or other parties to the transaction and the restrictions may be cancelled at any time by mutual written agreement.

Dominant – A species with the greatest abundance, percent cover, or influence in a community or stratum.

Dormant – Resting, or non-growth, phase.

Ecology – The study of interactions between living organisms and their environment.

Ecosystem – A natural unit comprising living organisms and their interactions with their environment, including the circulation, transformation, and accumulation of energy and matter.

Edge – The boundary between open land and woodland or between any two distinct ecological communities. This transition area between environments provides valuable wildlife habitat for some species, but can be problematic for sensitive species, due to increased predation and parasitism.

Emergent – Upright, rooted vegetation that may be temporarily to permanently flooded at the base, while the upper portions of the plant grow erect above the water surface; these plants do not tolerate prolonged inundation of the entire plant.

Endangered species – Species in danger of extinction throughout all or a significant part of its range. Protection mandated by the United States Endangered Species Act, 1973.

Even-aged stand – A group of trees that do not differ in age by more than 10 to 20 years or by 20% of the rotation age.

Exclosure – An area fenced to exclude white-tailed deer.

Exotic – Refers to species not native to Pennsylvania, or to the area in which they occur.

Fauna – The animals of a specified region or time.

Floodplain – The flat to nearly-flat lowland adjacent to a river or lake subject to at least intermittent flooding. Floodplains are designated by the frequency of the flood that is large enough to cover them. For example, the 10-year floodplain will be covered by the 10-year flood and the 100-year floodplain by the 100-year flood.

Flora – The plants of a specified region or time.

Forb – A broad-leaved (not grass-like) herbaceous plant.

Forest –An area dominated by trees where the leaf canopy is closed or nearly closed and the majority of tree crowns are overlapping, typically with between 60% and 100% tree cover.

Fragmentation – The segmentation of a large tract or contiguous tracts of forest to smaller patches, often isolated from each other by

nonforest habitat. Results from the collective impact of residential and commercial development, highway and utility construction, and other piecemeal land use changes.

Goods and services – In natural lands, this term refers to the products and functions that site features (soil, water resources) and native plant communities provide to human and wildlife populations. These include clean water and air, food, recreational opportunities, income-generating products (lumber, edible and medicinal plants), and beautiful viewsheds.

Grassland – Open area dominated by grass species.

Ground layer – The herbs, shrubs, and woody vines beneath the trees in a forest; or the lowest layer of vegetation in an open-canopy community.

Groundwater – Water found underground in openings in rock strata and soils.

Growing space – The major forces—light, water, inorganic nutrients, temperature, humidity, soil structure and other factors—that support plant growth in a given area.

Habitat – The geographically defined area where environmental conditions (e.g., climate, topography, etc.) meet the life needs (e.g., food, shelter, etc.) of an organism, population, or community.

Hardwood – Deciduous trees that have broad leaves, produce a fruit or nut, and generally go dormant in the winter.

Hazard tree – A tree with compromised structural integrity located near a "target", i.e., an area of human use or a structure. A hazard tree has the potential to fall—in part or in whole—and injure people or damage property.

Herb, Herbaceous – Plants with no persistent woody stem above the ground, as distinct from trees and shrubs.

Herbaceous layer – The layer of vegetation in which herbs are common or dominant, usually the ground layer.

Herbicide – Any chemical substance used to kill plants, especially weeds, or to check their growth.

Hydric soils – Periodically wet soils, in an undrained condition, that often support the growth of wetland vegetation. Soils with major hydric components are a conservative indicator of wetlands. Other soils have hydric components in limited settings, such as depressions, lowlands, swales, drainageways, and alluvial soils.

Hydrology – Describes the way water is distributed in the landscape, moves over the ground surface and underground, includes precipitation, evaporation, transpiration, and flow.

Hydrophyte, Hydrophytic – Describes any plant adapted to growing in water or on a substrate that is at least periodically deficient on oxygen as a result of excessive water content.

Interior forest – A forested area at least 100 meters (305') from any edge.

Intermittent – Refers to streams that do not flow continuously throughout the year.

Invasive – A plant that has the ability to usurp growing space from established native vegetation. Typically, they are prolific seeders and fast growing.

Litter – The uppermost layer of the forest floor consisting chiefly of decaying organic matter.

Marsh – A wetland dominated by herbaceous vegetation and usually having little or no peat accumulation.

Mast – All fruits of trees and shrubs used as food by wildlife. Hard mast includes nutlike fruits such as acorns, beechnuts, and chestnuts. Soft mast includes the fleshy fruits of black cherry, dogwood, and serviceberry.

Meadow – Open area dominated by grass and wildflower species.

Mesic – Describes areas of intermediate soil moisture content; moist but well drained.

Mineral soil – Soil free of organic matter.

Native – Describes species that occurred in Pennsylvania or in the area in which they are found prior to European settlement; not introduced by human activities; indigenous.

Natural regeneration – The replacement of one forest stand by another through natural seeding or sprouting.

Non-point-source pollution – Consists primarily of polluted stormwater runoff from urbanized areas and agricultural fields, in contrast to point-source pollution, which is discharged from pipes at industrial facilities or sewage treatment plants.

Old growth – Forests that approximate the structure, composition, and functions of native forests prior to European settlement. They vary by forest type, but generally include more large trees, canopy layers, standing snags, native species, and dead organic matter than do young or intensively managed forests.

Open area – An area not dominated by tall (> 15') trees.

Outslope – The grade from the upslope edge of the treadway to the downslope edge. Trails, especially sidehill trails, should have an outslope of 3% to allow for proper sheet drainage.

Overseed – The process of adding additional seed to an already established grassland/meadow either by broadcasting the seed onto the area or using a no-till drill to insert the seed into the ground.

Overstory – Trees in the upper level, or canopy, of the forest.

Palustrine – Describes wetlands; areas intermediate between aquatic and terrestrial habitats, supporting predominantly hydrophytic vegetation, where conditions are at least periodically wet enough during the growing season to produce anaerobic soil conditions and thereby influence plant growth.

Parent material – the type of rock from which a soil type is derived.

Patch – A small area of a particular ecological community surrounded by distinctly different ecological communities, such as a forest stand surrounded by agricultural lands or a small opening surrounded by forestland.

Perennial – A plant that persists and produces reproductive structures year after year; refers to streams and wetlands that contain water at or near the surface throughout the year.

Pioneer species – Species adapted to colonize and persist in open areas following major disturbances such as fire, flooding, or wind. They typically have light, wind-blown seed and, once established, have a rapid growth rate.

Plug – A plant grown in small (1"–2" square) containers that can be transplanted into a desired location.

Preservation – A management philosophy or goal which seeks to protect indigenous ecosystem structure, function, and integrity from human impacts. Management activities are generally excluded from "preserved" lands.

Prime agricultural soils – Soils that are deep, well-drained, and moderately sloped that can support high yields of crops with little management.

Puncheon – Also known as a bog bridge. A simple bridge constructed of two base logs (or sills) set perpendicular to the trail and two stringers, parallel to the trail and spiked to the top of the base logs.

Rare species – Species that exist only in one or a few restricted geographical areas or habitats or occur in low numbers over a relatively broad area.

Recruitment – The addition of new individuals to a population.

Reforestation – The re-establishment of forest cover by natural or artificial means on areas recently supporting forest cover.

Regeneration – The replacement of one forest stand by another as a result of natural seeding, sprouting, planting, or other methods; also young trees which will develop into the future forest.

Riparian zone – An area adjoining a body of water,

normally having soils and vegetation characteristic of floodplains or areas transitional to upland zones. These areas help protect the water by removing or buffering the effects of excessive nutrients, sediments, organic matter, pesticides, and pollutants.

Sapling – A small tree, usually defined as being between 2"–4" in diameter at breast height.

Seasonally wet – Areas with poorly-drained soils or high water table that hold water during certain periods of the year, typically during the late winter and early spring.

Second growth – the forests re-established following the removal of virgin (i.e., previously unharvested) or old growth stands. Most of Pennsylvania's forests are either second or third growth.

Seedling – A young tree originating from seed that is less than 4' tall and smaller than 2" in diameter at ground level.

Seep – A class of wetland created by groundwater emerging on lower slopes in small pools surrounded by vegetation. These create snow-free zones critical for wildlife feeding during winter.

Shade tolerance – The ability of a plant to grow under conditions of less than full sunlight. ***Tolerant***: having the ability to become established and survive in low light conditions for an extended period of time. ***Intermediate***: able to become established under a closed forest canopy and persist for short periods if local disturbances provide an increasing amounts of sunlight. ***Intolerant***: requires full sun conditions to colonize a site and persist.

Shrubland – An area dominated by shrubs and small trees with less than 25% total cover by trees; herbaceous plants may be present.

Sidehill – A sidehill trail, often literally cut out of the side of a hill, gains elevation by moving up a slope, gradually following the contour.

Snag – A standing dead tree with few branches, or the standing portion of a broken-off tree. Snags may provide feeding and nesting sites for wildlife.

Softwood – Conifers, evergreen and cone-bearing trees.

Species – A subordinate classification to a genus; reproductively isolated organisms that have common characteristics, such as eastern white pine or white-tailed deer.

Species richness – The number of species present in a community or a defined area.

Spring – Location of concentrated groundwater discharge.

Stand – A grouping of vegetation sufficiently uniform in species composition, age, and condition to be distinguished from surrounding vegetation types and managed as a single unit.

Statewide important soils – Soils that can support cultivation but require careful crop management.

Stewardship – The wise management and use of natural resources to ensure their health and productivity for the future with regard for generations to come.

Stratum – A horizontal layer of vegetation.

Stress – The application of an ongoing impact (e.g., drought, browsing, competition for growing space) that does not cause death.

Structure – The spatial arrangement of vegetation layers within a community.

Structural diversity – The number of different vegetative layers (canopy tree, understory tree, shrub, herb) within a forest. A structurally diverse forest provides habitat for the most wildlife species. This term can be used to characterize other plant communities, such as meadow or shrubland, that do or do not contain species of different heights.

Succession – The natural series of replacement of one plant community (and the associated fauna) by another over time and in the absence of disturbance.

Switchback – Used to gain elevation on sidehill trails. The switchback is a sharp turn in the opposite direction.

Terrestrial – Uplands; where vegetated, supporting vegetation that is not predominantly hydrophytic.

Threatened species – A species likely to become endangered in the foreseeable future, throughout all or a significant portion of its range, unless protected.

Trailhead – Beginning of a trail or trail section, or an access point, sometimes with parking, information signs, etc.

Tread, treadway – That part of the trail which is walked upon; the footpath.

Turnpike – Low, linear, elevated earthen walkways across flat wet areas, with fill held in place by rock or log cribbing.

Understory – The smaller vegetation (shrubs, seedlings, saplings, small trees) within a forest, occupying the vertical zone between the canopy and the herbaceous plants of the forest floor.

Uneven-aged stand – A group of trees of various ages and sizes growing together on a site.

Upland – Sites with well-drained dry to mesic soils.

Vernal pool or pond – Small, shallow, temporary pools of water present in spring and fall which typically do not support fish but are important breeding grounds for many species of amphibians. Some species, such as spring peepers and mole salamanders, are totally dependant upon such ponds.

Vertical structure – The arrangement of plants in a given community from the ground (herbaceous and woody shrubs) into the main forest canopy; a complex vertical structure is characterized by lush undergrowth and successive layers of woody vegetation extending into the crowns of dominant and codominant trees.

Virgin forest – A forest that has never been harvested or altered by humans.

Water table – The level of ground water. Where ground water is within reach of plant roots, the level of the water table usually varies through the year, being highest just prior to the start of the growing season, and decreasing as plants transpire water. Plant roots will usually not grow below the permanent level of water due to insufficient oxygen.

Waterbar – Rock or log structure diagonally across the trail to divert water and mitigate erosion.

Watershed – A region or area defined by patterns of stream drainage. A watershed includes all the land from which a particular stream or river is supplied.

Wetland – An area that is either transitional between land and water (where the water table is at or near the land surface) or area of land covered by shallow water (such as a marsh, swamp, bog, or fen). These areas fulfill an essential role in our landscapes by maintaining water quality, stabilizing shores and stream banks, controlling floods and erosion, and providing critical habitat to many plant and animal species.

Windthrow – The uprooting of trees by wind.

Woodland – An area dominated by trees, but having an open character with between 10% and 60% tree cover.

Xeric – Very dry; describes areas with dry, well drained to excessively well-drained soils.

Resources

Contacts

	FOREST	MEADOW	CROPLAND	WETLANDS	RIPARIAN	PONDS	STORMWATER	FINANCIAL ASSISTANCE
USDA Natural Resources Conservation Service (NRCS) www.nrcs.usda.gov Conservation Security Program (CSP) Environmental Quality Incentives Program (EQIP) Farm and Ranch Lands Protection Program (FRPP) Wetlands Reserve Program (WRP) Wildlife Habitat Incentives Program (WHIP) Agricultural Management Assistance (AMA) Conservation Reserve Program (CRP) Conservation Reserve Enhancement Program (CREP) **Pennsylvania NRCS** www.pa.nrcs.usda.gov/index.html *Chester/Delaware County* West Chester Service Center 601 Westtown Road West Chester, PA 19380-0990 610-696-0398	X	X	X	X	X	X	X	X
US Fish and Wildlife Service Pennsylvania Field Office 315 South Allen Street State College, PA 16801-4850 814-234-4090 www.fws.gov/northeast	X	X			X	X		

	FOREST	MEADOW	CROPLAND	WETLANDS	RIPARIAN	PONDS	STORMWATER	FINANCIAL ASSISTANCE
PA Department of Conservation and Natural Resources (DCNR) 7th Floor, Rachel Carson State Office Building P.O. Box 8767 400 Market Street Harrisburg, PA 17105-8767 717-787-2869 www.dcnr.state.pa.us	X	X		X	X			X
PA DCNR, Bureau of Forestry 6th Floor, Rachel Carson State Office Building P.O. Box 8552 Harrisburg, PA 17105-8552 717-705-5194 www.dcnr.state.pa.us/forestry Valley Forge District Office *(Berks, Bucks, Chester, Delaware, Lancaster, Montgomery, Philadelphia counties)* 845 Park Road Elverson, PA 19520-9523 610-582-9660	X			X	X			
PA Department of Environmental Protection (DEP) Southeast Regional Office 2 East Main Street Norristown, PA 19401 484-250-5900 www.dep.state.pa.us/dep/deputate/fieldops/se/se.htm				X	X	X	X	X
PA Game Commission Southeast Region *(Berks, Bucks, Chester, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Montgomery, Northampton, Philadelphia, Schuylkill, York counties)* 448 Snyder Road Reading, PA 19605 877-877-9470 Private Landowner Assistance Program	X	X	X	X	X	X		X

	FOREST	MEADOW	CROPLAND	WETLANDS	RIPARIAN	PONDS	STORMWATER	FINANCIAL ASSISTANCE
Penn State Cooperative Extension Southeast Region Penn State Berks-Lehigh Valley College Tulpehocken Road P.O. Box 7009 Reading, PA 19610-6009 610-378-4362 www.extension.psu.edu/seregion *Chester County* 601 Westtown Road, Suite 370 West Chester, PA 19380-0990 610-696-3500			X			X		
Chester County Conservation District 601 Westtown Road, Suite 240 P.O. Box 2747 West Chester, PA 19380-0990 610-696-5126 www.chesco.org/conservation				X	X	X	X	
Hardwood Lumber Manufacturers' Association of Pennsylvania, Inc. 545 W. Chocolate Avenue Hershey, PA 17033 800-232-HLMA 717-312-1244 www.hlma.org	X							
School of Forest Resources **Cooperative Extension Office** **The Pennsylvania State University** 7 Ferguson Building University Park, PA 16802-4302 814-863-0401 http://rnrext.cas.psu.edu	X		X			X	X	X
Society of American Foresters 5400 Grosvenor Lane Bethesda, MD 20814-2198 301-897-8720 www.safnet.org	X				X			

	FOREST	MEADOW	CROPLAND	WETLANDS	RIPARIAN	PONDS	STORMWATER	FINANCIAL ASSISTANCE
Pennsylvania Forestry Association 56 East Main Street Mechanicsburg, PA 17055 717-766-5371 http://pfa.cas.psu.edu	X							
Association of Consulting Foresters of America, Inc. *(National Office)* 723 N. Washington Street, Suite 4-A Alexandria, VA 22314 703-548-0990 www.acf-foresters.com	X							
Morris Arboretum of the University of Pennsylvania 100 East Northwestern Avenue Philadelphia, PA 19118 215-247-5777 www.business-services.upenn.edu/arboretum	X							
The Nature Conservancy 4245 North Fairfax Drive, Suite 100 Arlington, VA 22203 703-841-5300 www.nature.org Pennsylvania Field Office 15 East Ridge Pike, Suite 500 Conshohocken, PA 19428 610-834-1323 pa_chapter@tnc.org	X	X		X				

Additional Information Sources

General

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Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources, David J. Welsch, US Department of Agriculture, Forest Service, 1992

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Center for Watershed Protection, http://www.cwp.org

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The Pennsylvania Flora Project, http://www.paflora.org

The Pennsylvania Native Plant Society, http://www.pawildflower.org

US Department of Agriculture, NRCS Plants Database, http://plants.usda.gov

US Forest Service Tree Information Database, http://www.fs.fed.us/database/feis/plants/tree

Wild Ones – Native Plants, Natural Landscaping, http://www.for-wild.org

Invasive Plant Species

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Invasive Plants: Weeds of the Global Garden, John M. Randall and Janet Marinelli, Brooklyn Botanic Garden, 1996

Plant Invaders of Mid-Atlantic Natural Areas, Jil Swearingen, et al, National Park Service and US Fish and Wildlife Service, 2002

Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas, Mandy Tu, Callie Hurd, John M. Randall, Wildland Invasive Species Team, The Nature Conservancy, 2001

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Mid-Atlantic Exotic Pest Plant Council, http://www.ma-eppc.org

National Biological Information Infrastructure and National Invasive Species Council, http://www.invasivespecies.gov

The Nature Conservancy, The Invasive Species Initiative, http://tncweeds.ucdavis.edu

New England Wildflower Society, http://www.newfs.org/conserve/invasive.htm

Plant Conservation Alliance, Alien Plant Working Group, http://www.nps.gov/plants/alien

Tennessee Exotic Pest Plant Council, http://www.tneppc.org

US Department of Agriculture, Agricultural Research Service, Invaders Database System, List of Noxious Weeds, http://invader.dbs.umt.edu/noxious_weeds

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