Stewardship Handbook

for Natural Lands on the Lower Delaware National Wild and Scenic River

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Funded by:





Prepared by:



To YOU the land steward...

your time and your funds.

This Handbook is for you. You are faced with a daunting task: to take care of natural lands and protect the waterways that flow through and from them. Natural lands don't take care of themselves. Not here, not now. They need your help to be the natural lands they were meant to be, in the face of accelerating change, unrelenting pressure on dwindling resources, and never-ending competition for

You are absolutely necessary to the future of natural lands. Good land stewardship can turn degraded, barren lands into rich sources of diverse life. Good land stewardship can serve as an example to other land managers, building on itself to create a network of high quality natural lands. Good land stewardship can make a better future.

To be a good land steward you need to do two things: develop a stewardship plan for your land, and then implement the plan by managing your land.

Take your time. Look at this *Stewardship Handbook* not as a single resource but as many. Read this Introduction first to understand the basics of land stewardship. Then read the parts of the *Handbook* that you need to develop your plan. There are many other information resources available, to help with specifics of your plan. The *Handbook* includes references to these too.

The Handbook will give you the understanding of land stewardship principles that you need to develop your plan. But it cannot tell you about your land itself. That is up to you. Know your land. Watch it, listen to it, breathe it in, taste it, walk it forwards and backwards. Know the rocks, the water, the soil, the plants, and the wildlife. Know how it got to where it is. Then, only then, can you decide where it ought to be.

And one more thing.



On the Cover: Delaware River Sojourn, Mariton Wildlife Sanctuary, Pennsylvania. Photo courtesy of Steve Eisenhauer, NLT Staff Member



Table of Contents

Mapiii
Introduction1
Land Stewardship Along the Lower Delaware National Wild and Scenic River
Vegetation Cover Types
Hedgerow5
Shrubland
Meadow/Grassland
w chands
Stewardship Issues and the Landowner's Role10
Stormwater Management and Water Quality10
Non-point-source Pollution11Flooding13Groundwater Depletion14River and Streambank Stabilization15Riparian Buffers17Forest Fragmentation and Edge Effects20Invasive Plant Species22Deer Overabundance27Canada Goose Overabundance30
Non-point-source Pollution 11 Flooding 13 Groundwater Depletion 14 River and Streambank Stabilization 15 Riparian Buffers 17 Forest Fragmentation and Edge Effects 20 Invasive Plant Species 22 Deer Overabundance 27 Canada Goose Overabundance 30 Resources for Landowners 32
Non-point-source Pollution 11 Flooding 13 Groundwater Depletion 14 River and Streambank Stabilization 15 Riparian Buffers 17 Forest Fragmentation and Edge Effects 20 Invasive Plant Species 22 Deer Overabundance 27 Canada Goose Overabundance 30 Resources for Landowners 32 Backyard Habitat Programs 32
Non-point-source Pollution 11 Flooding 13 Groundwater Depletion 14 River and Streambank Stabilization 15 Riparian Buffers 17 Forest Fragmentation and Edge Effects 20 Invasive Plant Species 22 Deer Overabundance 27 Canada Goose Overabundance 30 Resources for Landowners 32 Backyard Habitat Programs 32 Native Plant Materials 33
Non-point-source Pollution 11 Flooding 13 Groundwater Depletion 14 River and Streambank Stabilization 15 Riparian Buffers 17 Forest Fragmentation and Edge Effects 20 Invasive Plant Species 22 Deer Overabundance 27 Canada Goose Overabundance 30 Resources for Landowners 32 Native Plant Materials 33 Sources 42



Introduction to The Lower Delaware National Wild and Scenic River

The National Wild and Scenic River System has been around for 40 years. Created by an Act of Congress in 1968, the Wild and Scenic Rivers Act calls on the nation to preserve select rivers with outstanding scenic, recreational, geologic, fish and wildlife, historic, cultural or other important values in free-flowing condition. Rivers in this national system are protected for the benefit and enjoyment of present and future generations.

Every bend in the river speaks to us of history, beauty, and opportunity. Its basin contains habitats that do not occur elsewhere in the region. Diverse flora and fauna thrive on its banks and islands. Yet today, the Delaware River supports one of the country's largest populations and industry.

The challenge is to manage the growth and use of the corridor and its resources to protect its outstanding character. The river flows through the very heart of the birthplace of our nation.

On the Pennsylvania side of the river, three scenic tributaries—Tohickon Creek, Tinicum Creek, and Paunacussing Creek—empty into the main river channel and share its special designation.

The Lower Delaware National Wild and Scenic River is not part of the national park system because there are no lands owned or managed by the National Park Service within its geography.



The marina at Lake Nockamixon, Nockamixon State Park, Pennsylvania.

Rather, it is known as a "Partnership Wild and Scenic River." It mainly flows through private property and public parklands, so it is managed through cooperation between many levels of government and different organizations. That is why it is so important for people like you who live, work, and play along the river to lend a hand in protecting the river and its valuable resources.

Land Stewardship Along the Lower Delaware National Wild and Scenic River



A view of Lambertville, New Jersey, taken from across the river in New Hope, Pennsylvania.

Why stewardship?

To maximize the ecological and community benefits of natural lands, landowners and land managers must establish an effective long-term land stewardship program.

he need to protect and steward remaining natural lands has grown along with the wave of suburban development surrounding the banks of the river. In response, public agencies and private foundations are helping municipalities and land conservancies protect critical natural lands within the region through fee acquisition and conservation easements. Some municipalities, through Smart Growth practices, now require that new developments contain a percentage of open space. 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.

Natural lands provide many environmental, ecological, economic, and recreational benefits including flood control, ecotourism, protection of soil and water resources, habitat for local and migratory wildlife, and areas for hiking and nature study.

natural lands are areas that are dominated by vegetative cover types native to our region (e.g., forest, meadow, marsh, barrens) and typically require less maintenance to perpetuate than lands outside this category, such as formal landscapes and agricultural fields.

What is land stewardship?

Stewardship is an active process of engagement with your land to direct it toward (or keep it at) a desired state. Because natural processes in the region have been and continue to be significantly altered by human activity, natural lands left to themselves will in most cases—become degraded and dysfunctional. It is not good enough to let natural lands go.

Defining stewardship goals for individual properties and understanding the existing resources and various issues and opportunities associated with each site are critical to sustaining healthy ecosystems beneficial to water quality, wildlife, and safe and enjoyable recreational areas for human visitors.



The Delaware Canal towpath, Delaware Canal State Park, Pennsylvania.

Every property is unique.

Human intervention, while necessary, should be minimized and should, as much as possible, support the natural processes inherent to the area.

Developing a Stewardship Plan

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 residential use areas on 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.

Step 9: Assemble the Stewardship Plan to record information gathered and decisions made.

Vegetation Cover Types

Use sually the greatest effect a land manager can have on achieving stewardship goals is through vegetation (cover type) 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 wetlands. 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.



Healthy native forests, with abundant tree regeneration and no invasive plants, are, sadly, uncommon in southeastern Pennsylvania.

HEALTHY NATIVE FOREST

There are few forested areas in southeastern Pennsylvania that remain in an ecologically healthy condition. To qualify as such would require a site to be well stocked with native trees relative to its age and site conditions, free of invasive plants, and not overbrowsed by deer. These criteria could encompass a variety of forest types, site histories, terrains, and "looks," from dense to relatively open, all young trees to varied age classes, reclaimed old field to never-logged steep hillside, or dry, sandy soils to muck that is saturated year-round. Any healthy native forest is rare in our region and provides important environmental (air and water purification, soil formation, erosion control, groundwater recharge, nutrient cycling, climate moderation), ecological (habitat for native wildlife, biodiversity conservation), and recreational benefits.

Benefits to regional conservation priorities

• *Interior forests*—those areas over 100 meters (305 feet) from an edge—are increasingly rare in the region due to fragmentation from past agricultural use and more recent increases in suburban development. They support many migratory songbird species that are declining 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 shading, absorb pollutants and accumulate sediments from agricultural and residential runoff, stabilize streambanks, and add leaves and woody debris to the stream, which furnishes food and shelter for aquatic organisms.
- Healthy forests absorb large amounts of carbon dioxide and sequester (store) carbon in various forms—leaves, soil organic matter, woody stems for various lengths of time until these materials decay or are burned. Increasing the region's forested area and maintaining forest health can help to *sequester more carbon and reduce greenhouse gases* that contribute to global warming.

HEDGEROW

Hedgerows are narrow swaths of trees between agricultural fields. They typically arose along fences (perching birds would deposit tree and shrub seeds) or as planted "living fences" of Osage-orange or multiflora rose. Over time they became repositories of rocks, trash, and old farm equipment. 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-tolerance tree species common in the region. They are a ubiquitous remnant of the agricultural legacy of the region, inhabiting remaining farmland, parks, nature preserves, and subdivisions.

To protect and enhance your natural lands, the most important stewardship strategy to develop is the desired vegetation (cover type).



Hedgerows, remnants of windbreaks between agricultural fields, can be corridors for the spread of invasive plants (above) and predators of grassland birds. Hedgerows can be valuable if used as a seed source in the conversion of adjacent farm fields to forest.

Benefits to regional conservation priorities

- Traditionally, hedgerows were seen as important *corridors* for wildlife movement, providing cover for small mammals and birds. With recent interest in protecting grassland birds this traditional value can be outweighed by hedgerows' propensity to facilitate predation on these threatened species (see below).
- Native species in hedgerows can be valuable as *seed sources* for restoration projects on adjacent agricultural fields that are under conversion to forest. However, this benefit is often outweighed by the detrimental contribution by most southeastern

Pennsylvania hedgerows of vast quantities of non-native, invasive shrub and vine seeds.

• Hedgerows are often used to **buffer** new residential development and are cultural features that may be desirable to maintain in a new subdivision, reducing its impacts on more ecologically significant areas.



Maintaining shrubland as a cover type requires periodic disturbance—typically mowing every three to ten years—to keep both tall trees and invasive plants from taking over.

The difficulty of maintaining healthy native shrublands and their potential to be reservoirs for invasive plants if not properly maintained make them a challenging cover type for the typical landowner. However, it is a very valuable cover type for wildlife.

SHRUBLAND

Shrublands are nonforested areas that have moved to the intermediate shrub/small tree stage of succession or are dominated by shrub species that greatly slow forest succession by inhibiting tree seedling establishment. The intermediate successional stage shrublands, often called thickets, usually grow into the forest stage in just a few years unless exposed to frequent tree-killing disturbance. The more persistent shrublands are those in which the dominant species change the environment to the detriment of tree regeneration or the soils are extremely wet, dry, or infertile. They may last many years without disturbance, but eventually they too are invaded and shaded out by trees of the species that are most tolerant of the dominant shrubs' influence or of the soil conditions, unless subjected to occasional disturbance.

Due to thousands of years of Native American burning and agricultural practices over much of the past three centuries, shrubland was relatively abundant. Until recently clearcutting and farmland abandonment across the region continually produced new shrubland to replace acreage steadily lost to forest succession. Shrubland abundance has rapidly declined as forests have matured and houses have consumed more recently abandoned farmland. The result has been the decline of birds and other wildlife that depend on this cover type.

Benefits to regional conservation priorities

• Native shrublands provide many of the same environmental benefits as forests and some unique ecological benefits, including habitat for threatened wildlife. Because they are used by species of birds uncommon or declining in our region (e.g., chestnutsided warbler, blue-winged warbler, prairie warbler, yellow-breasted chat, white-eyed vireo, willow flycatcher, blue grosbeak, indigo bunting, whippoor-will, American woodcock, grouse, northern bobwhite), they provide unique recreational (birdwatching and hunting) opportunities.

MEADOW/GRASSLAND

Meadows and grasslands are open areas dominated by herbaceous plants. Areas predominantly covered by grass species are called grasslands; those having a strong forb (wildflower) component are known as 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, meadows and grasslands 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.

There are few meadows or grasslands in southeastern Pennsylvania that are in an ecologically healthy condition, that is, dominated by native grass and forb species and free of invasive plants. Because shipping ports, croplands, and gardens in southeastern Pennsylvania have been points of entry for exotic species for centuries, invasive plants are particularly well established here.

Most meadows and grasslands exist as temporary ecosystems; without repeated disturbance, succession will eventually return the area to forest.



Grasslands (left) are open areas dominated by grasses. Meadows (right) are open areas dominated by grasses and wildflowers. Meadows and grasslands need annual disturbance by mowing or burning to prevent woody vegetation from becoming established. Drew Gilchrist (both)

This means that former agricultural fields—the foundation of most meadows and grasslands in the region—typically receive a plentiful supply of invasive species' seeds. The most likely sites for healthy existing meadows are those with extremely wet, dry, or infertile soils, which provide growing conditions far more favorable to native grass and forb species than to invasive species. Healthy marshes, wet meadows, and upland native meadows and grasslands



Unlike the shallow roots of turf grasses like Kentucky blue grass, the deep roots of native warm-season grasses help them tolerate marginal soils and, in turn, protect these soils from water and wind erosion.

are rare in our region and provide important environmental (air and water purification, soil formation, erosion control, groundwater recharge, nutrient cycling, climate moderation) and ecological (habitat for native wildlife, biodiversity conservation) benefits.

Benefits to regional conservation priorities

- Preserving habitat for grassland interior species, which require large blocks of meadow unbroken by hedgerows or highways, including several increasingly rare species of grassland birds (grasshopper sparrow, savannah sparrow, vesper sparrow, eastern meadowlark, bobolink, horned lark, northern bobwhite) whose populations have become imperiled due to the decline in this cover type. Maintaining meadows and grasslands in large blocks (at least 25 acres but preferably greater than 50 acres) or as part of a larger open landscape is necessary to provide habitat for these species.
- Preserving habitat for meadow and grassland species that do not require large, unbroken blocks, including many species of *declining and imperiled butterflies* (e.g., twospotted skipper, black dash, cobweb skipper, mulberry wing, long dash, frosted elfin, silvery blue, bronze copper, silver-bordered fritillary, eyed brown, Atlantis fritillary, giant swallowtail, falcate orangetip, northern metalmark). Native meadows and grasslands of just a few acres can provide habitat for these and other imperiled species.

WETLANDS

Wetlands may be defined as areas that satisfy at least two of the following three parameters: (1) they support hydrophytic (water-loving) plants, (2) they contain hydric (periodically wet) 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 environmental benefits they provide. Because the stewardship of wetlands is covered by federal and state regulations that are periodically modified, it is prudent to contact the USDA Natural Resources Conservation Service, Pennsylvania Department of Environmental Protection, or the Conservation District before conducting any stewardship activity in or near a wetland area.

Benefits to regional conservation priorities

- *Wildlife habitat*. Amphibians, aquatic insects, and many animals that depend on them as a major food source use wetlands as breeding and feeding sites.
- *Water quality protection*. Wetlands buffer streams by absorbing sediments and chemical pollutants.
- **Stream flow moderation**. By capturing and slowly releasing large amounts of precipitation, wetlands reduce the volume of water entering streams during storm events. By slowly replenishing groundwater and streams they help maintain stream flows during dry periods.

Converting pasture or cropland to a more natural cover type would be particularly beneficial if it is currently located in an area that is often wet.



Historically maligned, filled, dredged, and drained, wetlands are now considered essential for maintaining water quality. Good stewardship includes compliance with several levels of regulation designed to protect this valuable, yet vulnerable, habitat.

Although historically maligned as wasteland, wetlands are finally receiving proper recognition for the many important ecological and environmental benefits they provide.

Stewardship Issues and the Landowner's Role

Why water matters

WATER QUALITY

degraded by

contaminants from lawns and agricultural fields running off into streams

solve by

- installing/maintaining native vegetation along waterways (riparian buffers)
- reducing use of contaminants
- managing goose populations
- controlling livestock/pet waste
- managing first flush through stormwater management

WATER QUANTITY

degraded by

impervious surfaces preventing groundwater recharge

resulting in

drying up of wetlands and streams

solve by

- installing/maintaining riparian buffers
- infiltrating stormwater using BMPs

STORMWATER MANAGEMENT AND WATER QUALITY

The natural hydrologic cycle returns stormwater to the ground through infiltration: as rain falls, most of it percolates down through the soil into the groundwater table. Groundwater replenishes not only the underground aquifers that supply drinking water for much of the region but also wetlands and waterways. Suburban development, particularly the huge amounts of paved (impervious) surface that comes with it, as well as old-style stormwater management that pipes runoff into streams, has so altered this cycle that groundwater is depleted and flooding is common.

For the land steward the challenge is to restore, as much as possible, the natural hydrologic cycle on the stewarded land.

The primary threats to water quality and quantity in our region are modifications to hydrology caused by changes in land use. In natural conditions, of the approximately 50 inches of rain that falls within the river's watershed (those lands that drain into a waterway) each year, 12 inches infiltrate into the groundwater, 25 inches are evapotranspired into the air, and 8 inches run off as surface water. However, once the landscape is urbanized, these proportions change with four main effects:

- *Non-point-source pollution* results when excessive stormwater runoff volume carries pollutants from residential, commercial, and agricultural areas and sediment from erosion caused by an excessive runoff rate. (*Note: point-source pollution is discharged from pipes at industrial facilities or sewage treatment plants.*)
- *Flooding* results from excessive runoff volume.
- *Groundwater is depleted* by reduced infiltration.
- River and streambanks are destabilized by increased stormwater flows.

Overall, land development in a watershed results in the amplification of both the high and lows of the natural hydrologic cycle.

Non-point-source Pollution

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

• Loss and Degradation of River and Streamside Forested Areas and Wetlands

Decades of deforestation, agricultural expansion, and increasing suburban development have drastically reduced the extent of water edge protected by forest in the river region. Without the protective canopy and filtering and stabilizing root systems of riparian vegetation, streams can be degraded by warmer temperatures and higher levels of total suspended solids, nutrients, and bacteria from stormwater runoff and nearby farms (livestock, fertilizer application) and homes (failing septic systems, lawn fertilizers). When floodplains are kept naturally forested and with networks of wetlands, they serve to dissipate the velocity and disperse the volume of flood waters. This reduces downstream hazards to human health and impacts to property.



Uncontrolled stormwater runoff from adjacent roads and open areas can result in erosion within forested areas.



David Stecke

Without vegetation adjacent to a river and its streams, stormwater runoff flows at greatly increased volume into the waterway. This brings not only flooding and bank erosion, but also increased pollution as the runoff carries sediment, nutrients and chemicals from the surface runoff that would be filtered if a riparian buffer were present. Ideally a 100-foot-wide zone on both sides of a river should be vegetated.

• Thermal Pollution

Unnaturally warm water temperatures along some reaches of the river and local streams may exacerbate the impact of non-point-source pollution on the health of aquatic life. Warm water temperatures are mainly attributable to lack of shade along banks, discharge of warm surface water runoff from ponds and detention basins, and runoff from heated pavement and lawn areas. Thermal pollution can trigger a vicious cycle as warm water encourages algal blooms, which absorb more sunlight, further warming water. Algae is decomposed by bacteria, which consume oxygen from the water, further depleting dissolved oxygen, which is important to support aquatic organisms.



DEVELOPMENT AND THE HYDROLOGIC CYCLE: Stormwater naturally percolates through the soil, recharging groundwater. In undeveloped conditions (top left), 5 times more rainfall is infiltrated into the ground than runs off the surface. Land development modifies this natural hydrology, significantly reducing groundwater recharge and increasing stormwater runoff.

• Excessive Stormwater Runoff

River and stream water quality is degraded by erosion, sedimentation, and serious flooding associated with ineffective management of stormwater from impervious surfaces. Uncontrolled roadside runoff (which often contains oils, metals, and salt) from ditches and culverts is a region-wide problem. Severe erosion impacts are evident along stretches of headwater streams in the region, particularly in certain agricultural settings where functioning vegetated buffers have been lacking for many years. Sediment is generated by storm runoff and associated soil erosion from river and streambanks, farm fields, and construction sites. Excessive sediment can inhibit fish reproduction by smothering eggs, and can harm other aquatic life, particularly bottom-dwelling species that live between pebbles and cobbles, an important link in the aquatic food chain.

Unfortunately, forests are often seen as a good place to direct concentrated runoff from farm fields and roads. While forest cover and forest soils are able to capture and absorb precipitation better than any other land cover, forest vegetation is not good at protecting soils from high amounts of surface water inputs. Frequently, gullies are created within forests by stormwater runoff from adjacent agricultural or residential areas.

• Household Impacts

Residences in local watersheds may contribute to high fecal coliform bacteria levels and nutrient levels through failing septic systems and use of phosphatebased detergents. Phosphorus often contaminates runoff from lawns and gardens where chemical fertilizers are used and is an ingredient in household and commercial detergents, which enter creeks through wastewater systems. Phosphorus is the main nutrient responsible for eutrophication (nutrient enrichment, which causes algal blooms) in waterways. As algae decompose, dissolved oxygen is consumed, thereby diminishing the ability of the creek to support healthy populations of fish and other aquatic life. Residents can exacerbate bank erosion and sedimentation by mowing and dumping near rivers and streams (which prevents the growth of tree and shrub root structures that can stabilize the soil), altering channel shape, or filling wet areas that slow and absorb stormwater.

• Livestock and Pets in Rivers, Streams and Wetlands

The presence of cattle and horses in rivers, streams and wetlands can degrade water quality through trampling and erosion of banks and input of waste material. Dogs, even though they are smaller, can have a similar impact inputting nutrients, sediment, and fecal coliform bacteria.

Flooding

Flooding is a natural process whereby rivers and streams overflow their banks during heavy precipitation events or snowmelts and spill into floodplains. Many of the agricultural areas of the region have been cleared of natural vegetation for centuries. This allows rivers and streams to cut deeply into their channels, which reduces their ability to overflow their banks and disperse energy into the floodplain. As a result, even more downcutting occurs, further increasing the volume of water that the stream channel holds during storm events. This elevates damages to residents and structures downstream.



STORMWATER RUNOFF HYDROGRAPH

Conventional stormwater management facilities that do not provide infiltration or evapotranspiration only control the peak rate of runoff, not total runoff volume. Streams may still become degraded, even with stormwater basins, because standard detention facilities unnaturally prolong periods of high flows. All stormwater management facilities should include a volume reduction component.

Rivers and streams once buffered by forests that absorb and slow surface runoff must accommodate larger quantities of runoff flowing from developed landscapes and with higher peak rates—"flashier flooding."

By clearing vegetation, grading and compacting soils, and paving more of the land—even with stormwater management systems—we alter the natural flooding process in a way that prolongs periods of high flow in the river and local streams. The major cause of dangerous flooding is altered runoff patterns, as we plow fields and pave over watersheds, allowing most of the stormwater runoff to head directly into rivers and 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



Rivers and streams in developed watersheds cannot manage the higher stormwater flows, resulting in undercut banks and the loss of access to floodplains.

Groundwater depletion is a serious condition that can lead to drying of local wells and loss of baseflow to wetlands and streams.

Stormwater Best Management Practices (BMPs) are innovative management practices designed to re-create natural hydrology and so reduce flooding and increase groundwater recharge. centers. 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

Soils lose their natural groundwater recharge ability when natural vegetation is cleared and replaced with lawn, graded and compacted soils, and impervious surfaces such as paved areas and rooftops. These manmade features alter the ability of the soils to permit water infiltration, so that groundwater supplies are not being adequately recharged. At the same time, human use and consumption of ground and surface water supplies can deplete the availability of groundwater. Depletion of groundwater is difficult to monitor, since it requires comparison of groundwater, well, and stream gauge data over time.

• Drinking Water Supplies

Most local wells are private. Welldrilling permits and data on private well levels and yields has only recently been required by a few local Health Departments. 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.

• Stream Baseflow

As groundwater supplies diminish, less water reaches the streams that depend on groundwater during dry months. In first and second order streams, decreased baseflow magnifies the effects of pollutants. This results in increased stress on pollutant-sensitive aquatic species. Under drought conditions, some southeastern Pennsylvania streams can have so little input from groundwater that 90% of the stream flow is treated sewer discharge during dry summer months.

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.

River and Streambank Destabilization

Every stream and its floodplain evolves over time in the context of the specific slope, geology, vegetation, and climate of its drainage area. However, as land use changes, watershed hydrology changes, so the stream system must adapt to manage the new flows. Streams that were once fed by a steady flow of groundwater seeping from a natural landscape, may in turn cease flowing in drier months due to depleted groundwater baseflows.

Natural stream systems in Pennsylvania develop a dynamic equilibrium with their floodplain and channel that creates natural areas of moderate sedimentation and erosion, both in the channel and out onto the floodplain. In an undisturbed watershed, a stream meanders back and forth across its floodplain over the course of time. Streams respond to land clearing and development by quickly expanding their channels, inhibiting meandering.

Broader, more entrenched streams are unable to overflow their banks in a flood, restricting all the erosive velocities to the channel. These streams undercut surrounding vegetation, further destabilizing their banks, causing more erosion.

The Landowner's Role

Managing stormwater runoff from impervious surfaces is an essential aspect of land and water stewardship. It is important to consider each project not individually, but rather as one of a series of sites contributing cumulatively to the flooding, erosion, sedimentation, water pollution, and drought effects in each watershed. With careful attention to the ecology and hydrology of each site and each watershed, and with the use of innovative best management practices (BMPs), project designers can minimize a site's "stormwater footprint" by recreating the conditions of the site in its natural state.

Vegetation Clearing and Soil Grading

- Evaluate the grading plan to minimize unnecessary clearing, cutting, and filling.
- Retain the natural soil mantle 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 in open areas that could be converted to meadow or reforested areas.
- Avoid clearing vegetation anywhere within 100 feet of streams.

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.
- Where impervious cover does exist, incorporate vegetated "islands" to enhance opportunities for recharge.

Stormwater Management Systems

- Integrate stormwater systems throughout the site and early in the design process, and avoid shoehorning them into the open space as a final step.
- Make sure system design treats the first flush of runoff that carries the highest amount of pollutants.
- 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,

New stormwater BMPs filter runoff to improve water quality. Simply recharging runoff into soil rather than discharging it to wetlands and streams allows the soil and vegetation to remove excess nutrients, chemicals, sediments, and salts from paved areas, rooftops, and lawns. close to the impervious cover source where it is generated.

- Utilize non-structural, vegetationbased BMPs wherever possible.
- Merge the landscaping plan and natural lands/greenway lands management with stormwater management systems wherever possible.
- Recommended best management practices (BMPs):
 - -Rain gardens are small infiltration beds, depressed slightly below grade, and planted with wet-soiltolerant native trees, shrubs, and herbaceous plants to serve multiple functions: landscape features as well as biofilters to improve water quality, promote recharge, and provide habitat for plants and wildlife. Rain gardens can be incorporated into site plans within median strips, cul-desac islands, road shoulders, adjacent to parking lots, and in front lawns to handle roof and driveway runoff.
 - Vegetated swales and infiltration trenches can be included along road shoulders to disperse and recharge sheet flow from roads. This technique requires 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 rain gardens.

- —Level spreaders 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 discharged through an overflow designed to disperse sheet flow into open space.
- -Constructed wetlands and wet 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 habitat for aquatic life. These should be designed with sediment forebays.

Landscaping Plan

- Incorporate revegetation 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 the 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 your energy costs for home heating and cooling.
- Reduce the amount of turfgrass throughout the site and maximize the amount of reforested area, wildflower meadow, and native plant gardens. Use natural landscaping and planting practices as alternatives to lawn.

Given their critical position adjacent to water resources it is preferred that all riparian areas be maintained as forest or shrubland to maximize their buffering role.



Constructed wetlands serve many purposes—they provide living filters for runoff, areas of visual interest in the landscape, and habitat for aquatic life.

RIPARIAN BUFFERS

Riparian areas are lands immediately adjacent to rivers, streams or ponds and typically include floodplains, alluvial soils, and stream-related wetlands ("oxbow" swamps, marshes, and ponds). Given their critical position adjacent to water resources it is preferred that all riparian areas be maintained as forest or native shrubland to maximize their buffering role. A strip of meadow between forests and residential/agricultural areas may be preferred in situations where high inputs of surface stormwater are directed into the riparian area from adjacent agricultural fields or developed areas. Riparian forests can provide many benefits as well. The width of

	Resources and Considerations for Ripari	an Stewardship
Assistance	 Audubon Pennsylvania Penn State Cooperative Extension USDA Natural Resource Conservation Service PA/NJ Department of Environmental Protection, Resources, PA/NJ Game Commission 	 County Conservation District Rutgers Cooperative Extension NJ State Soil Conservation Committee (SSCC) PA Department of Conservation and Natural
Tools/Materials	 Monitoring: plant, bird, amphibian, insect identi Vegetation control: pruners, pruning saw, chains aquatic use, heavy-duty field mower/brush cutte 	fication books aw, "Weed Wrench," herbicides approved for r
Considerations	 Contact Conservation District or PA/NJ DEP about beginning work Monitor for invasive species at least annually and Monitor deer population and maintain at approp Create/extend adjacent forest buffer Use proper timing (when soils are very dry or fro Consider potential changes to hydrology from up 	t technical assistance and required permits before d control as quickly as possible riate level to sustain a healthy community zen) for any necessary activity stream land use change



The Riparian Forest Buffer

the buffer needed to protect the stream resources and provide environmental and ecological benefits will vary depending on soils and slope. Ideally the buffer should be 100 feet or more on either side of the river and may need to be more to include sensitive areas such as wetlands.

For the land steward the challenge is to protect water resources by maintaining the corridor as healthy forest, shrubland, or meadow.

The Landowner's Role

Water resources should be protected through shading from vegetation, uptake of agricultural and urban runoff, and should provide food for aquatic insects. Regardless of the existing resource, the goal should be to maintain or create a healthy forest, shrubland, or meadow corridor.

Riparian forests provide the greatest benefits to adjacent water bodies, particularly small streams. They help to maintain water temperatures through shading, absorb pollutants and accumulate sediments from agricultural and residential runoff, stabilize streambanks, and add leaves and woody debris to the stream, which furnishes food and shelter for aquatic organisms.

Healthy forests absorb large amounts of carbon dioxide and store carbon in various forms—leaves, soil, organic matter, woody stems—for various lengths of time until these materials decay or are burned. Increasing the region's forested area and maintaining forest health can help to sequester more carbon and reduce greenhouse gases that contribute to climate change.



Broad flat areas adjacent to rivers and streams with flood-tolerant plants slow down and temporarily hold seasonal and storm-produced floodwaters. Floodplains serve as natural shock absorbers for the dynamic expansion and contraction of a waterway over time. With increased volume of runoff (due to upstream clearing for cultivation and paving for development, and resulting diminished groundwater recharge), streams erode their banks, cut deeper channels, and lose their floodplains, becoming more "flashy" (undergoing wider and more frequent swings in volume) and flooding more often downstream.



Claudia Steck

Vegetation on forested riparian corridors adjacent to streams or ponds is extremely important for filtering pollution from runoff and slowing down stormwater. Stewardship should focus on maintaining the forest cover.

edge = a zone encompassing the interface between forested and nonforested areas, including the part of the forest that is subject to ecologically significant "edge effects"

forest interior = the part of the forest that lies more than 100 meters (about 300 feet) from the closest edge

FOREST FRAGMENTATION AND EDGE EFFECTS

Removal of native vegetation from large areas of the region—through conversion to agriculture and followed by residential and commercial development—have left the remaining natural lands as primarily fragmented "edge" type forest habitat. Edges are dominated by light-loving plants (often invasive non-natives) and they support much less diverse wildlife than large, contiguous forests.

For the land steward the challenge is to either reduce fragmentation through restoring links between forest patches, or to minimize edge effects by management of the invasive plants.



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 Landowner's Role

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

Remediation is often required at more recent edges, particularly on a southerly exposure 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.

When a harvest is appropriate, it is always best to engage the services of a private consulting forester to guide you through the process. The consulting forester will mark the trees to be cut according to your stewardship goals and make sure that the harvest operation is executed in a manner that protects soil and water resources and leaves your forest with increased potential for future harvests. The state service forester can provide a list of private consulting foresters.

Clear Cutting

Clearcutting, sometimes called canopy removal, entails the cutting of all trees within an area. Even though clearcutting 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.

has been poorly applied in many cases, it can be an effective method for establishing stands of economically valuable species, particularly oaks and black cherry, which have low to intermediate tolerance of shade (i.e., they require open conditions to successfully reach the canopy.

Used properly, in a limited area, with consideration given to slope and avoidance of wetlands and riparian areas, clearcutting can be an effective means of perpetuating our diminishing hardwood forests.

Clearcutting diversifies wildlife habitat by creating forest openings that harbor a suite of herbs and shrubs not found under a dense forest canopy.

Selection Cutting

Selection cutting helps to perpetuate uneven-aged forests. In this method larger canopy trees are harvested individually or in small groups. At the same time understory trees—usually with no economic value—are thinned. Thinning allows seedlings of shade intolerant species such as oaks, ashes, and tuliptree to acquire more growing space and get a jump-start towards the canopy. The smaller openings produced by selection cutting have less aesthetic impact than clearcuts, while still perpetuating tree species with greater economic and wildlife values. It also may leave some forest stands less susceptible to invasive plants.



DEGRADED FOREST—There are no young trees to replace the old ones; no shrubs or low trees for birds to find food, nesting sites or cover; and no wildflowers to provide food or cover for ground-nesting birds and small mammals, or nectar for pollinators. Deer overbrowsing, along with stresses on hydrology and the impact of invasive species, can degrade a healthy forest community to the point where it becomes unsustainable.



David Stecke

HEALTHY FOREST—How can you tell you're in a healthy forest? You can't see through it, at least in summer. Lush and three-dimensional, this forest is home to a complex, diverse community of life. It is the natural result of good stewardship. Deer may be present but at a density low enough that the forest can sustain itself. Water and nutrients are available in appropriate amounts, and exotic plants have not displaced the natives.

Highgrading

Highgrading (confusingly, sometimes called selective cutting) can result in the highest short-term economic return for the landowner and the greatest profit margin for the logger. However, it reduces the potential for future timber harvests and typically reduces wildlife values. In highgrading, individual canopy trees usually the largest and most commercially valuable—are selected for harvest.

INVASIVE PLANT SPECIES

Invasive plants—almost all of which are exotic (non-native) plants introduced for horticultural or agricultural purposes can spread rapidly and aggressively into natural areas and effectively displace native plants and lower biodiversity. Not only do they alter the makeup of the plant communities on a site, but they also may affect soil chemistry and hydrology. Exotic invasive plants are usually less beneficial to wildlife than the native plants they replace, contributing further to loss of biodiversity.

For the land steward the challenge is to manage invasive plants (eliminating them is highly unlikely) to a level that protects and sustains diverse native plant and animal communities.

The Landowner's Role

There are many management options for controlling invasive vegetation. These include physical removal, cutting, re-planting with native species, herbicides, and fire. Usually, the control of invasives on any given site requires a combination of two or more methods.

Physical Removal

The most effective practice is the selective removal of invasive species without disturbing the surrounding native vegetation. The invasive plant is denied growing space and the surrounding desirable (native) vegetation is well-positioned to occupy the vacated growing space. 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.

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.

Cutting

Removing some or all of the photosynthetic (food-producing) area of an invasive plant 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.

Mowing

Mowing removes most of the photosynthetic material from both desirable (native) and undesirable (non-native and invasive) plants. It effectively puts all plants on an equal basis in regards to the availability of aboveground growing space. This is,

invasive species =

one that rapidly spreads and outcompetes multiple native species

The most problematic invasive species at this time

Oriental bittersweet

(Celastrus orbiculatus): A woody vine that aggressively grows along forest edges 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 shades the leaves of the host tree and increases wind resistance and snow and ice accumulation, making it vulnerable to windthrow.



David Steckel

Japanese stiltgrass (*Microstegium vimineum*): A warmseason grass dispersed by deer and human walkers that quickly spreads to the detriment of native herbs and tree and shrub seedlings.

Multiflora rose

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





Autumn-olive (*Elaeagnus umbellata*): Once promoted as a wildlife food along with its relative, Russianolive (*E. angustifolia*), this shrub can rapidly invade abandoned fields and open canopy forests to the exclusion of all other plants.

Norway maple (Acer platanoides): A shadetolerant tree that is invading many forests throughout the region. Once established, its dense shade prevents virtually all plants from growing around it.





Jan Barmgei

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

Photos and detailed descriptions of individual plants are available at **www.nps.gov/plants/alien/index** and from other sources listed under **Additional Information Sources** in the back of this *Handbook*.

however, only a temporary situation. Because species vary greatly in their response to mowing, a mowing treatment will favor those species that can refoliate (occupy the available growing space) faster. Repeated mowings favor grass species (which grow from the base of the stem) and non-grass species that grow close enough to the ground to escape severe defoliation. Given the vigor of invasive plants, repeated treatments are usually necessary to make this method an effective control strategy.

Planting

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



an Barringe

A prescribed fire is defined as fire applied in a knowledgeable manner to fuels (live and dead vegetation) on a specific land area under selected weather conditions, to accomplish predetermined, well-defined, management objectives.

Herbicides

In most cases the use of herbicides alone is not an effective long-term solution for controlling invasives. Inherent in the sole reliance on herbicides is a "once and done" attitude that is not conducive to the long-term control of invasives. Inappropriate use of herbicides can degrade soil and water resources and harm humans and wildlife, particularly amphibians and aquatic animals. Used appropriately, however, herbicides can be an important tool for land managers in certain situations. Herbicides should be applied in natural areas only by qualified applicators trained in both the safe use of each herbicide and the identification of desirable (native) versus undesirable (invasive) species.

Fire

Fire has played an important part in shaping local plant and animal communities for thousands of years. The use of fire to control invasives by giving an advantage to native, firetolerant 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 equipped. Invasive Introduced Species of Plants, currently associated with the greatest harm to native biodiversity in southeastern Pennsylvania

COMMON NAME	SCIENTIFIC NAME	DESCRIPTION	RECOMMENDED CONTROL TECHNIQUES BEFORE REPLACEMENT PLANTING
ailanthus; tree-of-heaven	Ailanthus altissima	tree	physical removal (small seedlings); herbiciding bark; avoid cutting, which stimulates prolific root suckering
autumn-olive	Elaeagnus umbellata	shrub	physical removal; herbiciding bark or cut stem
bamboo, garden	Pseudosasa japonica	upright shrub	mowing; herbiciding young foliage
bittersweet, oriental	Celastrus orbiculatus	woody vine	cutting; herbiciding bark or cut stem
burning-bush	Euonymus alatus	shrub	physical removal; herbiciding cut stem
garlic mustard	Alliaria petiolata	biennial herb	physical removal
honeysuckle, amur	Lonicera maackii	shrub	physical removal; herbiciding bark or cut stem
honeysuckle, Japanese	Lonicera japonica	creeping shrub or woody vine	physical removal; herbiciding foliage
ivy, English	Hedera helix	prostrate or climbing woody vine	physical removal; herbiciding foliage or cut stem
knotweed, Japanese	Fallopia japonica	very large Eurasian perennial herb	physical removal; herbiciding foliage
loosestrife, purple	Lythrum salicaria	herbaceous plant aggressively spreading in wet open areas	herbiciding foliage
maple, Norway	Acer platanoides	tree	physical removal (small seedlings); herbiciding bark or cut stem
mile-a-minute	Persicaria perfoliata	herbaceous plant aggressively spreading in open areas	physical removal; herbiciding foliage
multiflora rose	Rosa multiflora	upright or often climbing shrub	physical removal; herbiciding bark or cut stem
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	physical removal; herbiciding foliage
privet, common	Ligustrum vulgare	shrub	physical removal; herbiciding bark or cut stem
stiltgrass, Japanese	Microstegium vimineum	herbaceous plant aggressively spreading in forest areas	physical removal; herbiciding foliage
viburnum, linden	Viburnum dilatatum	upright shrub	physical removal; herbiciding bark or cut stem

DEER OVERABUNDANCE

Deer are a natural part of the region's ecosystem, but long ago lost their primary natural predators (other than humans). A lack of natural controls coupled with a highly successful Pennsylvania Game Commission policy (originally implemented to save the species from extinction in the 19th century) focused on maximizing the sustained yield for hunters has resulted in populations much greater than natural lands can sustainably support.

Although deer thrive on the edge habitat that a fragmented, suburbanized landscape provides, in overabundant numbers they consume the young trees, shrubs, and wildflowers that make a forest healthy, beneficial to wildlife, and self-sustaining. They can also cause significant damage to agricultural crops and ornamental plantings, and contribute to the spread of Lyme disease and vehicular accidents.

For the land steward the challenge is to manage the deer population at a density that restores and sustains native plant communities.

We have so disrupted natural processes within the region, that we have made ourselves indispensable in the protection and restoration of natural lands.

The Landowner's Role

The decision to restore any forest must start with the goal of reducing and maintaining deer density at an appropriate level. Unless this goal is achieved first, the management of other stressors 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.

Active methods to control deer overbrowsing can be grouped into two categories: those that restrict or deter deer access to desired vegetation and those that reduce the deer population within a tract of land. The current tools used to modify white-tailed deer behavior include barriers, repellents, and lethal removal. Two other approaches that are often talked about but are infeasible at present or may be prohibited are contraceptives and trap and transfer.

Barriers

Barriers physically restrict deer from interacting with vegetation in the treated area. Options under this method include tree shelters, netting, and deer exclosure 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 trees and shrubs in formal landscapes and forest vegetation.

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, often with a base of capsaicin, the fiery alkaloid in chili peppers. Repellents can be effective in small areas where the goal is to reduce browsing damage to tolerable limits.

Contraceptives

Contraceptives to prevent pregnancy in deer have been tested and are a subject of ongoing research. The two major types of contraceptives are immunocontraceptives and hormonal contraceptives. Immunocontraceptives "vaccinate" an animal against egg proteins. Hormonal contraceptives work primarily by preventing ovulation in does.

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 greatest of which is finding a location willing to accept more deer.

Lethal Removal

Hunting is the most frequently used deer population reduction and maintenance method commonly available to landowners and land managers. Other lethal removal options, including deprivation permits for farmers and culls by sharpshooters are available, but tightly controlled. Browsing by overabundant deer populations is the most significant factor in forest decline in the river basin.



A density of 15–20 deer per forested square mile has been found in some areas to be a maximum level allowing minimal advance tree and shrub regeneration, with a density of 5–10 per square mile needed to sustain a high diversity of native species, including native herbaceous plants.

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
Perennials		Trees and Shrubs	
Aconitum uncinatum	monkshood	Acer spp.	maple
Actaea spp.	baneberry	Amelanchier spp.	service berry
Agastache scrophulariifolia	giant purple hyssop	Betula spp.	birch
Agrimonia parviflora	small agrimony	Calycanthus floridus	Carolina allspice
Allium cernuum/A. tricoccum	wild onion/leek	Carpinus spp.	hornbeam
Andropogon gerardii	big bluestem	Clethra alnifolia	summersweet
Aquilegia canadensis	wild columbine	Dirca palustris	leatherwood
Arisaema spp.	Jack-in-the-pulpit	Fagus spp.	beech
Aruncus dioicus	goat's beard	Fraxinus spp.	ash
Asarum canadense	wild ginger	Gleditsia triacanthos	honeylocust
Asclepias spp.	butterflyweed, milkweed	Hamamelis spp.	witchhazel
Aster novae-angliae	New England aster	Hypericum prolificum	Shrubby St. John's-wort
Aster oblongifolius	aromatic aster	Hypericum pyramidatum	Great St. John's-wort
Baptisia australis	blue false indigo	Leucothoe racemosa	fetterbush
Cimicifuga racemosa	black cohosh	Lindera benzoin	spicebush
Clematis virginiana	virgin's-bower	Liquidambar styraciflua	sweet gum
C. tripteris	tickseed .	Lonicera sempervirens	trumpet honeysuckle
Loreopsis rosea	rose coreopsis	Magnolia spp.	magnolia
Dicentra eximia	fringed bleeding-neart	Myrica pensylvanica	bayberry
Euphorbia corollata	flowering spurge	Nyssa sylvatica	sourgum
Coronium maculatum	lem	<i>Quercus</i> spp.	oak; acorris do attract deer
Helenium autumnale	Holop's flower	vibumum spp.	VIDUITIUTI
Hibiscus moschautos	swamp rose-mallow		
Tris versicolor	blue flag iris		
Ins versicolor Jeffersonia dinhulla	twin-leaf		
liatris spicata	dense blazing star		
Lobelia sinhilitica	great blue lobelia		
Mimulus ringens/M. alatus	monkey flower		
Monarda fistulosa	wild bergamot		
Panicum virgatum	switch grass		
Penstemon digitalis/P. hirsutus	beardtongue		
Phlox divaricata	blue wood phlox		
Phlox stolonifera	creeping phlox		
Physostegia virginiana	obedient plant		
Podophyllum peltatum	mayapple		
Pycnanthemum spp.	mountain-mint		
Polemonium reptans	Jacob's-ladder		
Rudbeckia fulgida/R. hirta	black-eyed Susan		
Scutellaria incana	skullcap		
Solidago spp.	goldenrod		
Symplocarpus foetidus	skunk-cabbage		
Verbena hastata	blue vervain		
Veronicastrum virginicum	Culver's-root		

Native deer resistant plants

CANADA GOOSE OVERABUNDANCE

Canada geese are attracted to open water—particularly open water bordered by lawn or other short, herbaceous vegetation that provides them a clear view of potential predators. Where vegetation is less disturbed or altered by humans, they usually live and feed in areas adjacent to larger streams. Goose populations in our region have exploded in recent decades with the proliferation of their ideal habitat in the form of golf course water hazards, stormwater basins, and old farm ponds that are now included in residential and other landscaped areas.

For the land steward the challenge is to manage the geese population at a density that prevents the degradation of water quality and reduces the destruction of vegetation.

The Landowner's Role

The following management recommendations for landowners apply to the year-round resident population of Canada geese; the much smaller migratory population seldom if ever causes any problems.

Habitat Management

The most effective way to decrease goose impacts is to change the area into habitat that is less attractive to them, preferably to one that would qualify as natural lands. Establishing a strip of natural cover (trees, shrubs, meadow) at least 20 feet wide around the water will deter geese from wandering into the mowed areas beyond. In some cases, it may even keep geese off rivers and streams. This method reinforces the general recommendation to establish and maintain riparian buffers along any water body. Habitat management is the best long-term method for reducing goose impacts on natural lands.

Fencing

A single strand of wire placed about 6–10 inches above the ground will help deter geese from walking from the pond 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. Even though they can easily fly over the wire, 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 it temporarily may be necessary.

Repellents

Repellents, such as methyl anthranilate and anthraquinones, are available to spray on vegetation to make it unpalatable to geese. They are expensive, but in theory should need to be used for only 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.

Lethal Removal

Lethal removal is often an effective way to dissuade flocks of geese from using a property. It usually requires the removal of only a few geese to induce the remaining geese to leave the area. Landowners can kill geese during the legal hunting season (September to mid-March). Although hunting seasons may not coincide with the time of year when © 2005



Canada geese and their droppings, one of the major causes of decreased water quality of ponds and streams due to fecal contamination and nutrient overload.

The most effective way to decrease goose impacts is to change the area into habitat that is less attractive to them.



Egg tampering can prevent nesting Canada geese from successfully fledging offspring, but it requires registration with the US Fish and Wildlife Service and requires the greatest caution to avoid being injured by geese defending their nest.

a landowner wants to discourage geese from his or her property, over time and combined with other deterrents, lethal removal could help to provide enough time for a natural riparian buffer to become established.

Egg Tampering

Geese can be discouraged from using a property by killing their eggs without breaking them or removing them from the nest. Geese will produce new eggs if a clutch is lost, but they will continue caring for intact eggs, even if the eggs are no longer viable. A goose pair will often abandon an area after attempting unsuccessfully to nest there.

Egg tampering, which consists of either oiling or addling, requires registering with the U.S. Fish and Wildlife Service and reporting your activities by October 31 each year. Addling eggs is shaking them violently to kill the embryo. In oiling, one uses a cloth saturated with cooking oil to completely wipe the eggshell to keep air from passing through the shell wall and smother the embryo. The key is not to cause any visible changes to the eggs or nest to avoid triggering the geese to build another nest and lay additional eggs.

These techniques, allowed between March 1 and June 30, should be done shortly after geese have finished laying eggs and are beginning to sit on the nest. A goose nest should be approached with the greatest caution and only when the goose pair is out of sight; geese defending their nests and offspring have been known to cause physical trauma to humans, including broken arm bones and head injuries.

Resources for Landowners

BACKYARD HABITAT PROGRAMS

The National Wildlife Federation's (NWF) Backyard Wildlife Habitat[™] certification program is designed to help individuals plan and apply a wildlife habitat plan for a home site or small acreage. It provides official certification for properties that meet four criteria necessary for wildlife habitat: food, water, cover, and places for wildlife to raise young. Property owners should also implement resource conservation practices. If your application and plan meet the criteria, you will receive a certificate and, if you wish, a sign to show your commitment to wildlife conservation.

You can apply online at the link below or, on request, you will be sent an application package.

Backyard Wildlife Habitat Program National Wildlife Federation 8925 Leesburg Pike Vienna, VA 22184-0001 www.nwf.org/backyardwildlifehabitat The **U.S. Fish and Wildlife Service**'s Office of Migratory Bird Management works with groups and individuals to conserve and manage migratory birds. This agency offers information about backyard habitats for birds and wildlife. Several pamphlets are available: Backyard Bird Feeding, Backyard Bird Problems, Attract Birds, Homes for Birds, and Migratory Songbird Conservation.

U.S. Fish and Wildlife Service Office of Public Affairs Washington, DC 20240 http://www.fws.gov/migratorybirds

The **Wildlife Habitat Incentive Program** (WHIP) is a voluntary **U.S. Department of Agriculture** program for improving or developing fish and wildlife habitat on private lands. The program provides both technical and financial assistance to establish and enhance habitat for priority species and habitat types. Eligible applicants work with their local Natural Resources Conservation Service (NRCS) staff to prepare and implement a wildlife plan of operations.

NRCS State Office or Gail Bartok 732-537-6042 http://www.nrcs.usda.gov/wps/portal/ Refer to NLT's Stewardship Handbook at www.natlands. org/handbook for glossary and additional information.

Large Trees

	WILDLIFE USERS	Buds, flowers, and leaves provide food for many birds and mammals. Chipmunks and squirrels eat seeds and some songbirds use twigs for nest building.	See red maple.	See red maple.	Catkins are used by redpolls and pine siskins. Foliage is used by browsers.	See river birch.
	DESCRIPTION	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.	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 (often found on floodplains). 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.	Height: 60'–70', Spread: 40'–50' Upright oval to rounded habit. Prefers moist, well drained soils. Tolerates some shade.	Height: 40'-70', Spread: 40'-60' Pyramidal in youth and rounded with age. Often grown multistemmed. Best adapted to moist soils (often found on floodplains). Used in areas that are alternately wet and dry.	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.
	PHYSIOGRAPHIC REGION	Piedmont Coastal Plain	Piedmont Coastal Plain	Piedmont Coastal Plain	Piedmont Coastal Plain	Piedmont Coastal Plain
	COMMON NAME	red maple	silver maple	sugar maple	river birch	sweet birch
•	SCIENTIFIC NAME	Acer rubrum	Acer saccharinum	Acer saccharum	Betula nigra	Betula lenta

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. Can grow well in full sun or 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.
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 (often found on floodplains).	Limited wildlife value.

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
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 fleshy blue cones. Useful for windbreaks, shelter belts, hedges.	Twigs and foliage eaten by browsers. Seeds are eaten most extensively by cedar waxwings. Evergreen foliage provides nesting and roosting cover for sparrows, robins, mockingbirds, juncos, and warblers.
Liquidambar styraciflua	American sweetgum	Coastal Plain	Height: 60'–75'+, Spread: 40'–50' Pyramidal in youth, rounded crown at maturity. Likes deep, moist, acid soils. Occurs naturally on bottomlands.	Goldfinches and purple finches eat winged seeds.
Liriodendron tulipifera	tuliptree	Piedmont Coastal Plain	Height: 70'–90', Spread: 30'–50' Long, straight trunk with a narrow canopy. Fast grower. Plant in full sun and a well drained loam. Wood somewhat weak.	Moderate wildlife importance. The purple finch and cardinal are principal users.
Nyssa sylvatica	black gum	Piedmont Coastal Plain	Height: 30'–50', Spread: 20'–30' Pyramidal in youth and irregularly crowned at maturity. Prefers moist, well drained, acid soils. Full sun or semi-shade. Deep taproot.	Fruit is relished by many songbirds. Users include wood ducks, robins, woodpeckers, thrashers, flickers, and mockingbirds.

WILDLIFE USERS	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.	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.	See white oak. of in	See white oak.	Limited wildlife value. Ib, ils,	Provides excellent cover for deer and songbirds. Nesting site for several warblers. Seeds are eaten by juncos, chickadees, and siskins.
DESCRIPTION	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.	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.	Height: 60'–70', Spread: 25'–40' Strongly pyramidal with ascending branches. One c the faster growing oaks. Full sun. Found naturally wet soils but is adaptable to many soil types.	Height: 60'–75'+, Spread: 40'–50' Habit is round-topped and symmetrical. Full sun. Prefers loamy, well drained soils. Fast growing.	Height: 60'–80', Spread: 35'–50' Pyramidal in youth, assuming a rounded shape wit age. Full sun or part shade. Prefers deep, moist so but is tolerant of heavier soils.	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.
PHYSIOGRAPHIC REGION	Piedmont Coastal Plain	Piedmont Coastal Plain	Piedmont Coastal Plain	Piedmont Coastal Plain	Piedmont Coastal Plain	Piedmont Coastal Plain
COMMON NAME	eastern white pine	white oak	pin oak	red oak	American linden	eastern hemlock
SCIENTIFIC NAME	Pinus strobus	Quercus alba	Quercus palustris	Quercus rubra	Tilia americana	Tsuga canadensis

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
Amelanchier arborea/laevis	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.
Cercis canadensis	eastern redbud	Piedmont	Height: 20'–30', Spread: 25'–35' Small tree with rounded crown. Likes moist, well drained soils. Found naturally only on limestone or diabase soils in Pennsylvania. 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.
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 opaca	American holly	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.
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.

WILDLIFE USERS	Used by grouse, brown thrasher, cedar waxwing, squirrels, and deer.	See nannyberry.
DESCRIPTION	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.	Height: 12'–15', Spread: 8'–12' Round-headed tree or multi-stemmed shrub. Adaptable to many soil types. Sun or shade.
PHYSIOGRAPHIC REGION	Piedmont Coastal Plain	Piedmont Coastal Plain
COMMON NAME	nannyberry	blackhaw virburnum
SCIENTIFIC NAME	Viburnum lentago	Viburnum prunifolium

Shrubs

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
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.
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	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.
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

Resources for Landowners

WILDLIFE USERS	Used heavily by grouse, scarlet tanager, bluebirds, thrushes, and other songbirds.	Twigs are eaten by deer and rabbits. Fruit is used by grouse.	Used by grouse, brown thrasher, cedar waxwing, squirrels, and deer.
DESCRIPTION	Height: 6'-12', Spread: 8'-12' Upright, multi-stemmed shrub with spreading branches. Requires moist, well drained soils. Full sun or light shade.	Height: 4'-6', Spread: 3'-4' Low, sparsely branched shrub. Adaptable to dry soils. Extremely shade tolerant.	Height: 6'–8', Spread: 6'–15' Multi-stemmed, dense, rounded shrub. Adaptable to most soil conditions, but prefers well drained. Suckers freely.
PHYSIOGRAPHIC	Piedmont	Piedmont	Piedmont
REGION	Coastal Plain	Coastal Plain	Coastal Plain
COMMON NAME	highbush	maple-leaved	southern
	blueberry	viburnum	arrow-wood
SCIENTIFIC	Vaccinium	Viburnum	Viburnum
NAME	corymbosum	acerifolium	dentatum

Refer to NLT's Stewardship Handbook at www.natlands.org/handbook for more native trees, shrubs, perennials, and grasses.

SOURCES

Native Plant Nurseries, PA Area

Buddies Nursery P.O. Box 14, Birdsboro, PA 19508 610-582-2410 www.buddiesnursery.com

David Brothers Bean Road Nursery P.O. Box 123, Whitehall and Bean Rds Worcester, PA 19490 610-584-1550 www.davidbrothers.com

Edge of the Woods Native Plant Nursery 2415 Rte 100, Orefield, PA 18069 610-395-2570 www.edgeofthewoodsnursery.com

Meadowbrook Farm 1633 Washington Ln, Meadowbrook, PA 19046 215-887-5900 www.meadowbrookfarm.org

Moon Nurseries P.O. Box 672, 145 Moon Rd Chesapeake City, MD 21915 800-803-TREE www.moonnurseries.com

Natural Landscapes 354 North Jennersville Rd, West Grove, PA 19380 610-869-3788 www.naturallandscapesnursery.com

New Moon Nursery 13 Ways Ln, Kennett Square, PA 19348 888-998-1951 www.newmoonnursery.com

Northeast Natives and Perennials 1716 E Sawmill Rd, Quakertown, PA 18951 www.nenativesandperennials.com

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

Octoraro Farm and Gardens 698 Lees Bridge Rd, Nottingham, PA 19362 610-932-0225 www.octorarofarm.com

Octoraro Native Plant Nursery 6126 Street Rd, Kirkwood, PA 17536 717-529-3160 www.octoraro.com Potts Nurseries LLC 427 Ontelaunee Dr, Shoemakersville, PA 19555 888-806-9093 www.pottsnurseriespa.com

Redbud Native Plant Nursery 1214 N. Middletown Rd, Glen Mills, PA 19342 610-358-4300 www.redbudnativeplantnursery.com

Shemin Nurseries P.O. Box 649, 100 Green Tree Rd, Oaks, PA 19456 610-666-0595 www.sheminnurseries.com

Sylva Native Nursery and Seed Company 3815 Roser Rd, Glen Rock, PA 17327 717-227-0486 www.sylvanative.com

Temple University/Ambler Nursery 580 Meetinghouse Rd, Ambler, PA 19002-3994 215-283-1330 (Wholesale only)

Yellow Springs Farm 1165 Yellow Springs Rd, Chester Springs, PA 19425 610-827-2014 www.yellowspringsfarm.com

Native Plant Nurseries, NJ Area

Allegiance Landscape & Garden Center 104 Main St, Helmetta, NJ 08828-1020 732-521-3347

Atlock Farm 545 Weston Canal Rd, Somerset, NJ 08873 732-356-3373 www.atlockfarm.com

Caliper Farms & Nursery 447 Griggstown Rd, Belle Mead, NJ 08502 908-904-9446 www.caliperfarms.com

Chesterfield Gardens Inc. 615 Chesterfield-Jacobstown Rd Chesterfield, NJ 08515 609-298-2726

Croshaw Nursery 113 Mill Ln, Columbus, NJ 08022 609-298-0477

D&R Greenway Native Plant Nursery One Preservation Pl, Princeton, NJ 08540 609-924-4646 www.drgreenway.org Fernbrook Nursery, Inc 150 Bordentown-Georgetown Rd Chesterfield, NJ 08505 609-298-8282 www.fernbrooknursery.com

Hionis Greenhouses & Garden Center 4 Coddington Rd, Whithouse Station, NJ 08889 908-534-7710 www.hionisgreenhouses.com

Kale's Nursery & Landscape Services, Inc. 133 Carter Rd, Princeton, NJ 08540 609-921-9248 www.kalesnursery.com

Mapleton Nurseries 140 Mapleton Rd, Kingston, NJ 08528 609-430-0366 www.mapletonnurseries.co

Pinelands Nursery and Supply 323 Island Rd, Columbus, NJ 08022 609-291-9486 www.pinelandsnursery.com

Plant Detectives 45 Rte 206, Chester, NJ 07930 908-879-6577 www.plantdetectives.com

Pleasant Run Nursery 93 Ellisdale Rd, Allentown, NJ 08501 609-259-8585 www.pleasantrunnursery.com

Princeton Nurseries P.O. Box 185, Allentown, NJ 08501 800-916-1776 www.princetonnurseries.com

Rare Find Nursery 957 Patterson Rd, Jackson, NJ 08527 732-833-0613 www.rarefindnursery.com

Rutgers Landscape & Nursery 1051 US Hwy Rte 202 North Ringoes, NJ 08551 800-422-6008 www.rutgersln.com

Scott Farm Nursery 1554 Tanyard Rd, Sewell, NJ 08080 856-464-0530

Toadshade Wildflower Farm 53 Everittstown Rd, Frenchtown, NJ 08825 908-996-7500 www.toadshade.com Triple Oaks Nursery and Herb Garden P.O. Box 385, 2359 Delsea Dr Franklinville, NJ 08322 856-694-4272 www.tripleoaks.com

Village Nurseries, Inc. 818 Old York Rd, Hightstown, NJ 08520 609-448-0436 www.villagenurseriesnj.com

Wildflower Sources

Brandywine Conservancy Box 141, Chadds Ford, PA 19317 610-388-2700

Ernst Conservation Seeds 9006 Mercer Pk, 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 Rd, Harleysville, PA 19438 610-584-6302

Information Sources

Guide to Pennsylvania Nursery Stock Pennsylvania Nurserymen's Association, Inc 1924 N Second St, Harrisburg, PA 17102

New England Wild Flower Society, Inc Garden in the Woods 180 Hemenway Rd, Framingham, MA 01701 508-877-7630

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 Publications, 1951

The Plants of Pennsylvania, An Illustrated Manual, 2nd Edition, Ann F. Rhoads and Timothy A. Block University of Pennsylvania Press, 2007

Riverfront Property Owners' Guide to Wild & Scenic Rivers, a publication of National Park Service, Bureau of Land Management, US Fish & Wildlife Service, and US Forest Service, November 2005 www.rivers.gov

CONTACTS

Bucks County Conservation District

1456 Ferry Rd, Ste 704, Doylestown, PA 18901 215-345-7577 www.bucksconservation.org

Department of Environmental Protection (DEP)

Pennsylvania Southeast Regional Office 2 East Main St, Norristown, PA 19401 484-250-5900 www.portal.state.pa.us/portal/server.pt/community/ southeast regional office/13778

Pennsylvania Northeast Regional Office 2 Public Square, Wilkes-Barre, PA 18701-1915 570-826-251 www.portal.state.pa.us/portal/server.pt/community/

northeast_regional_office/13779

New Jersey Division of Fish and Wildlife P.O. Box 420, Trenton, NJ 08625-0420 609-292-2965 www.state.nj.us/dep/fgw

Hunterdon County Soil Conservation District

687 Pittstown Rd, Ste 1, Frenchtown, NJ 08825 908-788-9466 http://hcscd.weebly.com

Mercer County Soil Conservation District 508 Hughes Dr, Trenton, NJ 08690 609-586-9603

http://www.mercerscd.org/index.html

Natural Lands Trust

1031 Palmers Mill Rd, Media, PA 19063 610-353-5587 www.natlands.org

Northampton County Conservation District

14 Gracedale Ave, Greystone Building Nazareth, PA 18064-9211 610-746-1971 www.northamptoncd.org

PA Department of Conservation and Natural Resources (DCNR)

7th Floor, Rachel Carson State Office Building 400 Market St, P.O. Box 8767 Harrisburg, PA 17105-8767 717-787-2869 www.dcnr.state.pa.us PA DCNR Bureau of Forestry 6th Floor, Rachel Carson State Office Building 400 Market St, P.O. Box 8552 Harrisburg, PA 17105-8552 717-705-5194 www.dcnr.state.pa.us/forestry

Penn State University,

College of Agricultural Sciences School of Forest Resources, Cooperative Extension 416 Forest Resources Building University Park, PA 16802 814-863-0401 www.ecosystems.psu.edu/extension

Northampton County Cooperative Extension 14 Gracedale Ave, Nazareth, PA 18064 610-746-1970 www.extension.psu.edu/northampton

Bucks County Cooperative Extension Neshaminy Manor Center 1282 Almshouse Rd, Doylestown, PA 18901-2896 215-345-3283 www.extension.psu.edu/bucks

USDA Natural Resources Conservation Service (NRCS)

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) www.nrcs.usda.gov

Pennsylvania NRCS One Credit Union Place, Ste 340 Harrisburg, PA 17110-2993 717-237-2100 http://www.nrcs.usda.gov/wps/portal/nrcs/site/pa/ home

New Jersey NRCS 220 Davidson Ave, 4th Flr, Somerset, NJ 08873 732-537-6040 http://www.nrcs.usda.gov/wps/portal/nrcs/site/nj/ home

U.S. Fish and Wildlife Service 1849 C St, NW, Washington, DC 20240 1-800-344-WILD (9453)

Natural Lands Trust land for life