Wyomissing Parklands Natural Resources Stewardship Plan Appendices

August 2024

PREPARED FOR:

The Borough of Wyomissing

PREPARED BY:

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About this Document

The following appendices are intended to provide supplemental background information and insights into topics discussed in the Wyomissing Parklands Natural Resources Stewardship Plan.

The appendices are grouped by general topics to facilitate review and deeper study. The resources assembled in this document are selective representatives of related studies and research pertaining to sustainable land management practices and implementation. The documents not intended to be all encompassing.

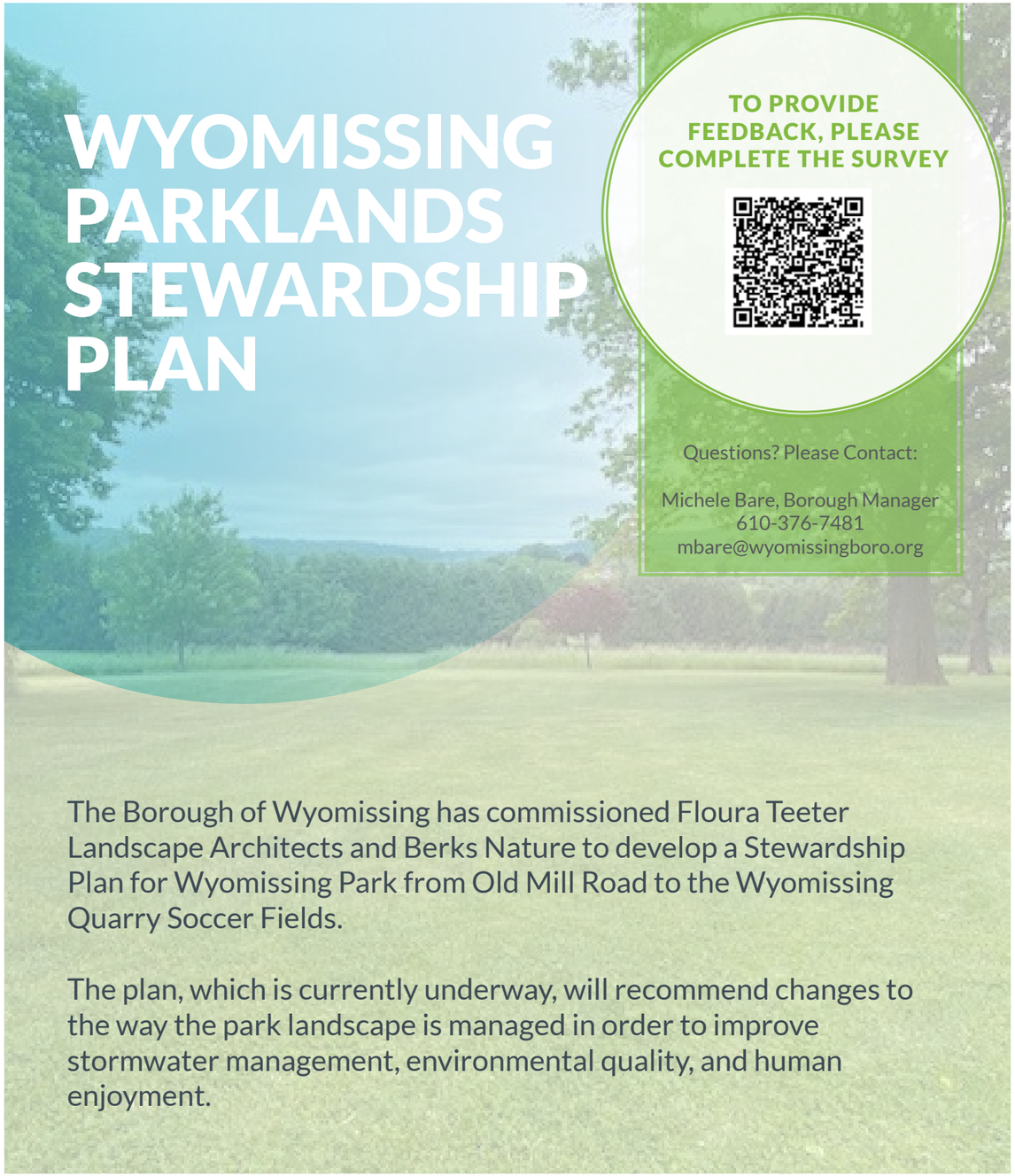
Information covered within these appendices should not serve as additional management guidelines or recommendations for the parklands as they are not site specific. The appendices are an in depth introduction to current best practices and application examples for the additional studies and engineering drawings identified in the Path to Implementation section of the Stewardship Plan.

List of Appendices

Appendix A: Community Survey Data

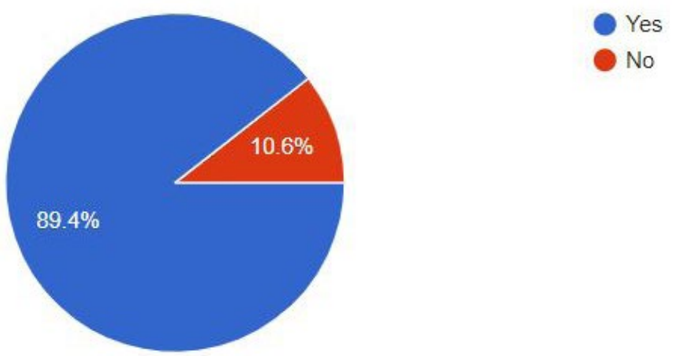
Survey Advertisement Flyer
Responses Received

Survey Flyer



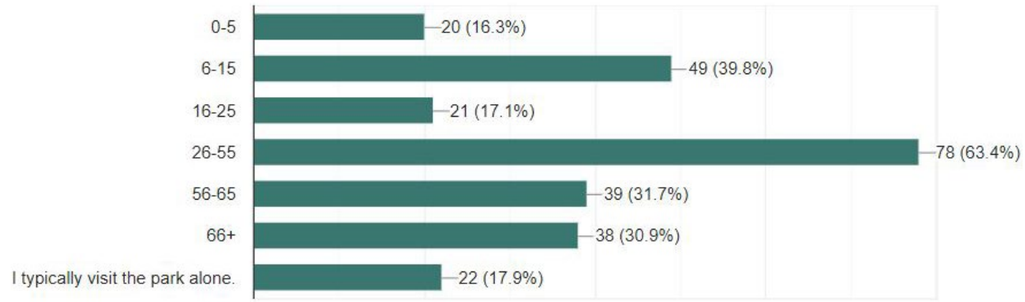
Do you live in Wyomissing Borough?

123 responses



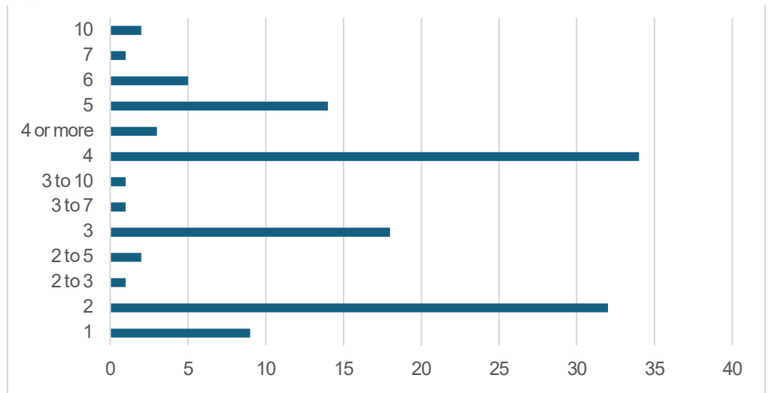
What are the ages of the people with whom you use the park and trails? (choose all that apply)

123 responses



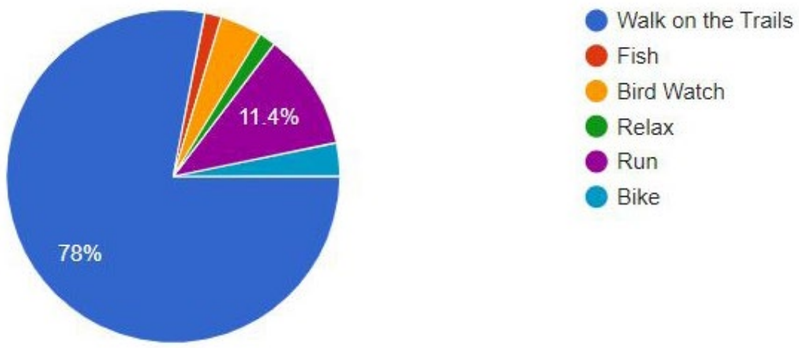
How many members are in your family or group?

123 responses



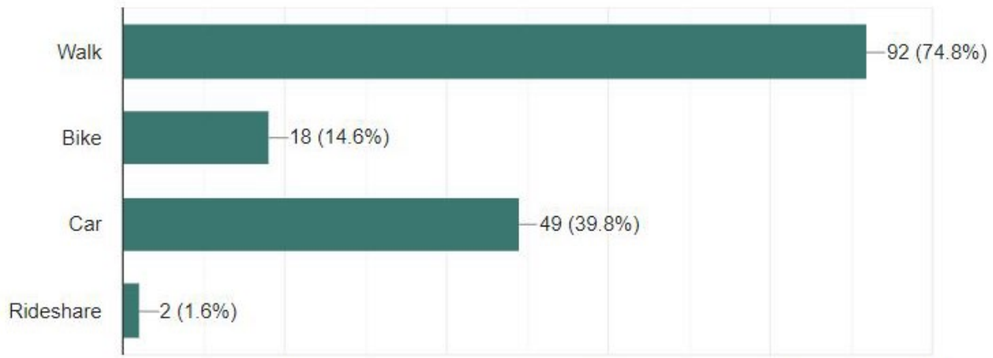
What is your favorite thing to do in Wyomissing Park?

123 responses



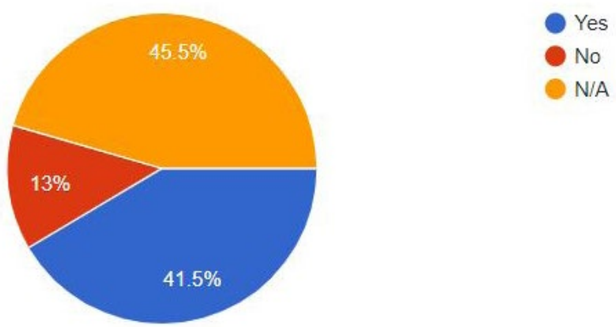
How do you get to the park?

123 responses



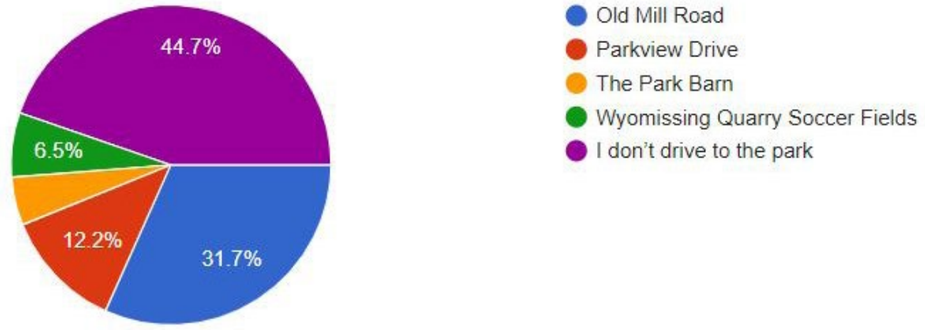
If you arrive by car, do you feel there is adequate parking?

123 responses



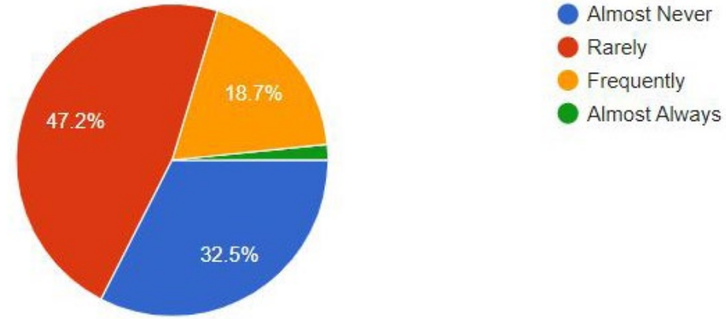
What is your preferred parking location?

123 responses



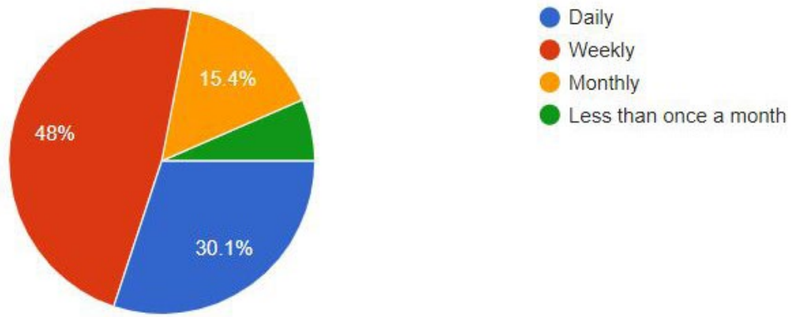
How often do you find the parking is full and you have to try another location?

123 responses



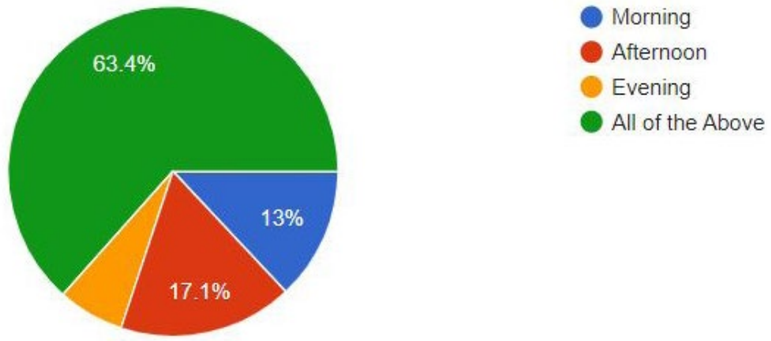
How often do you visit the park?

123 responses



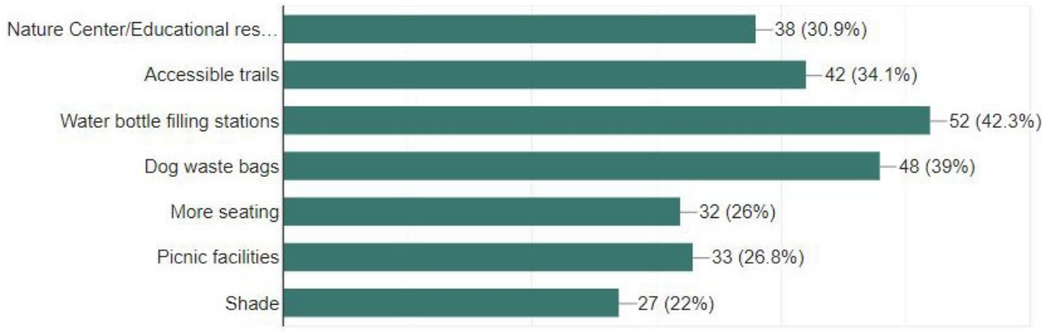
What time of day do you use the park?

123 responses



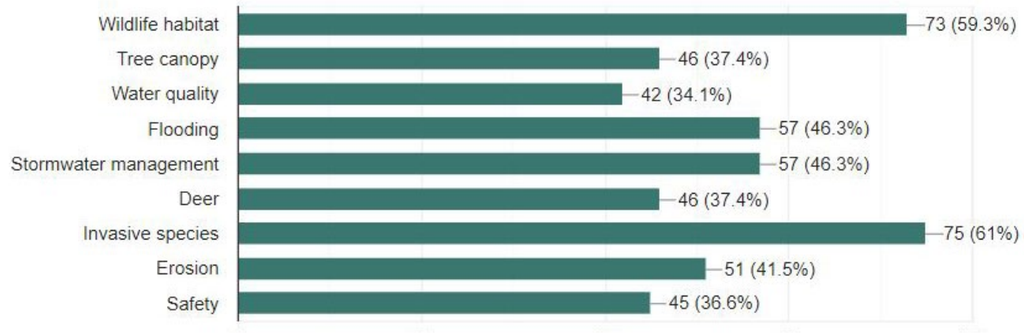
What additional amenities would you like to see in the park?

123 responses



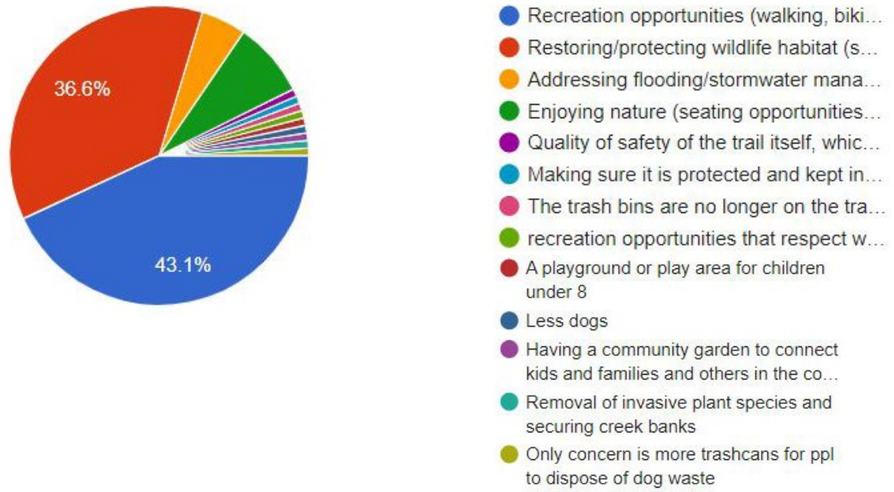
Are you concerned about the following things in the park? (choose all that apply)

123 responses



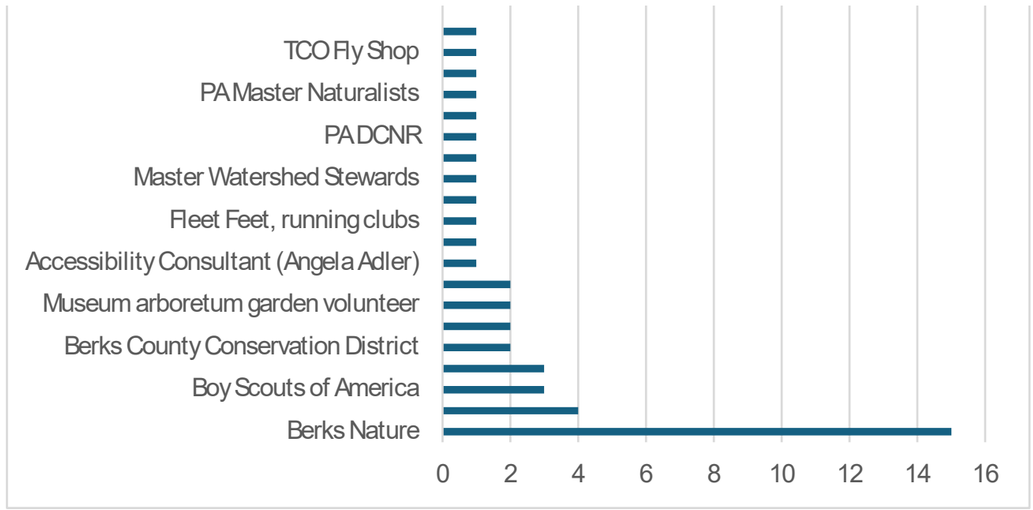
What is your top priority for the future of the park?

123 responses



Which organizations would be great partners for the implementation of the Stewardship Plan? (fill in name and website if known)

36 responses



What would you like to see in Wyomissing Park that is not currently available?

63 responses

- Turn the water fountains back on.
- Dog park
- Nature and Environmental Education Center
- An educational building with a restroom and ability to offer programming and more events/ activities/workshops.
- Trash / recycling cans
- I'd like to see the trails improved. In some areas they are becoming a bit hazardous.
- Water-filling stations
- Water fountains or the ability to fill water bottles somewhere. A workout equipment area like the west reading playground would be lovely
- Dog waste bags and trash cans
- I think the park system is fine as it stands. My concern is adding more activities will bring in too many people and make using the park unpleasant. Overcrowding could ruin the peacefulness and calm that exists on most days. Weekends and summer evenings already feel crowded sometimes.
- Better patrol; monitoring of illegal fishing and swimming
- Drinking water
- As noted above Nature Center
- Trail connections to more neighborhoods
- Playground
- Swing set or playground
- A simple playground or play area for children. The nearest playground is happy hollow, which is a mile away and further for those who live in the western part of Borough. It can incorporate educational resources, as well.
- Environmental education, appropriate training of outside contractors working on parkland, seating, educational signage, diligent removal of invasive species.
- More seating
- Restrooms
- Better maintenance of paths (they quickly erode)
- No dogs in general park areas but offer a designated dog area
- Restrooms
- Tennis programs for adults, plus backboard, and use (by fee) of a ball machine housed at courts and recycle bin for used tennis balls; possible patrols by Wyo police on bikes and laws governing use of battery scooters and skateboards and bikes (travel too fast on trials)
- Water stops
- A beautiful community Garden which takes a part of the field back to its original farming roots. So important to build community among all ages in the Boro! A healthy and strong connected community is the best gift we could give to the people who live in the Boro. Also teaching a wide range of skills to those looking for ways to grow a healthy community!

- Educational activities for kids
- A small observation deck at the gravel parking lot on Old Mill Rd would provide an opportunity for people with mobility problems to enjoy the rich bird life and the scenery of the adjacent meadow. It would also provide a site for bird watching programs.
- Program to ensure ongoing removal of invasive plant species
- Fitness Equipment
- Water Fountain/Bottle Filling Station
- Public excise equipment
- Nature programs for children, adults, family, similar to Spring Township offerings.
- Fenced in dog park
- Water filling stations and bike repair stations
- Educational resources
- Nothing specific.
- A few more trash can for pet waste.

Please provide any additional feedback.

41 responses

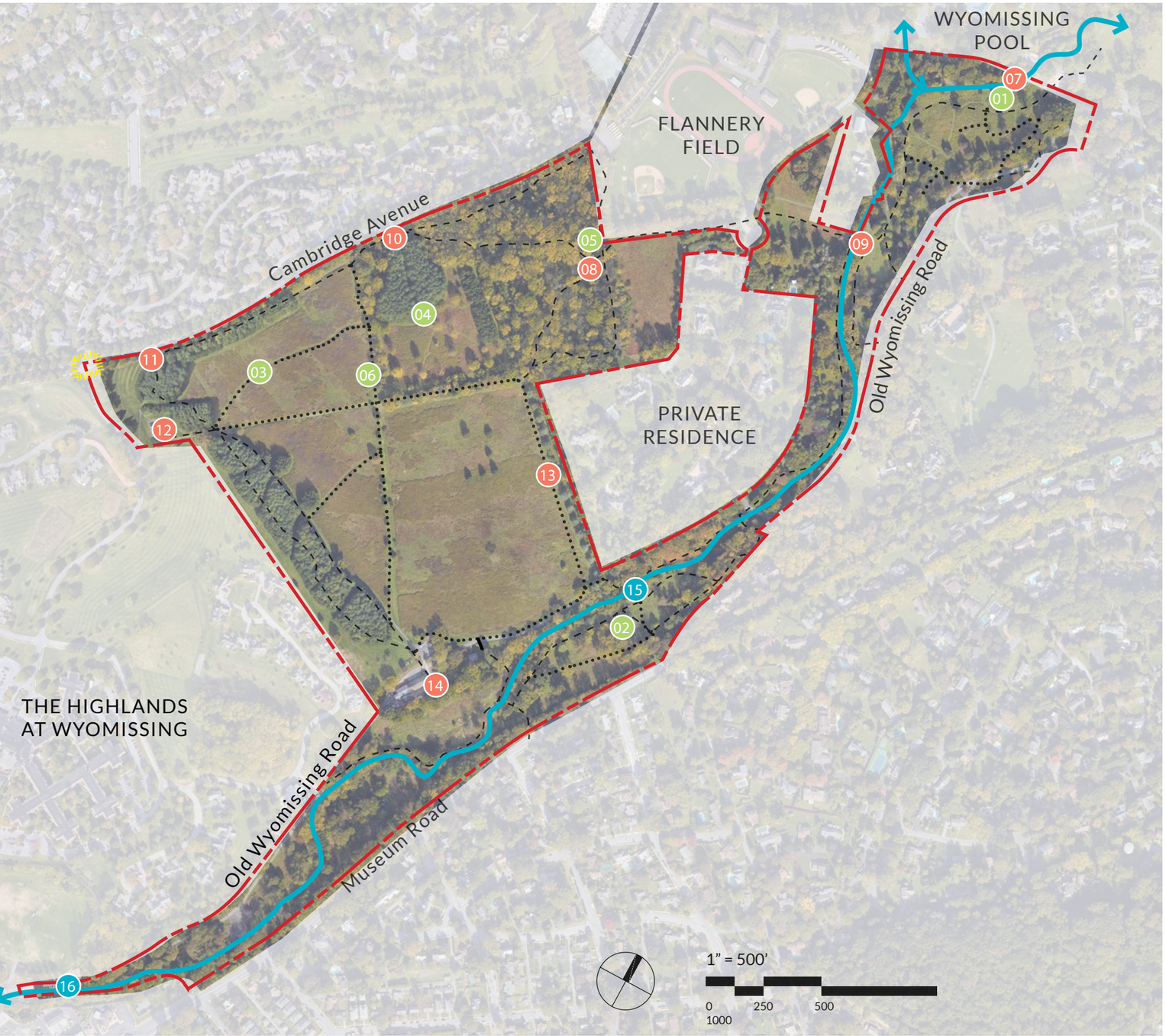
- We love our park system and all that it offers.
- Many older or young citizens cannot "hold it", especially those with medical issues. I know residents who no longer use the trails because of this issue.
- I think the parklands are well taken care of. Borough maintenance does an excellent job. Please don't change the beauty of the park. That's what makes it special. Additional parking is not needed. There is plenty of street parking.
- The parklands are lovely the way they are. I really hope NO major changes will be happening to the parklands.
- Lots of the understory is invasive honeysuckle. Some areas could be restored with understory clearing and monitoring.
- The pond is potentially nice, but it commonly has signs of stagnant growth, mud etc
- Would like to see ALL parks in Wyomissing being worked on not just Wyomissing "Proper"
- Thank you for all you do to provide and protect our beautiful park system.
- Our borough has gone downhill in the past 4 years with no one taking responsibility for making sure the paths are maintained (there are so many deep ruts and uneven paths to run or walk on); ponds are filthy; need more trash receptacles; ensure that bicyclists follow all road rules (I.e., stop and stop signs, signal when appropriate, etc.); make more police available during the morning rush hours - and all day for that matter - to target speeders, etc. who are a threat to walkers, runners, children and adults alike, who are walking to and from the parklands as well as on the streets.
- We do NOT want a manicured park like the Reading Museum end
- Birdsong Fairy Trail in Hendon, NY is awesome!! You could have organizations pay for a fairy house they design + help with the costs of trail maintenance.
- Keep the park wild
- Bathrooms

- Rock trails are hard for strollers
- Removal of invasive species including
- Ailanthus altissima
- I'm not sure if safety cameras are feasible, but we had a very scary incident occur when our daughter was ten, and an adult man approached her, and her friend, and exposed himself. This has been our only safety incident, but it was very traumatic. The police were involved immediately but he was never caught. Cameras are the only thing I can think of that would have helped. This occurred in the paths right across from the pool. I know it happened to other people as well. Maybe if there were at least a few cameras and then signs posted about the cameras, it would help.
- Overall we love the park, my husband and I run and walk there often, but my daughter avoids it now.
- I commend the Wyomissing Borough for asking for the residents input on this!
- Thank you for the opportunity to submit my information, preferences, and thoughts ahead of time. If there are proposals from Floura Teeter Landscape Architects about parts of the park that may carry sentimental/emotional weight it may be well to communicate this as well as conduct another survey on the specifics of the proposal.
- I have used the park for 30+ years and I still absolutely love it. In addition to the above, I'd also like to see reminders? for people to pick up after their dogs. I often start walks at the Highlands entrance with my young sons and I've never seen so much dog feces as I have the past two years. It's really gotten prevalent. Thank you for addressing this in some way. I look forward to seeing the recommendations and improvements! Thanks again!
- The park needs to be cleaned up. I'd like to participate in a community clean up. Earth day is around the corner! The teens on bikes have to be monitored during the spring & summer months. I've felt unsafe in the park.
- Thank you for this extraordinary community resource and your excellent care of the park!
- I appreciate that this park is not built up and more natural. It is wonderful to feel connected to nature in a pure, untouched way within the community. Offers a little escape and feeling of being away from urbanization.
- The park is a jewel! I access it from the museum in WR
- Must stop draining the reflecting pond during tadpole season, killing off thousands of potential frogs, toads etc
- It is really frustrating when cops aggressively patrol the creek. My family and I often will skip stones, or play by the water and are not swimming. There have been a few times where we have been told to get away from the banks and have to be on our way. I respect the no swimming, however, I wish we could be left alone when enjoying the creek side.
- I was not aware that flooding and water quality were problems but if so they need to be addressed.
- Both happy hollow and the Wyomissing hills playgrounds are used for Tot Lot/playground during the summer, so it would be nice to have another option that could be used for those who don't participate in these summer programs.
- We were devastated to see the destruction of the pollinator meadows this weekend when we visited to look for early spring wildflowers. Everything was completely mowed to the ground, eliminating habitat and food for pollinators, birds, and other wildlife. It was heartbreaking to see the land so mismanaged with such significant consequences on the meadow ecosystem.
- Thank you for all you do to provide a great park experience!
- I am curious as why so many evergreen trees (as well as other species) are dying off in our area
- Juveniles being rude , cars parked and picnicking in the park are worrisome
- Removal of deer, poison hemlock. Open vistas of Wyo Creek by removal of honeysuckle; find

concessioner for Stone House to offer coffee, sandwiches, sweets, 7am to 2pm? --no inside seating, just to-go, picnic hampers, etc. order by app? Good source of revenue. Someone like Dosie-Dough?; Consider fees for non-residents use of parking and possible usage fee of residents. Engage Highlands to see if any trails from Quarry (for runners mostly) could traverse their property. Forest in areas (near baseball diamond) requires some clear cutting and planting of oaks, beeches, etc. Mostly junk wood as is. Address flooding of creek, boulders, etc.

- Keep up the good work! So glad that the cherry trees were returned to the circle at Reading and Wyomissing Blvds :)
- Please keep me posted on the outcome of this survey. I am happy to
- Get involved to spearhead this vital and enjoyable project!
- The major threat I see to the natural resources of the park is the spread of invasive plants. The associated loss of biodiversity has implications for the insect life that birds and other wildlife depend on. Japanese knotweed first appeared about 6 years ago and no mitigation has been attempted, for instance. There are so many others. ... This park is a bit of easily accessible nature for borough residents. I would NOT want to see the addition of any amenities such as picnic facilities that would result in more littering, noise, and illegal parking. The park is heavily used as it is, and I hope that any changes are designed to enhance it's value as a place for us to de-stress in nature, rather than dodge crowds and run into organized events, music, etc. Caring responsibly for the valuable native plant and animal life we still have in the park is our community's opportunity to do our part to preserve a livable earth for those who will come after us. This is our responsibility.
- Thanks for this effort! It would be wonderful to see the park return to its prior natural beauty.
- For context, I am a resident of West Lawn/Spring Township, a few blocks away from Wyomissing Parkland. I used the park multiple times per week, daily in the summer. Thanks for maintaining a great park! Can't wait to see what the stewardship project brings!
- Epharta unleashed dog park has done a great job - might be with talking with them
- The park system needs less "man made" additions and alterations. Those to combat erosion, flooding, destruction of natural habits for wildlife, etc. are expected. However, bike pumps, water filling stations, added pavillions, etc. hurt the natural ambiance of the park system. Part of what makes it special is the fact it is unaltered with various additions and there for Wyomissing residents to enjoy, both to walk and to simply see as a staple of Wyomissing. Thanks!
- Note: The "Additional Amenities" question requires an answer. I selected "Accessible Trails" just to pick something. Nothing needs to be added.
- The park system is beautiful the way it is!
- There is no need for additional parking. The park system is for Wyo residents to enjoy, since Wyo residents pay to take care of this amenity. One of the perks for living in the Boro!
- Providing additional parking would cause loss of green space and increase park usage in a negative way.

Appendix B: Trail Counter Data



Legend

- Recommended Crosswalk
- 01 Grass - Goodman Barn & Creek Trail
- 02 Grass - Creek Trail & Museum Rd.
- 03 Grass - W Slope & Shirk Bench
- 04 Grass - Uphill from W. Berks Parking Spot
- 05 Grass - Cedar Trail
- 06 Grass - Winter's Way
- 07 Gravel - Creek Trail @ Old Mill Parking
- 08 Gravel - Near Wyo Baseball Field
- 09 Gravel - Cherry Lane Trail
- 10 Gravel - Pinewoods Trail @ Western Berks Parking Spot
- 11 Gravel - Pinewoods Trail @ Cambridge & Parkview
- 12 Gravel - Summit Trail @ Highlands Parking Lot
- 13 Gravel - Summit Trail Between Pinewoods & Other Trail
- 14 Gravel - Lot near Park Barn Lot
- 15 Paved - Old Wyomissing Rd Between Ruth's Bridge to Maintenance Barn
- 16 Paved - Western Parking Lot

Trail Counter Locations

Appendix C: Forest Management

Best Management Practices for Pennsylvania Forests
Best Management Practices for Pennsylvania Forests Terms
Forest Stewardship - Wildlife
Trail Maintenance

Best Management Practices

for Pennsylvania Forests

Promoting forest stewardship through education, cooperation, and voluntary action

PennState Extension

PennState Extension

Prepared by the Best Management Practices task force, under the auspices of the Forest Issues Working Group, Shelby E. Chunko, editor

Compiled by Shelby E. Chunko and Wilbur E. Wolf, Jr. with the support of the School of Forest Resources at Penn State, the Pennsylvania Forest Stewardship Program, and the Pennsylvania Hardwoods Development Council

Illustrations by Patrick Britten

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Foreword

Forest Issues Working Group

The Forest Issues Working Group (FIWG) provides a forum where a diverse group of professional natural resource managers, forest landowners, scientists, environmental organizations, and other citizens concerned about Pennsylvania's forests can exchange views, concerns, and information with the objective of promoting better understanding and cooperation on key forestry issues. It was formed in 1991 as a joint effort of the Penn State School of Forest Resources, the Pennsylvania Hardwoods Development Council, and Maurice Forrester of the Susquehanna Economic Development Authority—Council of Governments.

The Best Management Practices (BMPs) project grew out of discussions held at a 1993 meeting of the FIWG, during which the group identified the need to establish and publish minimal acceptable forest management guidelines that could be used and applied by landowners, loggers, foresters, and other natural resource professionals throughout Pennsylvania. They agreed that a broadly representative task force should be created to draft and seek consensus on a set of BMPs. This publication is the result of that process.

Members of the FIWG have made significant contributions, some serving on the task force, others reviewing drafts of this publication. Consistent with its approach to other issues, however, the FIWG as a body has not taken a position on the details of this publication, and continued support for these BMPs and any subsequent revisions will depend on the actions of individual members.

Those who have participated in compiling this publication hope its contents serve as a useful "educator," "thought stimulator," and "refresher course" for all who are directly responsible for and care about the future of Pennsylvania's forests. The publication and the discussions of BMPs are designed to stimulate the readers to consider carefully the effects of planned activities on the future of forest resources. Compilers have tried to include enough information on each subject area to make the various aspects of BMPs implementation easy to understand, regardless of background or professional expertise of readers.

Best Management Practices: need and objectives

BMPs for silvicultural activities in forested wetlands and for controlling erosion and sedimentation from timber harvesting operations already have been established for Pennsylvania forests. (See references, pages 26 and 28.) The BMPs outlined in this publication are designed to supplement existing BMPs to benefit a wider array of forest resources and values. They reflect what we know today about using forest resources wisely and well.

Many of the trees on Pennsylvania's forested acres are now of *sawtimber* size (see Glossary of Forest Terms), and demand for our hardwood species has never been higher. The potential for an accelerated level of harvesting activity in Pennsylvania forests is high. Timber harvesting and other forest

management activities have both short- and long-term effects on the entire forest ecosystem. Therefore, it is imperative that we employ BMPs in all aspects of forest management activities so that those effects are positive. S*ustainable forestry* requires that we think and act in the "long term" rather than only in the "short run." Planning for the long term is not always easy for people to do, but if we don't, we run the risk of reducing the value and future availability of our forest resources.

BMPs must remain flexible over time, to accommodate changes in the social, economic, and environmental contexts of forest resource use; our education in this area must be ongoing. Through reading and applying the information compiled here, you will be reminded of how proper management and silvicultural practices can help us reap continuous economic benefits from the forest while still maintaining or improving wildlife habitat, protecting forest soils and waters, and ensuring the continuation of productive forest ecosystems.

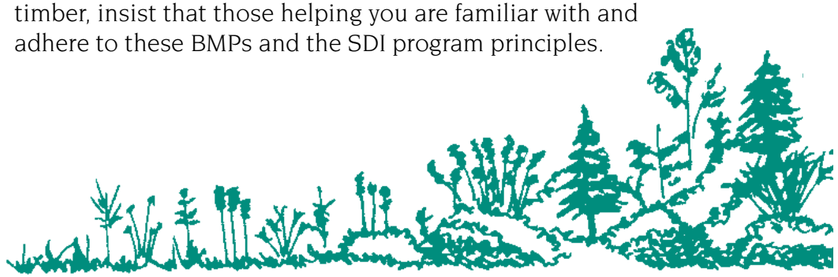
Implementation: voluntary or mandatory

Which approach to implementing BMPs—voluntary or mandatory—will better ensure the future health and productivity of Pennsylvania forests? This publication is written under the assumption that voluntary compliance, reinforced with education, will serve all of us better in the long run, both economically and socially.

Ethics are fundamental to voluntary compliance. The stewardship ethic implies that we who own or work in our forest lands have a moral obligation to leave them in better condition than we found them. In practical terms, voluntary compliance in implementing BMPs can help avoid the establishment of additional regulatory statutes, many of which can be burdensome, time consuming, costly, and not necessarily conducive to long-term forest health and productivity.

BMPs and the Sustainable Forestry Initiative℠ of Pennsylvania

The Sustainable Forestry Initiative (SFI) is an industry-sponsored and supported program with a mission of implementing sustainable forestry practices nationwide. The SFI of Pennsylvania is interested in ensuring that these practices occur on every timber harvest conducted in the state. Therefore, they have embraced the BMPs described in this publication as upholding the principles and objectives of their program. SFI encourages timber harvesters and foresters in Pennsylvania to participate in training programs to learn how to implement these BMPs. If you plan to harvest timber, insist that those helping you are familiar with and adhere to these BMPs and the SDI program principles.



How to use this book

Best Management Practices for Pennsylvania Forests is a nontechnical guide to forest resource management intended for use by natural resource professionals and lay persons alike. All words and terms that may not be familiar to the reader are *italicized* the first time they appear and are defined in the glossary of forest terms at the end of this book

The first two sections of the book, Introduction and Forest Management Basics, provide a brief overview of Pennsylvania forests—their history and importance, as well as basic information about forest ecology, silvicultural practices, and forest health. Regardless of the extent of your background in forest resource management, you will find it useful to read or review these two sections.

The third section, Best Management Practices, is the "meat" of the book. The Best Management Practices (BMPs) section provides guidelines for pursuing various components of forest resource management—including planning, forest renewal and tending, and protecting nontimber forest resources, such as aesthetics and wildlife habitat. (Regional BMPs may also be available. Check with the Department of Conservation and Natural Resources, Bureau of Forestry.) Each forest resource management component includes an objective, the primary issue upon which the BMPs are based, considerations and concerns regarding the management component, and a checklist of BMPs that address those considerations and concerns. The checklist is provided in general terms. If needed, the reader can get more detailed information and specific parameters from the publications listed at the end of each management component, under "For Additional Information."

Relevant laws and regulations are referenced as applicable throughout the text and detailed in the fourth section, Regulations Affecting Forest Management.

Introduction

Pennsylvania's forests: importance, history, and description

Nearly 60 percent of the 28 million acres within Pennsylvania borders is covered with forests. Forests provide benefits we simply cannot live without. These benefits can be grouped into three categories: economic, environmental, and aesthetic.

E*conomic*: Nearly 30 percent of Pennsylvania's economy is based on the forest. Our state's forest products are in demand worldwide. More than 100,000 people are employed in our $4.5 billion forest products industry, the fourth largest industry in the state. Each year, we produce more than one billion *board feet* of hardwood lumber and use approximately three-quarters of a million *cords* of *pulpwood* to produce paper and building board products. Approximately 20 percent of our private households supplement their winter heating with 250,000 cords of firewood—higher wood fuel usage than in any other state. Our forests are home to abundant populations of nongame and game animals. Wildlife watchers willingly spend money to feed, house, and otherwise care for the animals that dwell in or near the forest. Fishing and hunting licenses add more than $25 million to Pennsylvania's average annual state revenue. Other forms of recreation and tourism add to the high economic contribution from our forests.

E*nvironmental*: Forests protect soils from erosion, provide high-quality water (Pennsylvania has 25,000 miles of forested waterways), and improve air quality. (For every ton of new wood that grows, about 1.47 tons of carbon dioxide are removed from the air, and 1.07 tons of life-giving oxygen are produced.) The diversity of plants and animals that inhabit our forest lands across the state represent a wealth of cultural, medicinal, and environmental resources that we are just beginning to discover. The health of our forests is a prime indicator of the health of our total environment.

A*esthetic*: There are few who venture into the forest who do not recognize the human need for the natural beauty and peace of mind that the forest provides. As the pace of our lives and the demands on our time seem only to increase, the value of time spent in the forest—whether we camp, hunt, hike, watch wildlife, or simply collect our thoughts—becomes more important. The forest also fulfills the aesthetic needs of those who simply enjoy viewing the wooded landscape from afar, as well as those who feel good just knowing the forest is "there," even if they never venture into it.

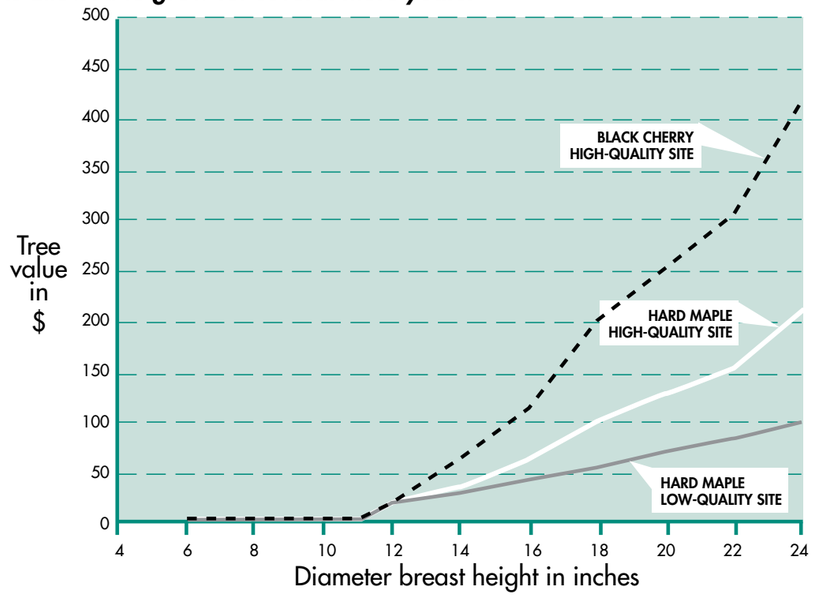
Several hundred years ago, Pennsylvania forests stretched from border to border. From the Piedmont region in southern Pennsylvania to the Northern Tier, a variety of hardwood species were intermingled with *stands* of Eastern white pine and hemlock. As settlers came in droves from Europe, the forests of Pennsylvania began to fall in their path. Farmers cleared forestland for agriculture. Lumber towns sprang up as Pennsylvania led the race to supply the growing nation with timber. By the early 1900s very little of the state's original forest remained. In the haste to harvest timber, other forest resources often were ignored. Steep hillsides were left bare, soil washed into streams and rivers, fires burned out of control, and wildlife habitats were drastically altered.

In all but a few small patches, the forests we have today grew on their own; vigorous fire control and prevention and low deer populations allowed *natural regeneration* to occur on abandoned farm fields and cut-over forests following several decades of widespread disturbance around the turn of the century. Consequently, most of the forests in the state are roughly the same age, give or take 25 years. A walk in a typical Pennsylvania woodland reveals that, in most areas, Eastern white pine and hemlock have become subordinate to a variety of mixed hardwoods—oak, cherry, hickory, maple, yellow poplar, and other species. Blight has reduced the once plentiful American chestnut to a shrub. White and red oaks and cherry have been joined by red maple as the *dominant* species in the *overstory*. In some areas of Pennsylvania, naturally induced mortality in the *deciduous canopy* is allowing Eastern white pine to make a comeback.

Economics and sustainable forestry

The promise of economic gain is a powerful lure. More significantly, economic gain, in the great majority of cases, provides the means to implement other management practices that can maintain and improve our forests for wildlife, recreation, *biological diversity*, and future woodland health and productivity. In realizing economic gain from the use of forest resources, we need to recognize that what we consume today can affect the resources available to our children. Ongoing management practices demonstrate that managing and using our forests wisely can provide at least as much as we need to sustain us now without jeopardizing the future resource, economically (Figure 1) and environmentally.

Figure 1. In some cases, the value of a tree will increase dramatically if it is allowed to grow for several more years.



Forest management basics

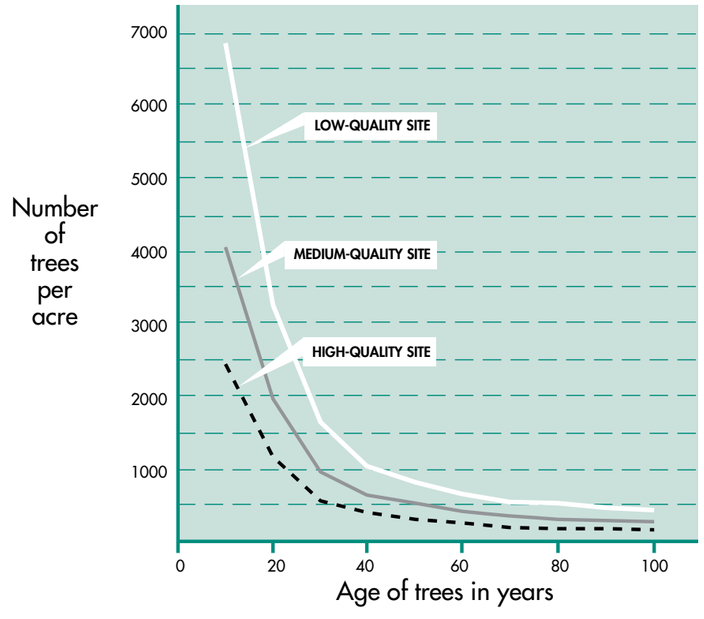
Ecological principles and processes

Forest *ecology* is the study of the forest as a biological community, with emphasis on the interrelationships among the various trees and other organisms constituting the entire community, and on the interrelationships between these organisms and the physical environment in which they exist. These interrelationships define or describe a forest *ecosystem*.

The forest ecosystem is dynamic—as in all living systems, change is inevitable (Figure 2). We can, to a degree, predict what will happen during the *successional* stages of a forest, and we are increasing our knowledge of the patterns of natural disturbances, such as winds, fires, damaging ice and snow, and outbreaks of native insects or diseases. We are less able to predict invasion by unexpected plant and animal species. Even for those disturbances whose patterns we can describe, it is difficult to predict their impact on a particular place at a particular time. What is certain is that no ecosystem remains forever the same. The domain of natural science has come to realize that management plans and techniques should try to work with, rather than prevent, changes in ecosystems.

The development of a forest is influenced by many factors—soil types and depths; groundwater patterns; the steepness and directional slope of the terrain; various microbial populations; the presence and fluctuating population sizes of numerous species of fungi, plants, and animals; the regional climate; the microclimate on the forest floor; the conditions that exist in adjacent or nearby areas; human activity; and the neverending, cyclic process of growth, aging, death, decay, and *renewal*.

Figure 2. Even without human intervention, the number of trees per acre decreases overtime.



The vegetation that succeeds on any given site under some set of environmental circumstances and conditions has a great influence on the types and species of microbial and animal life that will thrive there. And the types and levels of microbial and animal populations, in turn, affect the future success and composition of the plant life.

As we have acquired some degree of understanding of the complex web of ecological principles at work in the forest, we have found ways to speed up or slow down these natural successional processes. The art and science of manipulating the pace of nature in the forest and controlling forest establishment, composition, structure, and individual tree growth is called *silviculture*.

The role of timber harvesting

Humans have always needed products from the forest, and over time that demand has increased with our overall standard of living. Timber harvesting is a vital tool in renewing or enhancing and improving the vigor, diversity, and beauty of the forest while providing benefits to society. In the process of cutting trees for wood products, we modify wildlife habitat and alter natural systems (e.g., increase or decrease water flow, increase or decrease mast production, or change species composition).

In any discussion of forestry practices, of which timber harvesting is just one, it is useful to define a "stand" and make the distinction between a stand and a forest. A stand is an area of forest with similar species composition, age, and site conditions. A stand can be *pure* (at least 90 percent of the dominant trees are of one species) or *mixed*. It also can be *even-aged* (all the trees in the stand are approximately the same age) or *uneven-aged* (trees in the stand are of different ages). A pure, even-aged stand has the simplest structure, while a mixed, uneven-aged stand has the most complex.

The forest is the sum of its stands. Keeping that in mind, it is easy to understand that the forest, as a whole, can be sustained even while timber harvesting and other regeneration practices are being carried out on individual stands.

Although timber harvesting accounts for only a small portion of our working forests' life cycles, how and when timber is harvested play a major role in determining the character of the forest far into the future. Experience has indicated that disturbance may contribute to higher diversity. We know that timber harvesting can be pivotal for *forest renewal* and forest improvement in areas that previously have been misused.

Timber harvesting can play an important role in forest management, regardless of the owner's objectives. Properly planned timber harvesting promotes the growth of desirable trees and other plants, stimulates regeneration, and alters wildlife habitat to favor certain species. Timber harvesting also can temporarily alter the aesthetic or recreational value of the forest. Timber harvesting should be done only when there are benefits to be gained, and it should always be done in a way that is intended to improve or renew a forest. However, it should not be a foregone conclusion

that timber harvesting will be a part of every landowner's management plan. When timber harvesting is incorporated into management plans, it should be done to help landowners meet their objectives, whatever they might be.

Silvicultural practices

The goals of silviculture are the improvement and successful renewal of a forest community. Silvicultural practices are generalized procedures, usually involving cutting, that foresters adapt into individualized prescriptions for specific stands.

Classic silvicultural practices include *intermediate treatments* (*cleanings*, *thinnings*, and *improvement cuts*) and *regeneration methods* (done with the goal of starting a new forest). The complex mix of conditions from stand to stand dictates that silvicultural practices be modified or combined to suit site-specific conditions. Motives for managing forests have changed considerably since the early twentieth century, making the successful application of silvicultural practices an increasingly complex art. Objectives have expanded from timber management to multiple-use management to ecosystem management, in which maintaining the health, productivity, and continuity of the entire forest ecosystem is our principal goal.

The basic silvicultural practices in use today are briefly outlined here. Their application will be discussed more fully in the next section.

INTERMEDIATE TREATMENTS

Intermediate treatments are done while the forest is still growing to *economic* or *biological maturity*. Intermediate treatments are usually applied sufficiently before the forest reaches economic or biological maturity (economic maturity occurring before biological maturity) so that the *residual stand* will be able to respond to increased light, water, and nutrients or to reduced competition.

- *Cleanings*, which may also be thought of as "weedings," occur early in the life of a stand. They are made to favor species desired by the landowner by removing non-merchantable, undesirable (as defined by the landowner) *herbaceous* and woody species, including invasive, non-native species. Cleanings typically are not done past the *sapling* stage of the stand being treated. Because they do not have an immediate payoff, cleanings must be regarded as an investment in the future mature forest.
- *Thinnings and improvement cuts* have the goals of controlling *stand density*, increasing tree vigor, and selecting the species and individuals that will constitute the future forest. Thinnings and improvement cuts conducted in the latter stages of forest growth (or *rotation*, if timber management is the goal) frequently yield merchantable volume. The differences between thinnings and improvement cuts are sometimes difficult to discern, since they both are conducted using similar means to achieve similar ends. Thinning takes tree *spacing* into account, focusing on removing trees that are judged to be poor "competitors" and will probably die before they reach maturity. Improvement cuts, on the other hand, while not ignoring individual trees' competitive abilities, focus on removing trees of undesirable species or form to concentrate growth potential on the most desirable species and individuals.

The net results of intermediate treatments are that undesirable trees are removed from the stand, and resources (sunlight, moisture, nutrients, and space), and therefore growth, are redistributed to selected trees. Intermediate treatments also can help check the spread of infectious agents.

REGENERATION METHODS

Regeneration methods mimic the creation of openings in the forest by natural disturbances. The most important goal of the regeneration process is to re-establish a healthy forest. It is important to understand that regeneration in Pennsylvania's forest types almost always occurs naturally, either by stump sprouts (new trees arising from residual stumps), by root sprouts, or by naturally dispersed seed. Planting and seeding (artificial regeneration) sometimes are used to regenerate Pennsylvania forests, especially to establish or renew pine plantations. A focal point of regeneration is to renew not only the trees, but also the other beneficial woody and herbaceous vegetation that contributes to a functioning forest ecosystem.

There are four requirements to consider before making a regeneration cut: (1) abundant advanced regeneration (seedlings and sprouts) should be present on the forest floor, or there should be ample seed in the forest-floor *litter* that can germinate after the overstory is removed; (2) seedlings and sprouts should be well distributed; (3) they should be desirable species; and (4) vegetation that will inhibit the growth and development of seedlings and sprouts should be controlled. In Pennsylvania, there often is a fifth requirement: protecting seedlings and sprouts from over-browsing by white-tailed deer.

Once the above requirements are met, the regeneration cut can proceed under several methods. Usually, as mentioned earlier, these methods are combined or modified according to the conditions of the area to be harvested. Regeneration cuts usually generate income from timber, regardless of whether the objective is to make some money, to salvage a dead or dying stand, or to alter wildlife habitat.

- *The single-tree selection and group selection methods* mimic the natural processes of single trees or relatively small groups of trees dying and falling or being blown down by a localized burst of wind. Both methods favor the regeneration of *shade-tolerant* species. *Selection* cutting should be applied with skill and care because it easily can degenerate into "*selective*" cutting, also known as diameter-limit cutting or high-grading (see page 15). Under both methods, establishing areas of advanced regeneration is an ongoing process, from the time of the first cut through each successive cut.
  - *The single-tree selection method* removes individually selected trees throughout all diameter classes, creating small gaps in the canopy to facilitate regeneration. This method is generally the most expensive method of harvesting and requires the greatest amount of care and skill on the part of the forester and the logger. Advanced regeneration established before the harvest must be of shade-tolerant species that are known to grow well in the low-light conditions that persist even after harvest.

– *The group selection method* removes trees in a number of 0.1- to 1-acre areas to create openings in the forest canopy. The larger the opening, the more likely that regeneration of sun-loving (*shade-intolerant*) species will develop and persist in the openings. Shade-tolerant species are more likely to sprout and survive near the edges of the opening and in the uncut forest between the openings. For shade-tolerant species to compete successfully with shade-intolerant species in the openings, they should be present as advanced regeneration before the harvest.

- *Shelterwood, seed tree, and clear-cut methods* mimic nature's more catastrophic processes, such as wildfires, tornadoes, and hurricanes, which can bring down multiple acres of trees in one fell swoop. These three methods are used to regenerate tree species whose best germination and growth occur with full or nearly full sunlight.

  – *The shelterwood method* leaves a large number of trees standing long enough to establish and protect "advanced regeneration" sites until the seedlings and saplings are well established. (Because the residual trees also serve as a continuing seed source, the shelterwood method is desirable when insufficient advanced regeneration is present.) After regeneration is well established, the sheltering trees are harvested, permitting the advanced regeneration to occupy the site fully.

  – *The seed tree method* leaves a few of the best trees standing to become the parent trees of the new forest. This method has limited application in Pennsylvania forests.

  – *The clear-cut method*, in its pure form, removes all the trees in a multi-acre area in a single cut. However, as management plans have evolved to include multiple objectives, it is not unusual to find that even in a clearcut area, some tree species are reserved in the interests of biodiversity, wildlife habitat, or aesthetics. These include rare or slow-growing species, good mast producers, and wolf trees, den trees, and some snags. This method is the most controversial and often the target of public outcry. However, there are biologically based justifications for clear-cutting, given that the four (often five) requirements for regeneration listed above have been satisfied. Clear-cutting may be the best way to promote early successional forests that are essential for numerous plant and wildlife species. Clear-cutting is the best method for regenerating those tree species (such as black cherry, aspen, and yellow poplar) that require full sunlight, at least in their early life.

CROP TREE METHOD

The crop tree method is a relatively new, hybrid method that combines features of both intermediate treatments and regeneration methods. Currently, the crop tree method is being used to release trees selected for retention to meet an owner's objective. Regeneration may become established as openings around the crop trees are created. This regeneration will be released when the crop trees are harvested in the future. Since most regeneration will develop in partial shade, the crop tree method appears to favor shade-tolerant species.

Forest protection and health

Pennsylvania forests are subject to attack by insects, diseases, and fire. Gypsy moth has decimated untold acres of oak stands. Chestnut blight has virtually eliminated one tree species. Beech, hemlock, and dogwood are each battling their own pests. In many areas of the state, tree seedlings, shrubs, and wildflowers are losing the battle to over-browsing by white-tailed deer. Wind, snow, ice, and drought also take their annual toll on forest vegetation.

Some losses are unavoidable, but they can be minimized by incorporating BMPs that support a landowner's objectives into a sound forest management plan. Sometimes the best way to minimize a loss is through a salvage cut—literally, a harvesting operation conducted to salvage timber that has been damaged or killed by insects, disease, weather, or other natural phenomena. Details on BMPs that will protect and improve forest-land and minimize the adverse effects of forest management operations are presented in the next section.

High-Grading

There is concern among all sectors of the forestry community that high-grading—the harvesting of only those trees that will give the highest immediate economic return—may lead to a widespread decline in forest resource quality. Two practices, diameter-limit cutting and selective cutting, generally fall into this category. In diameter-limit cutting, all saleable trees above a certain diameter are harvested. Selective cutting usually removes the largest, most valuable trees and may leave large-diameter, poor-quality, low-value trees. In each case, most of the trees that remain after the harvest are genetically inferior or physically defective. Neither method gives any thought to the composition of the future forest.

In even-aged forests such as those in Pennsylvania, smaller-diameter trees are not necessarily younger trees. It is more probable that these smaller trees are:

1. slow-growing species of the same age as different, fast-growing species;
2. the same species of the same age but growing on an inferior microsite; or
3. the same species of the same age but genetically inferior to their larger-diameter counterparts.

Because slower-growing and poor-quality trees are retained, high-grading diminishes the diversity and economic value of the future forest. Landowners may agree to high-grading because of a lack of knowledge about the practice and its undesirable consequences. High-grading also can be driven by short-term economic considerations. Immediate cash flow may be higher with high-grading, but potential environmental degradation and decreased future timber values will more than cancel the immediate cash advantage.

Stewardship requires that landowners consider the future consequences of high-grading when making a decision whether or not to accept the use of the practice on their land. Resource professionals and harvsters also have an obligation to look beyond the present when recommending forest management practices to landowners.

Best Management Practices

Introduction

The Best Management Practices that follow are divided into three components of forest management: planning, forest operations, and forest values. Planning is essential for successful forest operations and the protection of forest values.

Aerial photographs and county soil surveys are two useful and recommended tools to help landowners and natural resource professionals plan forest management activities. Aerial photographs are available for viewing from Bureau of Forestry county service foresters and at county offices of the Farm Service Agency (FSA, formerly ASCS). You can order your own copies of aerial photographs through FSA offices. County soil surveys are available at county offices of the Natural Resources Conservatation Service (NRCS, formerly SCS).

Forest operations include regeneration and tending. Without successful regeneration, the future of the forest is jeopardized. In Pennsylvania, forest regeneration is a critical issue. Tending focuses on the stand—the residual stand as well as the effects of insects, diseases, and fire—and on site quality maintenance, which includes soil productivity and water resources.

Forest values, in addition to the timber, soil, and water resources addressed under forest operations, include aesthetics, wildlife habitats, species of special concern, and unique habitats.

All three components of good forest management emphasize the future of the forest. Landowners must understand that they have the ultimate responsibility for what happens on their land. They also must understand that the effects of their activities can extend beyond their property boundaries. The first step in managing forestland with a stewardship ethic is to develop a working relationship with those who can help you. For landowners, that means working with at least one natural resource professional, such as a forester, wildlife specialist, botanist, or ecologist. For natural resource professionals, it means establishing an interdisciplinary network of colleagues. Forest landowners, natural resource professionals, and timber harvesters all should follow BMPs when planning and implementing land-management activities, and be aware of the short- and long-term effects of those activities.

As stewards, we gather the knowledge of a forest that we need to evaluate both the short-term and long-term consequences of our actions. That knowledge helps us make responsible choices and trade-offs among the alternatives, weighing immediate financial gain against long-term financial and environmental benefits and costs.

Accommodating a variety of wildlife and plant species requires providing them with a variety of suitable growing conditions. Normal forest management operations can be used to develop a mix of age classes and stand structures, and this mixture may contribute to the desired variety of habitats. When landowner goals emphasize particular species, the mixture of stand types and age classes on the landscape will be dictated by the needs of those species. Both for variety and for particular species, additional special actions can and should be incorporated into the overall plan.

When management plans call for a harvesting operation, special attention to water resources is essential. Water resources are most susceptible to off-site impacts. Heavy sediment loads can travel for miles and adversely affect fish habitat, stream vegetation, and human uses far downstream. Changes in forest cover near streams can cause changes in water temperature, which may result in changes in aquatic plant and animal habitat.

Timber harvesting can result in a major change to the appearance of the harvested area. Frequently this change, especially in areas highly visible to neighbors or the general public, creates opposition to timber harvesting. Landowners and harvesters can modify the operation to minimize the impact of harvesting on the physical appearance of the area. The parties involved need to understand that lower *stumpage* values or lower return to the harvester may result from the modification.

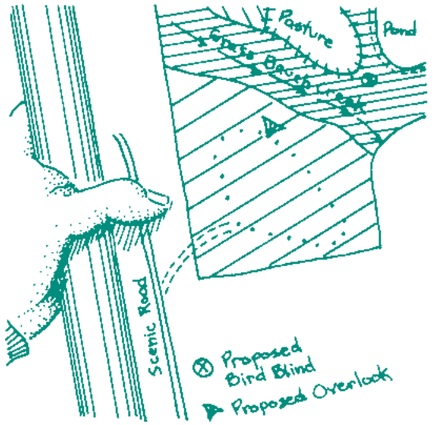
There are other trade-offs that landowners, resource professionals, and harvesters must consider when planning forest management strategies. Improving appearance by removing snags and *cavity trees* may lower wildlife values. On the other hand, retaining snags, dead trees, and cavity trees, while improving wildlife values, may provide operational hazards for the harvester and make it more difficult to operate safely. Familiarity with BMPs can help us recognize the trade-offs and make intelligent decisions about forest management activities.

BMPs are universally accepted activities that have positive effects or minimize negative effects on the forest ecosystem. Their impacts can be limited to individual stands or spread over multiple ownerships. Some BMPs are multipurpose. For example, *buffer strips* along streams designed to control sedimentation can also serve as wildlife travel corridors, result in habitat diversity, and maintain stream water temperature and nutrient levels. The BMPs in this publication are organized to take you through the full range of forest management activities that follow.

The BMPs provide the basics—minimal acceptable standards—of good forest management, although some landowners may choose to do more. By becoming familiar with the BMPs and using them as a guideline for both short-term and long-term forest management activities, each of us who holds some responsibility for the future of Pennsylvania's forests can become a better steward and contribute to a bright future for Penn's Woods.

Please note that the considerations and concerns, as well as the BMP strategies to address them, are merely a checklist. More detailed information is available in the publications listed at the end of each forest resource management component.

Planning



Objective: To optimize short-term and long-term benefits of forest management activities through adequate planning.

Issue: Management activities undertaken without planning can produce undesirable environmental, economic, and aesthetic consequences.

Considerations and Concerns:

1. Many private landowners are not aware of the values avaiable from their forestland.
2. Many private landowners do not define what they want from their forestland.
3. Many private landowners do not involve resource professionals in forest management planning.
4. Forest management activities, particularly harvesting, are often undertaken for short-term gain, without thought for the forest's future. (See Figure 1, page 8, and sidebar, page 15.)

BMPs:

1. Inventory resources on the property, including general plant/tree communities, water resources (*streams*, *spring seeps*, *wetlands*, *vernal ponds*), soils, and unique areas (*endangered*, *threatened*, or *rare species* habitat, rock outcroppings, notable views).
   a. Initially inventory at a level of detail necessary to address preliminary goals and objectives.
   b. Later conduct a more detailed analysis to meet specific landowner operational needs, such as harvesting.
   c. Be aware of how the resources on the property fit in with the surrounding landscape.
2. Landowner, working with a natural resource professional, should identify preliminary goals and objectives.
3. Mark and maintain property boundary lines. (See Regulations Affecting Forest Management: Timber Trespass Law.)
4. Develop realistic goals and objectives based on the resource inventory and available landowner time and finances. Be as specific as possible when enumerating objectives (e.g., does "managing for wildlife" mean creating habitat for a wide variety of wildlife or concentrating on habitat requirements for one or two species).
5. Consider the effects of planned activities on surrounding properties.
6. Create a written management plan based on the resource inventory and landowner objectives. Include a map showing stands or management units and a timetable for completion of recommended activities.

For Additional Information:

Fajvan, Mary Ann. *Pennsylvania Woodlands No. 9: Developing a Woodland Management Plan*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Finley, James C. *Pennsylvania Woodlands No. 3: Resource Evaluation*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Forest Advisory Services. *Directory of Consulting and Industrial Foresters*. DCNR Bureau of Forestry, Harrisburg, Pa.

Forest Advisory Services. *Forest Districts, District and County Service Foresters*. DCNR Bureau of Forestry, Harrisburg, Pa.

Harvey, Helene and James C. Finley. *Forest Stewardship Bulletin No. 6: Planning Your Forest's Future*. DCNR Bureau of Forestry, Harrisburg, Pa.

Jones, Stephen B. and Roe S. Cochran. *Pennsylvania Woodlands No. 11: Managing Your Woodlot with the Help of a Consulting Forester*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Pennsylvania Forest Stewardship Program. *Directory of Resource Professionals Available to Write Forest Stewardship Plans*. DCNR Bureau of Forestry, Harrisburg, Pa.

Forest operations

REGENERATION AND RENEWAL

Objective: To ensure that the forest of the future is a productive forest.

Issue: Timber is being harvested without regard for forest regeneration and renewal.

Considerations and Concerns:

1. Pennsylvania's forests are maturing; harvesting should lead to renewal.
2. Preharvest assessment of advanced regeneration and potential problems will minimize the possibility of regeneration failure.
3. Deer are having a major impact on forest regeneration.
4. Pennsylvania forests lack advanced regeneration of desirable species.
5. Once seed sources of desirable species are gone, it is difficult to reproduce a productive forest for the future.

BMPs:

1. Assess advanced regeneration, seed sources for postharvest regeneration, and potential stump and root sprouting.
2. Assess and, if necessary, control competing vegetation such as ferns, grasses, and other undesirable *understory* tree and shrub species.
3. Assess and, if necessary, control the potential loss of seed, seedlings, and sprouts to deer and other wildlife.
4. Provide for regeneration each time harvests are made under the uneven-aged system.
5. Consider the biological requirements of the species you want to regenerate, whether by natural reproduction or planting.

For Additional Information:

Bihun, Yuri, James C. Finley, Stephen B. Jones, and Ellen Roane. *Forest Stewardship Bulletin No. 7: Timber Harvesting: An Essential Tool of Forest Stewardship*. DCNR Bureau of Forestry, Harrisburg, Pa.

Gingrich, Samuel F. and Benjamin A. Roach. 1968. *Even-aged Silviculture for Upland Central Hardwoods*. Agriculture Handbook 355. USDA Forest Service Northeastern Forest Experiment Station, Radnor, Pa.

Grace, James R. *Pennsylvania Woodlands No. 8: Principles of Silviculture*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Grace, James R. *Pennsylvania Woodlands No. 10: Hardwood Management for Economic Return*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Marquis, David A. and Ronnie Brenneman. 1981. *The Impact of Deer on Forest Vegetation in Pennsylvania*. Gen. Tech. Rep. NE-65. USDA Forest Service Northeastern Forest Experiment Station, Radnor, Pa.

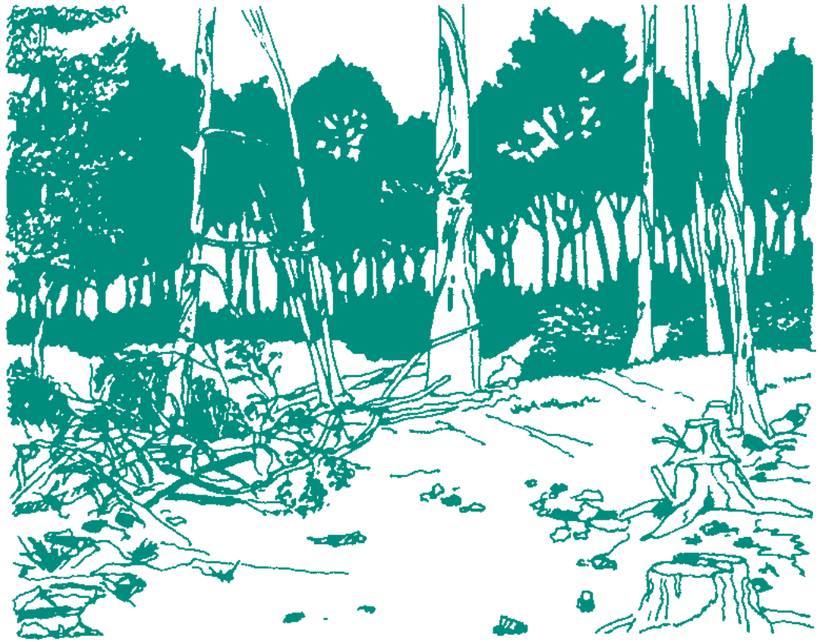
Marquis, David A., Richard L. Ernst, and Susan L. Stout. *Prescribing Silvicultural Treatments in Hardwood Stands of the Alleghenies*. Gen. Tech. Rep. NE-96. USDA Forest Service Northeastern Forest Experiment Station, Radnor, Pa.

Perkey, Arlyn W., Brenda L.Wilkins, and H. Clay Smith. *Crop Tree Management in Eastern Hardwoods*. (NA-TP-19-93). USDA Forest Service, Northeastern Area State and Private Forestry, Morgantown, W. Va.

Forest operations

TENDING

Stand—residual stand protection



Objective: To minimize the negative impacts of management activities on vegetation remaining on the site.

Issue: The stand that will remain after intermediate treatments is subject to damage or degradation during forest management operations.

Considerations and Concerns:

1. Intermediate treatments should leave the forest in better condition than it was in before the activity was undertaken.
2. Careless operation of equipment results in damaged trees.
3. Proper planning can minimize the chances of damaging or degrading the residual stand.

BMPs:

1. Focus on protection of the residual stand rather than on the trees being removed.
2. During intermediate operations, retain seed source of species needed to achieve long-term management objectives.
3. Avoid intermediate cuttings that may increase interfering plant communities, such as grasses and ferns, or be prepared to treat interfering vegetation before the regeneration cut.
4. Design and lay out *skid trails* and *skid roads* to minimize damage by avoiding residual trees and using *bumper trees* to protect them from skidding damage.
5. Exercise special care when harvesting trees during the growing season (usually between April and August), when residual trees are most susceptible to felling and skidding damage.
6. Identify and mark unique vegetation to be protected.
7. Ensure that a stand compatible with long-term management objectives remains after intermediate treatments. Instead of selecting for cutting, select for retention:
   a. species adapted to the site
   b. trees not likely to develop *epicormic branching* from exposure to increased sunlight
   c. properly spaced trees
8. Avoid high-grading (page 15).

For Additional Information:

Gingrich, Samuel F. and Benjamin A. Roach. 1968. *Even-aged Silviculture for Upland Central Hardwoods*. Agriculture Handbook 355. USDA Forest Service Northeastern Forest Experiment Station, Radnor, Pa.

Grace, James R. *Pennsylvania Woodlands No. 10: Hardwood Management for Economic Return*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Marquis, David A. and Ronnie Brenneman. 1981. *The Impact of Deer on Forest Vegetation in Pennsylvania*. Gen. Tech. Rep. NE-65. USDA Forest Service Northeastern Forest Experiment Station, Radnor, Pa.

Marquis, David A., Richard L. Ernst, and Susan L. Stout. *Prescribing Silvicultural Treatments in Hardwood Stands of the Alleghenies*. Gen. Tech. Rep. NE-96. USDA Forest Service Northeastern Forest Experiment Station, Radnor, Pa.

Perkey, Arlyn W., Brenda L.Wilkins, and H. Clay Smith. *Crop Tree Management in Eastern Hardwoods*. (NA-TP-19-93). USDA Forest Service, Northeastern Area State and Private Forestry, Morgantown, W. Va.

Forest operations

TENDING

Stand—insects, diseases, and fire

Objective: To minimize the adverse impacts on forest resources from insects, diseases, and fire.

Issue: Insects, diseases, and fire can make it difficult to accomplish forest management goals and objectives.

Considerations and Concerns:

1. Most landowners and some resource professionals fail to recognize the effects of insects and diseases on forests.
2. Proper management can minimize the impacts of insects and diseases.
3. Landowner objectives may have to be modified to deal with insects and diseases.

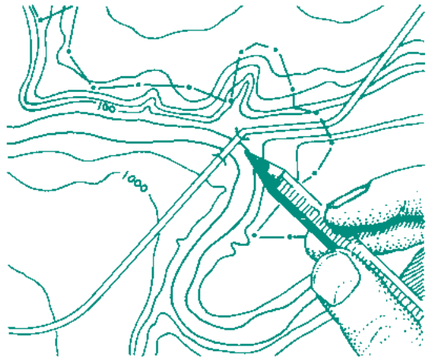
BMPs:

1. Monitor insect and disease populations.
2. Take appropriate control measures when insects or diseases are likely to prevent the accomplishment of landowner goals and objectives.
3. Consider increasing species diversity, changing species composition, or changing stand structure to minimize susceptibility to insect and disease attack.
4. Maintain access roads to facilitate fire control.
5. Consider a timber harvest to salvage dead and dying trees.

For Additional Information:

National Acid Precipitation Assessment Program. D*iagnosing* I*njury to* E*astern* F*orest* T*rees*. USDA Forest Service, Forest Pest Management, Atlanta, Ga., and Penn State Department of Plant Pathology, University Park, Pa.

Forest operations



TENDING

Site quality protection—productivity

Objective: To protect the ability of the soil to sustain desired plant and animal communities.

Issue: Operations at the wrong location and during inappropriate weather can damage soil structure and lower *site quality*.

Considerations and Concerns:

1. Current equipment makes it possible to move large volumes of timber in all kinds of weather and soil conditions.
2. Careful removal of forest products can be the key to having a productive forest in the future.
3. Soil compaction inhibits regeneration.
4. Deep ruts can damage roots, which can lead to decay, stain, reduced growth, and mortality.

BMPs:

1. Minimize soil compaction and rutting by matching operating techniques, season of operation, and equipment to soil types and moisture levels.
2. Use soil surveys, topographic maps, and on-site evaluations as guides when planning *log landing*, skid road, and *haul road* locations.
3. Modify landing and road locations to reflect actual soil, *parent material*, and topographic conditions.
4. Keep landing and road network at minimum size necessary to remove harvested timber efficiently.
5. Do not contaminate soils with fuels, lubricants, and other chemicals.

For Additional Information:

Brown, Darlene B., ed. 1993. B*est* M*anagement* P*ractices for* S*ilvicultural* A*ctivities in* P*ennsylvania's* F*orest* W*etlands*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

DEP Bureau of Land and Water Conservation, Cambria County Conservation District, and College of Agricultural Sciences Penn State Cooperative Extension. *Controlling Erosion and Sedimentation from Timber Harvesting Operations*. 1992. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Forest operations

TENDING

Site quality protection—water resources

Objective: To minimize the movement of soil into water resources during forest management operations.

Issue: Erosion and sedimentation from forest management activities can affect water quality.

Considerations and Concerns:

1. Operations that affect soil and water are regulated by law. (See Regulations Affecting Forest Management Activities: Environmental Regulations.)
2. Small changes in the operation can eliminate many of the negative impacts.
3. Forested wetlands are often difficult to identify, especially during dry seasons.

BMPs:

1. Comply with all provisions of Chapter 102 and Chapter 105 of the Clean Streams Law and the Dam Safety and Encroachments Act, respectively. (See Regulations Affecting Forest Management Activities: Environmental Regulations.)
2. Design roads to shed surface water quickly.
3. Design roads and landings to prevent or divert surface water flow.
4. Avoid locating roads and landings on seasonally wet soils.
5. Consider slope when laying out roads and landings.
6. Provide adequate riparian buffers between disturbed areas, such as roads or landings, and streams or wetlands.
7. Bridges and culverts are the preferred methods of crossing *intermittent* and *perennial* streams. When *fords* are used for truck crossings, stabilize the bottom with clean rock.
8. Cross wetlands only when absolutely necessary.
9. If forest operations necessitate taking heavy equipment into wetlands, conduct those operations, whenever possible, during the driest periods or when the wet area is solidly frozen.
10. Do not skid through water courses or spring seeps.
11. Do not contaminate water bodies and soil with forest management chemicals and petroleum products.
12. Retire the road network properly at the completion of operations.

For Additional Information:

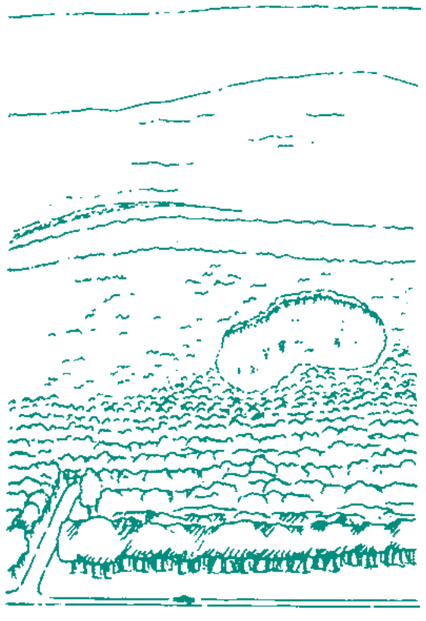
Brown, Darlene B., ed. 1993. *Best Management Practices for Silvicultural Activities in Pennsylvania's Forest Wetlands*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

DEP Bureau of Land and Water Conservation, Cambria County Conservation District, and College of Agricultural Sciences Penn State Cooperative Extension. *Controlling Erosion and Sedimentation from Timber Harvesting Operations*. 1992. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Welsch, David J. 1991. *Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources*. NA-PR-07-91. USDA Forest Service, Northeastern Area State and Private Forestry, Radnor, Pa.

Forest values

AESTHETIC CONSIDERATIONS



Objective: To minimize the adverse visual effects from harvesting and other forest management activities.

Issue: Much of the opposition to forest management activities, particularly harvesting, is due to the changed physical appearance of the area.

Considerations and Concerns:

1. Most landowners are concerned about the appearance of their property.
2. Acceptance of forest management activities by the general public is increased by having the job look good.

BMPs:

1. Cut all broken trees, *leaners*, and badly scarred trees except where they are being retained for a specific purpose.
2. Locate landings away from public view.
3. Protect and release from competition trees with unusual shapes and colors.
4. Design cutting areas to take advantage of natural contours; avoid straight lines when possible.
5. Lop tops of harvested trees near public roads, frequently used trails, recreational areas, and residential sites. (Note: This might increase the adverse impacts of deer on regeneration, because intact tree tops left behind help protect young growth.)
6. Use as much of the harvested wood as possible to minimize debris. (Note: This might reduce habitat for small mammals, reptiles, amphibians, and beneficial insects.)
7. Clean up all *refuse* daily.
8. Regrade and seed landings, using native grasses wherever possible.
9. Keep mud off public roads and out of streams.
10. Consider leaving a visual buffer along traveled roads.

For Additional Information:

Jones, Geoff. 1993. A *Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners*. NRAES-60. University of New Hampshire Cooperative Extension, Northeast Forestry Resource Extension Council Series, Northeast Regional Agriculture Engineering Service, Ithaca, N.Y.

Jones, Geoff and Douglas Weisman. 1994. *The Carfeul Timber Harvest: A Video Guide to Logging Aesthetics*. Weisman Video Productions, Watertown, Mass. (Sponsored by the Society for Protection of New Hampshire Forests; cosponsored by the New Hampshire Division of Forest and Lands and the University of New Hampshire Cooperative Extension.)

Kendra, Angelina and Ellen M. O'Donnell. *Forest Stewardship Bulletin No. 8: Planning for Beauty and Enjoyment*. DCNR Bureau of Forestry, Harrisburg, Pa.

Forest values

UNDERSTANDING WILDLIFE HABITATS

Objective: To consider the impacts of forest management activities on wildlife resources and understand the trade-offs necessary to accomplish landowner goals and objectives.

Issue: Forest management activities have positive and negative effects on wildlife resources.

Considerations and Concerns:

1. Wildlife is important to landowners and the general public.
2. The effects of forest management activities on wildlife are often overlooked.

BMPs:

1. Inventory habitat features on the property, and be aware of their relationship to surrounding lands.
2. Protect sensitive habitats, such as spring seeps, vernal ponds, riparian zones, cliffs, caves, and *rubble land*.
3. Develop missing special habitats, such as evergreen cover, grape arbors, and herbaceous openings, through planting, cutting, or other manipulations.
4. Protect cavity trees, snags, and food-producing shrubs and vines.
5. Maintain overhead shade along cold-water streams.
6. Use forest management activities to develop habitats required by species desired by the landowner.

For Additional Information:

Brooks, Robert P., Daniel A. Devlin, and Jerry Hassinger. 1994. *Wetlands and Wildlife*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

DeGraaf, Richard M. and Alex L. Shigo. 1985. *Managing Cavity Trees for Wildlife in the Northeast*. Gen. Tech. Rep. NE-101. USDA Forest Service Northeast Forest Experiment Station, Radnor, Pa.

DeGraaf, Richard M., Mariko Yamasaki, William B. Leak, and John W. Lanier. 1992. *New England Wildlife Management of Forested Habitats*. Gen. Tech. Rep. NE-144. USDA Forest Service Northeast Forest Experiment Station, Radnor, Pa.

Devlin, Daniel and Jack Payne. *Pennsylvania Woodlands No. 6: Woodland Wildlife Management*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Green, Duane. 1991. *Trees and Shrubs for Living, for Wildlife, for Conservation in the Mid-Atlantic*. USDA Forest Service, Northeastern Area State & Private Forestry, Morgantown, W.Va.

Hassinger, Jerry, Lou Hoffman, Michael J. Puglisi, Terry D. Rader, and Robert G. Wingard. 1979. *Woodlands and Wildlife*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Hassinger, Jerry and Jack Payne. *Pennsylvania Woodlands No. 7: Dead Wood for Wildlife*. College of Agricultural Sciences Penn State Cooperative Extension, University Park, Pa.

Hassinger, Jerry, Charles E. Schwarz, and Robert G. Wingard. 1981. *Timber Sales and Wildlife*. Pennsylvania Game Commission, Harrisburg, Pa.

Hobson, Scott S., John S. Barclay, and Stephen H. Broderick. 1993. *Enhancing Wildlife Habitats: A Practical Guide for Forest Landowners*. NRAES-64. Northeast Forest Resource Extension Council Series, Northeast Regional Agriculture Engineering Service, Ithaca, N.Y.

Sullivan, Kristi L. and Margaret C. Brittingham. *Forest Stewardship Bulletin No. 5: Wildlife*. DCNR Bureau of Forestry, Harrisburg, Pa.

Forest values

SPECIES OF SPECIAL CONCERN AND UNIQUE HABITATS

Objective: To recognize the importance and contribution of unique or special resources to the ecological integrity of the property and the Commonwealth.

Issue: Unique areas and plant and animal species of special concern need to receive specific attention in forest management activities.

Considerations and Concerns:

1. Landowners often are unaware of the existence of species of special concern or unique areas on their properties.
2. Many landowners would be willing to protect special resources on their properties if they had information and advice on what actions to take to protect them.
3. The loss of additional endangered, threatened, or rare species will diminish the biological wealth of our state.

BMPs:

1. Become aware of the presence of and protect endangered, threatened, and rare species' habitats and unique habitat features.
2. Know the habitat requirements of endangered, threatened, and rare species on the property so that activities can be planned either to avoid disturbing or to enhance these habitats.
3. Keep in mind that plant habitats can be very small and specific. Learn to recognize these special microsites.
4. Develop specific management plans for unique areas and habitats with the help of a resource professional.

For Additional Information:

Genoways, Hugh H. and Fred J. Brenner. 1985. *Species of Special Concern in Pennsylvania*. Carnegie Museum of Natural History, Pittsburgh, Pa.

Majumdar, Shyamal K., Fred J. Brenner, and Ann F. Rhoads. 1986. *Endangered and Threated Species Programs in Pennsylvania and Other States: Causes, Issues and Management*. Pennsylvania Academy of Science, Philadelphia, Pa.

McGuinness, Barbara J., ed. 1995. *A Heritage for the 21st Century: Conserving Pennsylvania's Native Biological Diversity*. Pennsylvania Fish and Boat Commission, Harrisburg, Pa.

Pennsylvania Fish and Boat Commission and Pennsylvania Game Commission. 1985. *Endangered and Threatened Species of Pennsylvania*. Wild Resource Conservation Fund, Harrisburg, Pa.

Regulations affecting forest management

Environmental regulations

Several laws and regulations address earth-moving activities that have the potential to degrade the quality of waters of the Commonwealth of Pennsylvania. Since timber harvesting involves earth moving, individuals involved in harvesting forest products should be familiar with these laws and regulations. The following list includes current federal, state, and local laws and regulations that normally affect timber harvesting operations. While the road bonding regulations included in this discussion do not directly relate to water quality, they are provided in order to assist logging operators in developing a harvesting plan.

FEDERAL

Federal Water Pollution Control Act Amendments of 1972, Section 404.

B*rief description*: This legislation established a permit program to be administered by the U.S. Army Corps of Engineers to regulate discharges of dredged or fill material into the "waters of the United States." Discharge of fill material includes road fills at stream crossings. A major emphasis of Section 404 is the protection of wetlands.

Application: Most logging road stream crossings are exempt from permitting under Section 404 because they are classified as "minor road crossing fills." To gain this exemption, the following four conditions must be met:

1. Fill actually placed into a stream channel cannot exceed 200 cubic yards.
2. The stream must be properly bridged (must pass expected high flows).
3. Wetlands must not be affected.
4. All other best management practices must be followed.

The Corps of Engineers and the Pennsylvania DEP, Bureau of Dams and Waterways Management have a joint permit application process. One application is submitted for both federal and state permits. Since the responsibilities of these two agencies overlap to a great degree, their compliance activities complement each other.

Establishing contact with the Pennsylvania DEP, Bureau of Dams and Waterways Management, will ensure that the timber harvester is advised on the applicability of Section 404 to a particular stream crossing situation.

STATE

Chapter 102, Erosion Control Rules and Regulations—issued under Act of June 22, 1937, P.L. 1987 (Clean Streams Law).

B*rief description*: Chapter 102 requires that an erosion control plan be developed, implemented, and maintained for every earth disturbing activity within the Commonwealth. The plan must consider the control of erosion and sediment during the activity, as well as proper restoration after the activity. The plan should consider the control of all factors that relate to the causes of erosion and sediment.

Application: Timber harvesting operations that involve earth disturbance of more than 25 acres require a permit from DEP. Additional information and applications concerning earth disturbance permits can be obtained by county conservation districts. Most timber harvests disturb less than 10 percent of the harvested area.

Chapter 105, Dam Safety and Waterway Management Rules and Regulations—issued under Act of 1978, P.L. 1375, No. 325 (Dam Safety and Encroachments Act).

B*rief description*: Chapter 105 requires proper planning, design, construction, maintenance, and monitoring of all dams, reservoirs, water obstructions, and encroachments. Conservation of water and protection of the water quality, natural regime, and carrying capacity of water courses are the primary thrusts of Chapter 105.

Application: All persons planning to construct, operate, maintain, modify, enlarge, or abandon any dam, water obstruction, or encroachment must apply for a permit from DEP, Bureau of Dams and Waterways Management. This requirement applies to all water courses. (A water course is defined as "any channel of conveyance of surface water having defined bed and banks, whether natural or artificial, with perennial or intermittent flow.") Chapter 105 regulates any encroachment construction within the defined boundary of the 100-year frequency floodway (provided by the Federal Emergency Management Agency—FEMA) or, in the absence of such mapping or contrary evidence, within 50 feet from the top of the streambank. DEP regulations may waive permit requirements for water obstructions on streams with drainage areas of less than 100 acres.

All permit applications, pursuant to Chapter 105, must be accompanied by an erosion and sediment control plan meeting the requirements of Chapter 102. Conservation districts review and determine the adequacy of erosion and sediment control plans, and their statement as to the plan's adequacy must accompany the encroachment permit application. For temporary road crossings permitted under General Permit No. 8 (GP-8), applicants need not acquire approval of their proposed erosion and sediment control plan before applying for an encroachment permit. However, the applicant must acquire approval of the erosion and sediment control plan from the appropriate conservation district prior to construction. To use GP-8, applicants must notify the Bureau or the local conservation district of their intent to use the General Permit.

Applicants may *not* begin work until they have notified and received from the Bureau an acknowledgment letter of their notification to perform work. Section 5 of the General Permit requires the applicant to notify the Bureau of Dams and Waterways Management of their planned work, including the required information. The Bureau's acknowledgment letter does not approve any drawings, details, or specifications of the proposed work, but acknowledges the applicant's intent to perform the work described. The applicant is responsible for ensuring that the work is done in accordance with the sample drawings and conditions of the General Permit and any conditions noted in the acknowledgment letter. The Fish and Boat Commission and the township and county in which the project is located must also be notified. (See Municipal Notification of DEP Permit Application Submittal, page 38.)

Fish and Boat Code—Act 175

B*rief description*: The Fish and Boat Code states "No person shall alter or disturb any stream, stream bed, fish habitat, water, or watershed in any manner that might cause damage to or loss of such without necessary permits." "Necessary permits" include any permits required pursuant to Chapter 102 and Chapter 105. The Fish and Boat Code further states that no person, regardless of intent, shall allow any substances deleterious (to fish life) to run, flow, wash, or be emptied into the waters of the Commonwealth of Pennsylvania.

Chapter 441, Access to and Occupancy of Highways by Driveways and Local Roads—issued under Act of June 1, 1945, (P.L. 1242, No. 428 (36 P.S. Sec. 670-420).

B*rief description*: Chapter 441 requires a permit for all driveways, local roads, and drainage facilities or structures constructed or altered within state highway rights-of-way. Permit applications must be submitted, in the name of the *owner* of property, to either the district or county PennDOT office having jurisdiction where the work will be performed. The permit application must be submitted before construction.

A*pplication*: Any harvest operation that will involve accessing a state highway by constructing a new or modifying an existing access point will require PennDOT approval. The local PennDOT office should be contacted about the specifics of a particular situation. PennDOT personnel will then help prepare the required permit application. Logging roads usually qualify for a "Minimum Use Driveway" permit.

Chapter 189, Road Bonding Regulations: Hauling in Excess of Posted Weight Limit on Highways—officially decreed under authority of Title 75, Sections 4902 and 6103 of the Vehicle Code.

B*rief description*: This chapter regulates the use of highways posted with weight restrictions for vehicles and combinations having a gross weight in excess of the posted weight limit, and applies to both state highways and highways under the jurisdiction of local authorities. Local traffic may exceed posted weight limits if the posting authority determines that vehicles over the posted weight are not likely to damage the highway. For vehicles determined likely to damage a posted highway, a permit must be obtained from the posting authority. The permit to exceed a posted weight limit is issued on condition that the permittee agrees to accept financial responsibility for excess maintenance of the posted highway or portion thereof to be used by the permittee.

A*pplication*: Persons proposing to haul over posted roads or bridges should contact the authority responsible for maintenance of the particular roads or bridges. This may be the county, the township, or PennDOT.

Municipal Notification of DEP Permit Application Submittal—Act 14 (H.B. 682)

B*rief description*: DEP must require all applicants for a permit or permit revision to provide written notice to each municipality in which activities are located (usually township and county).

A*pplication*: DEP may not issue or deny any permit or permit revision until 30 days after the municipalities have *received* the required written notices. (In the case of solid and hazardous waste permits, a 60-day waiting period is imposed.) The act does not apply to any permits relating to coal-mining activities.

This act has a direct impact on timber harvest operations that will require any type of DEP permit, specifically stream encroachment permits (including GP-8) and earth disturbance permits.

If a municipality does not request the right to review and comment on a permit application within 30 days of receiving *notification from the applicant*, the municipality forfeits its opportunity to comment. This 30-day period can be reduced if the applicant approaches the municipalities and obtains written statements relinquishing their rights to review.

N*otification is the responsibility of the applicant*.

LOCAL

Local municipal regulations concerning earth moving, timber harvesting, and other activities associated with forest management vary considerably. Therefore, it is advisable for earth movers, landowners, resource professionals, and timber harvesters to become familiar early in the planning stages with codes and ordinances currently enforced by the municipality in which work is anticipated.

Zoning and Land Use

As of early 1995, timber harvesting ordinances were known to exist in at least 135 Pennsylvania townships. It is advisable to check with the appropriate township(s) before any timber harvesting activities are planned or executed (see page 42). For more information, read the publication T*imber Harvesting in Pennsylvania*: I*nformation for Citizens and Local Government Officials*, available from the Penn State Cooperative Extension office in your county.

Compliance

Certified Conservation District personnel, DEP compliance specialists and engineers, and Waterways Conservation officers have the legal power to enter private property for the purpose of administering applicable laws and regulations. Conservation district staff are often the first regulatory personnel to contact anyone involved in an earth moving activity. Situations involving compliance questions are resolved most easily when the district inspectors and timber harvesters work in a cooperative, positive manner.

Individuals or companies who persist in violating any of the laws or regulations intended to protect Pennsylvania streams are subject to substantial fines and penalties. Willful or negligent violations carry even heavier penalties.

Individuals from as many as five different agencies are responsible for ensuring compliance with applicable laws and regulations. Their areas of responsibility are indicated in the chart on the following two pages.

Responsibilities of agencies for erosion and sedimentation control

AGENCY	RESPONSIBLE PERSON	RESPONSIBILITY
Conservation District	Conservation district manager and/or Conservation district E & S technician	Review of E & S plans in accordance with Chapter 102 Processing of earth disturbance permits in accordance with Chapter 102[a] Compliance inspections of earth moving activities in accordance with Chapter 102[a]
DEP Regional Office, Soils and Waterways Section	Regional engineer and/or Compliance specialist	Compliance inspections, compliance actions, and enforcement of Chapter 102 Field support to conservation district administration of Chapter 102
DEP Regional Office, Soils and Waterways Section	Hydraulic engineer	Issuance of water obstruction permits in accordance with Chapter 105[b] Compliance inspections, compliance actions, and enforcement of Chapter 105
Pennsylvania Fish and Boat Commission	Waterways Conservation officer	Compliance inspections, compliance actions, and enforcement of the Fish and Boat Code
Pennsylvania Department of Transportation	PennDOT representative(s)	Issuance of driveway permits in accordance with Chapter 441 Compliance inspections, compliance actions, and enforcement of Chapter 441

(continued on next page)

		Issuance of excess maintenance permits (road bonding) for state highways in accordance with Chapter 189 Compliance inspections, compliance actions, and enforcement of Chapter 189, as it pertains to state highways
US Army Corps of Engineers	Army Corps representative(s)	Issuance of "dredge and fill" permits in accordance with Section 404 of the Federal Clean Water Act of 1977 Administer federal regulations pertaining to wetlands Compliance inspections, compliance actions, and enforcement of Section 404 of the Federal Clean Water Act of 1977 (Note: Army Corps activities are closely coordinated with management efforts of the DEP Bureau of Dams and Waterways Management.)
Local municipality	Supervisors or township representative(s)	Enforcement of local codes and ordinances (including township highway bonding, in accordance with Chapter 189)

[a] Chapter 102 responsibilities of conservation districts vary with the level of involvement endorsed by the district directors. Most districts (63 of 66) have accepted inspection and compliance responsibilities.

[b] The DEP Bureau of Dams, Waterways, and Wetlands has initiated a program in which some inspection duties, general permit review and issuance, and permit exemption determinations, pursuant to Chapter 105, have been delegated to certain conservation districts.

Occupational Safety and Health Administration (OSHA) regulations

The Occupational Safety and Health Administration logging standards that went into effect in February 1995 replace the OSHA pulpwood logging safety standards and are designated in the OSHA safety standards package as Sec. 1910.266 Logging Operations. All logging operations, regardless of the product produced, are covered. The new standards do not cover the construction or use of cable yarding systems, which are detailed in state logging safety standards in most Western states.

Detailed information is available in the following publications:

- *The Logger's Guide to the New* OSHA *Logging Safety Standards*. Oct. 1994. American Pulpwood Association Inc., Washington, D.C.
- *The Federal Register, Part* II: *Logging Operations*: *Final Rule*. U.S. Department of Labor, Occupational Safety and Health Administration. 29 CFR Parts 1910 and 1928.

Other regulations

The Pennsylvania Municipalities Code (Act 67 and 68) and the Right to Practice Forestry Act—53 P.S.§10603(f)

B*rief description*: The Municipalities Code (MPC) and the Right to Practice Forestry Act both state that zoning ordinances may not unreasonably restrict forestry activities. The MPC goes further by saying that "…to encourage maintenance and management of forested or wooded open space and promote the conduct of forestry as a sound and economically viable use of forested land throughout this Commonwealth, forestry activities, including, but not limited to, timber harvesting, shall be permitted use by right in all zoning districts in every municipality."

Application: The intent of these statutes is to make it easier to carry out forestry activities by limiting the scope of zoning. Given this broad legislative mandate, municipalities that regulate forestry activities will have to craft ordinance provisions that are based on sound forestry principles and practices. The statute does not define "unreasonable," and no appellate court decisions have yet interpreted it. If a zoning ordinance prohibits timber harvesting in zoning districts with significant forests or makes timbering a special exception or conditional use subject to many burdensome and time-consuming requirements, the ordinance is subject to challenge by landowners and loggers alike.

Timber Trespass Law—Act 10 of 1994, P.S. §8311

B*rief description*: The Timber Trespass Law allows landowners to bring a civil lawsuit to recover three times the value of the timber cut or removed in cases of intentional trespass or two times that value for negligent trespass. Landowners also can recover the costs of establishing the value of the timber cut or removed and of complying with state erosion and sedimentation control rules. The specific wording of the law is as follows:

§8311. Damages in actions for conversion of timber.

(a) General rule.—In lieu of all other damages or civil remedies provided by law, a person who cuts or removes the timber of another person without the consent of that person shall be liable to that person in a civil action for an amount of damages equal to:

(1) the usual and customary costs of establishing the value of the timber cut or removed and of complying with the erosion and sedimentation control regulations contained in 25 Pa. Code Ch. 102 (relating to erosion control); and

(2) one of the following:

(i) three times the market value of the timber cut or removed if the act is determined to have been deliberate;

(ii) two times the market value of the timber cut or removed if the act is determined to have been negligent; or

(iii) the market value of the timber cut or removed if the defendant is determined to have had a reasonable basis for believing that the land on which the act was committed was his or that of the person in whose service or by whose direction the act was done.

(b) Restitution.—Any damages awarded under this section shall be reduced by any restitution which is made under 18 Pa. C.S. §1107 (relating to restitution for theft of timber).

(c) Definitions.—As used in this section, the following words and phrases shall have the meanings given to them in this subsection:

Timber. Standing trees, logs, or parts of trees that are commonly merchandised as wood products.

Market value. The value of the standing timber at local market prices for the species and quality of timber cut or removed at the time it was cut or removed.

Glossary of forest terms

Age class—a distinct aggregation of trees originating from a single natural disturbance or regeneration cutting.

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

Biological diversity—see Biodiversity.

Biological maturity—the stage before decline in the life cycle of a tree when annual growth is offset by breakage and decay.

Board foot—a unit of wood 1 inch thick, 12 inches long, and 12 inches wide.

Buffer strip—forestland, usually along a road or waterway, managed to lessen visual or environmental impacts of timber harvesting.

Bumper trees—trees intentionally left standing adjacent to skid trails and roads to protect residual trees from damage when harvested timber is moved to the log landing site. Bumper trees are cut at the end of the harvesting operation.

Canopy—the upper level of a forest, consisting of branches and leaves of taller trees.

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

Cord—a stack of wood measuring 4 by 4 by 8 feet.

Cleaning—a release treatment made in an age class not past the sapling stage in order to free the favored trees from less desirable individuals of the same age class that overtop them or are likely to do so.

Deciduous—losing or shedding leaves at the end of the growing season.

Den Tree—see cavity tree.

Dominant—trees with leaf-bearing branches (crowns) extending above the general level of the main canopy and receiving full sunlight from above and partial light from the sides.

Dormant—resting, or nongrowth, phase.

Ecology—the study of interactions between living organisms and their environment.

Economic maturity—the time in the life cycle of a tree or stand when harvesting can be most profitable.

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

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

Epicormic branching—delayed shoot development, or branching that occurs after other branches have developed higher on the tree trunk, often the result of the exposure of a maturing tree to previously unavailable sunlight. Epicormic branches typically arise from dormant buds that have maintained their vascular connection.

Ford—a shallow section of a stream that is stabilized with stone and used for crossing.

Forest renewal—the growth of a new forest, which includes not only the trees but also the other beneficial woody and herbaceous vegetation that contributes to the overall integrity, diversity, and health of the entire forest community and its interdependent ecological functions.

Haul road—a road designed for use by trucks to transport harvested timber from the log landing to its destination.

Herbaceous—pertaining to nonwoody vegetation, such as grasses and wildflowers.

Improvement cutting—a cutting made in a stand past the sapling stage primarily to improve composition and quality by removing less desirable trees of any species.

Intermediate treatment—a collective term for any treatment designed to enhance growth, quality, vigor, and composition of the stand after the establishment of advanced regeneration and before the final harvest.

Intermittent—refers to streams that do not flow continuously throughout the year.

Leaners—damaged trees that have been tipped or dislodged from the soil during a harvesting operation.

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

Log Landing—the area at the end of a skid road where harvested timber is stored or prepared for transport from the woodlot.

Lop—cut up the tops of harvested trees to reduce their height.

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

Microsite—a small area in which soil nutrients, water availability, sunlight, and other resources affect the growth and development of only one or a few trees and other plants.

Natural regeneration—the replacement of one forest stand by another through natural seeding or sprouting.

Overstory—trees in the upper level, or canopy, of the forest.

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

Perennial—refers to streams and wetlands that contain water at or near the surface throughout the year.

Pulpwood—timber used to make paper and wood products other than lumber.

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

Refuse—man-made debris.

Regeneration method—a cutting method designed to promote and enhance natural establishment of trees. Even-aged stands are perpetuated by seed tree, shelterwood, and clearcutting methods. Uneven-aged stands are perpetuated by selecting individual or small groups of trees for removal.

Renewal—see forest renewal.

Residual stand—trees remaining following any cutting operation.

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

Rotation—the planned time interval between regeneration cuts in a forest.

Rubble land—an area characterized by its high content of large rock fragments.

Sapling—a small tree, usually defined as being between 2 and 4 inches in diameter at breast height.

Sawtimber—a relatively well-formed tree large enough to yield at least one sawlog, which is used for lumber. Usually the small end of a sawlog must be at least 10 to 12 inches in diameter for hardwoods.

Seasonally wet—refers to wetlands that have water at or near the surface only during periods of abundant rainfall or snow melt.

Seedling—a young tree originating from seed that is less than 4 feet tall and smaller than 2 inches in diameter at ground level.

Selection cut—the removal of trees singly or in small groups for the purpose of regeneration. A well-designed selection cut removes trees of lesser quality and trees in all diameter classes along with merchantable and mature, high-quality timber.

Selective cut—the removal of high-quality trees singly or in small groups based on a minimum diameter limit. Selective cuts often equate to high-grading and can compromise the quality of the future stand.

Shade intolerant—the inability of a tree to become established and survive at relatively low levels of sunlight. Shade-intolerant species, such as black cherry, aspen, and yellow poplar, germinate and grow best in full sunlight.

Shade tolerant—the ability of a tree to become established and survive at relatively low levels of sunlight. Sugar maple, Eastern hemlock, and beech can persist for many years in the shady understory.

Silviculture—the art, science, and practice of establishing, tending, and reproducing forest stands.

Site quality—the potential productive capacity of a site, usually expressed as volume production of a given species.

Skid—drag logs by lifting one end off the ground to reduce resistance.

Skid road—a road designed for frequent use by skidding equipment. Skid roads typically incorporate water-control structures.

Skid trail—a trail requiring less construction than a skid road because it is used less frequently by skidding equipment.

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

Spring seep—a class of wetland created by groundwater emerging in small pools surrounded by vegetation. Spring seeps create snow-free zones critical for wildlife feeding during the winter.

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

Stand density—a quantitative, absolute measure of tree occupancy per unit of land area in such terms as numbers of trees, basal area (cross-sectional area of a tree trunk at breast height), or volume.

Stem—the main trunk of a tree (also called bole).

Structure—the species composition of a forest stand *by age class*.

Stumpage—the commercial value of standing trees.

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

Sustainable forestry—the management of forests to meet the needs of the present without compromising the ability of future generations to meet their own needs.

Thinning—a cutting that reduces stand density of trees, made primarily to improve growth, enhance forest health, or recover potential mortality.

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

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

Vernal (or autumnal) pond—a class of wetland characterized by small, shallow, temporary pools of fresh water present in spring and fall, which typically do not support fish but are important breeding grounds for many species of amphibians. Some species, such as spring peepers and mole salamanders, are totally dependent upon such ponds.

Wetland—area that is either transitional between land and water (where the water table is at or near the land surface) or area of land covered by shallow water (such as a marsh, swamp, bog, and fen). Although only 2 percent of Pennsylvania remains as wetlands today, these areas fulfill an essential role in our landscapes by maintaining water quality, stabilizing shores and stream banks, controlling floods and erosion, and providing critical habitat to many plant and animal species.

Wolf tree—a large, branchy tree that occupies more space in the forest than similar trees of the same diameter. Wolf trees may have high

The Forest Stewardship Program is administered nationally by the USDA Forest Service and is directed in Pennsylvania by the DCNR Bureau of Forestry with assistance from a statewide steering committee. The Forest Stewardship Program assists forest landowners in better managing their forestlands by providing information, education, and technical assistance. For more information about program services and publications contact: The Pennsylvania Forest Stewardship Program, DCNR Bureau of Forestry, P.O. Box 8552, Harrisburg, PA 17105-8552. Phone: 800-235-WISE, or 717-787-2105.

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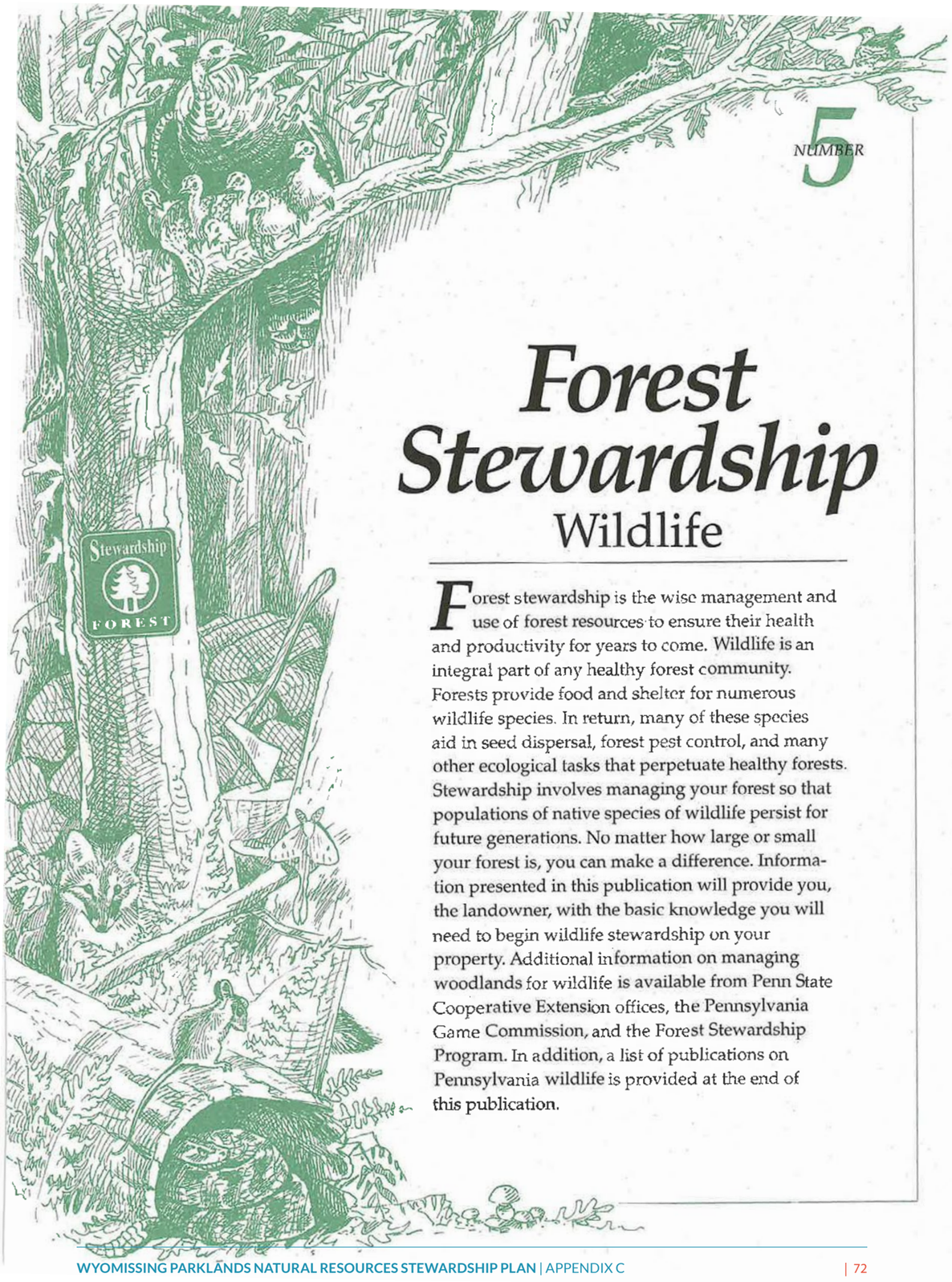


NUMBER 5

Forest Stewardship

Wildlife

Forest stewardship is the wise management and use of forest resources to ensure their health and productivity for years to come. Wildlife is an integral part of any healthy forest community. Forests provide food and shelter for numerous wildlife species. In return, many of these species aid in seed dispersal, forest pest control, and many other ecological tasks that perpetuate healthy forests. Stewardship involves managing your forest so that populations of native species of wildlife persist for future generations. No matter how large or small your forest is, you can make a difference. Information presented in this publication will provide you, the landowner, with the basic knowledge you will need to begin wildlife stewardship on your property. Additional information on managing woodlands for wildlife is available from Penn State Cooperative Extension offices, the Pennsylvania Game Commission, and the Forest Stewardship Program. In addition, a list of publications on Pennsylvania wildlife is provided at the end of this publication.

Contents

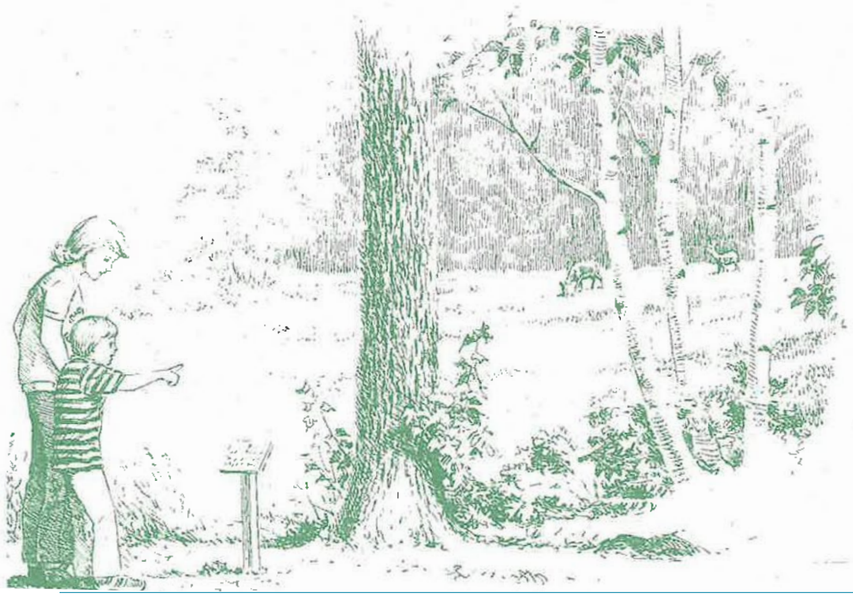
Benefits of Wildlife

As a forest manager, the landowner plays an important role in ensuring that present and future generations can enjoy the many benefits of wildlife. In Pennsylvania, more than 60 percent of all adults participate in some form of recreation related to wildlife. Watching a scarlet tanager alight on a branch, identifying ten species of warblers on your own forest tract, or pursuing a white-tailed deer on a cold November day are all recreational activities associated with wildlife. A major benefit gained from owning forestland is being able to hunt wildlife on your own property. Forest landowners also can enjoy the beauty of wildlife. Listening to a wood thrush sing, admiring a monarch butterfly perched on a milkweed, or watching a red fox dash across a forest clearing can be inspirational and provide a soothing break from an otherwise hectic day.

Although most landowners are aware of the recreational and aesthetic benefits of wildlife, few realize the ecological services provided by the variety of wildlife inhabiting our forests or the multiple benefits associated with these services. Each species performs a specific function in the ecosystem that directly benefits other living organisms, including people. For example, squirrels bury acorns for food but fail to retrieve many of them. Acorns that are not uncovered become a new generation of oak trees. In this way, squirrels help provide for continual forest growth. Many other birds and small mammals distribute seeds throughout the landscape. Blue jays are particularly important in long-distance dispersal of seeds, such as acorns and beechnuts. Jays collect these seeds and carry them to distant sites where they bury them in soft ground or under grass and fallen leaves. In a study of blue jays in Virginia, 50 blue jays transported 150,000 acorns in one month. Some of these were retrieved and consumed by the jays later that year, but many were left to regenerate the forest.

Goshawk

Another ecological function of wildlife is insect control. Bats are insectivorous, feeding on small flying insects, such as mosquitoes, moths, and beetles. A bat may consume as much as one-half its body weight in insects every night, thereby helping control insects harmful to both forests and humans. Birds also consume insects that in large numbers would be harmful to trees. Earthworms and rodents turn over the soil and recycle nutrients. These are just a few examples of the many ecological functions performed by wildlife.



WILDLIFE FOOD PLANTS

PLANT SPECIES	WILDLIFE SPECIES USING PLANT FOR FOOD	NO. OF SPECIES USING PLANT	SEASONS AVAILABLE[1]
Blackberry	brown thrasher, chipmunk, gray catbird, rabbit, ring-necked pheasant, robin, white-tailed deer	56	S, F
Cherry	black bear, cedar waxwing, raccoon, red squirrel, rose-breasted grosbeak, ruffed grouse, white-footed mouse	56	S, F
Grape	black bear, cardinal, fox sparrow, gray fox, mockingbird, ruffed grouse, wild turkey	53	S, F, W
Ragweed	dark-eyed junco, goldfinch, horned lark, mourning dove, red-winged blackbird, sparrows	49	F, W
Dogwood	bluebird, cardinal, cedar waxwing, rabbit, ruffed grouse, wild turkey, wood thrush	47	S, F, W
Oak	black bear, blue jay, raccoon, ruffed grouse, white-tailed deer, wild turkey, wood duck	43	Sp, F, W
Sedge	horned lark, ruffed grouse, sparrows, wild turkey	43	Sp, S
Bristlegrass	bobolink, cardinal, mourning dove, ring-necked pheasant, red-winged blackbird	40	S, F, W
Serviceberry	beaver, bluebird, cardinal, cedar waxwing, gray catbird, red squirrel, scarlet tanager, veery, white-tailed deer	39	Sp, S
Blueberry	black bear, gray catbird, rabbit, rufous-sided towhee, skunk, white-footed mouse, white-tailed deer	37	S, F
Elderberry	bluebird, brown thrasher, cardinal, indigo bunting, rabbit, rose-breasted grosbeak	36	S
Pine	beaver, black-capped chickadee, brown creeper, gray squirrel, mourning dove, porcupine, nuthatches	33	W
Panic grass	dark-eyed junco, sparrows, red-winged blackbird, wild turkey	32	F
Beech	black bear, blue jay, chipmunk, porcupine, ruffed grouse, squirrels, tufted titmouse, white-tailed deer, wild turkey	31	Sp, F, W
Poison ivy	black-capped chickadee, gray catbird, downy woodpecker, flicker, hairy woodpecker, hermit thrush, wild turkey	28	F, W
Sumac	bluebird, cardinal, black-capped chickadee, hermit thrush, rabbit, robin	28	F, W
Maple	beaver, chipmunk, porcupine, rose-breasted grosbeak, squirrels, white-tailed deer	27	Sp, S, F
Pokeweed	bluebird, cedar waxwing, gray catbird, gray fox, mourning dove, raccoon, red fox	25	F
Greenbriar	gray catbird, hermit thrush, mockingbird, raccoon, ruffed grouse	23	F, W
Birch	black-capped chickadee, beaver, porcupine, rabbit, ruffed grouse	22	Sp, S
Virginia creeper	bluebird, great-crested flycatcher, pileated woodpecker, red-eyed vireo	22	F, W
Hickory	chipmunk, red-bellied woodpecker, rose-breasted grosbeak, squirrels, wood duck	19	Sp, S, F, W
Aspen	beaver, porcupine, ruffed grouse, white-tailed deer	17	Sp, S, F, W
Hawthorn	fox sparrow, gray fox, raccoon, ruffed grouse	15	S, F
Hemlock	black-capped chickadee, porcupine, red squirrel, ruffed grouse, white-footed mouse	13	F, W
Alder	beaver, goldfinch, ruffed grouse	11	Sp, S, F, W

SOURCE: Compiled from Martin, A.C. et al. 1951. *American Wildlife and Plants, A Guide to Wildlife Food Habits.* Dover Publications, Inc.

[1]Sp = spring, S = summer, F = fall, W = winter.

Habitat Requirements Provided by the Forest

To survive, each animal species requires four basic elements—food, cover, water, and space. The combination of these elements required by each animal is referred to as that animal's habitat. When managing your forest, it is important to remember that for a particular species to inhabit your land, each element of that species' habitat must exist in sufficient quantity and quality.

Blackberry

FOOD

A variety of trees, shrubs, vines, and herbaceous plants is needed to provide wildlife with food in each season, but especially in winter when food may be scarce. In general, plants that produce fleshy fruits, nuts, or seeds are valuable wildlife food sources. A variety of plant species also will help to ensure the availability of nuts, acorns, seeds, and fruit. Red and white oaks, for example, may produce acorns in different years. Having more than one species of oak in your forest increases the probability of producing acorns every year.

The table on the previous page is designed to help you recognize some of the plant species that provide food for wildlife. The table includes examples of woody and herbaceous species; the number of wildlife species in the northeastern United States that use each plant; examples of specific birds and mammals that use each plant for food; and the season(s) that each species provides food for wildlife. While plants are listed in order of the number of wildlife species that use them, even those used by only a few wildlife species are important.

In addition to plants, many wildlife species feed on insects or other animals. A variety of species, from slimy salamanders and garter snakes to bluebirds, warblers, shrews, bats, and black bears, make insects a part of their diets. Providing habitat for insects (rotting logs, stumps, dead trees or snags, etc.) will in turn provide feeding areas for insectivorous wildlife. Rocks, logs, cavities, and woody materials (e.g., fallen tree tops) also provide habitat for amphibians, reptiles, and small mammals, which in turn serve as food for carnivorous species, such as hawks, owls, several types of snakes, shrews, and red and gray foxes.

COVER

All wildlife requires cover for nesting and protection from predators and adverse weather conditions. Herbaceous forest openings provide ground cover for some nesting birds, as well as travel and escape cover for small mammals. Scattered throughout the forest, brushy areas provide excellent escape and nesting cover for species ranging from songbirds to woodcock and white-tailed deer. Mature forests provide nesting and feeding cover for canopy-nesting birds and cavity-nesting birds and mammals.

You may wish to enhance the cover on your property with evergreens, cavities, and brush piles. Hemlock, white pine, rhododendron, and other evergreens are most commonly used by wildlife as cover from harsh weather conditions. Stands of evergreens provide protection from snow and winter winds. Some birds, such as the mourning dove, nest primarily in evergreens. In addition, evergreen needles or leaves provide food for deer in winter, when other food is

Deer mouse

Ruffed grouse in evergreen cover

scarce. The value of evergreen cover depends upon the species, size, and age of the stand as well as its proximity to other cover types. Evergreens are best located near brushy areas or small herbaceous openings. A variety of wildlife will benefit from a mixture of tall, mature conifers, such as white pine or hemlock, in one area and low-growing evergreens nearby, such as rhododendron, mountain laurel, or young conifers.

Thirty-five species of birds and twenty species of mammals in Pennsylvania use tree cavities for nesting and escape cover. Cavities also are used by various reptiles and amphibians. Cavity trees can be either living or dead. Retaining a combination of both kinds will meet the needs of a variety of wildlife species. Trees of different heights and cavities of different sizes will be of greatest benefit to wildlife. The most valuable cavity trees show evidence of use, such as gnawing around the entrance, or a smooth, worn entrance. They have the following characteristics:

- a healthy crown and the potential to survive for years
- a cavity entrance located where rain cannot enter the hole
- ability to provide multiple benefits for wildlife (e.g., seed production, multiple dens, and cavities in large dead limbs)

Cavities are most valuable when located near streams and forest openings or in proximity to other cover types. For more detailed information on cavities and a list of species that use them, see the Penn State publication *Pennsylvania Woodlands 7: Dead Wood for Wildlife*.

Fallen logs of various sizes, stumps, cut tree tops, and brush piles also can provide cover for wildlife.

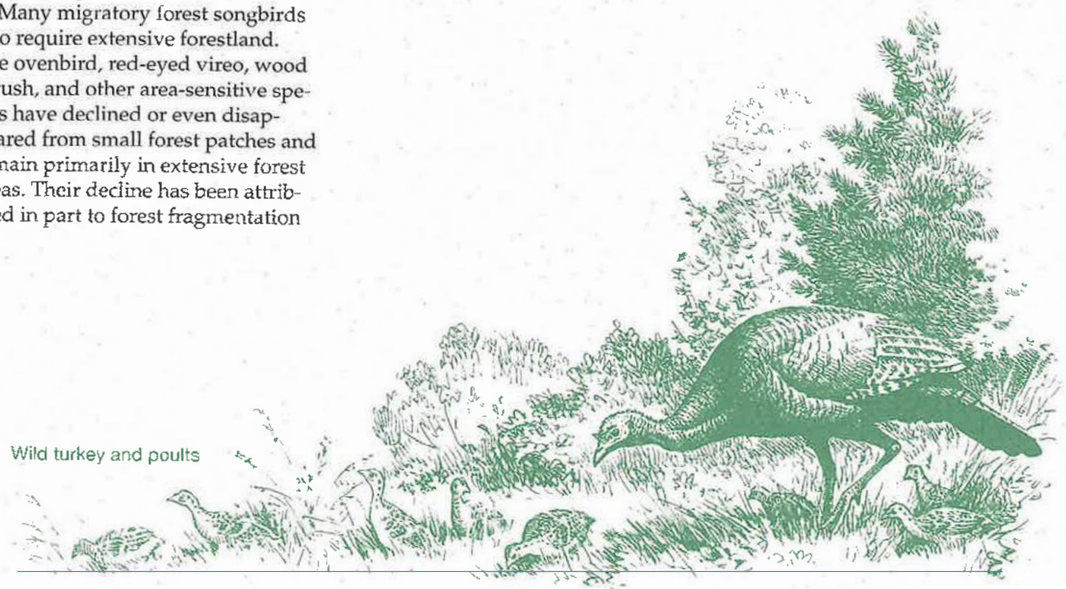
Wood thrush

SPACE

In addition to food and cover, each wildlife species requires space in which to live. This space, referred to as an individual's home range, must be large enough to provide sufficient food, cover, and water to support the animal. Some species, such as the goshawk, have large home ranges and therefore require large continuous areas of forest. Other species, such as many amphibians and reptiles, have poor dispersal abilities and are unable to traverse great distances over terrain with little cover. A simple dirt road, a clearcut, or an agricultural field, for example, may mean the difference between life and death for a dispersing salamander. These species require continuous tracts of forest, unbroken by large clearcuts or agricultural and suburban development.

Many migratory forest songbirds also require extensive forestland. The ovenbird, red-eyed vireo, wood thrush, and other area-sensitive species have declined or even disappeared from small forest patches and remain primarily in extensive forest areas. Their decline has been attributed in part to forest fragmentation resulting from human modification of the environment. When large forest areas are fragmented into several smaller forest areas by suburban development and agricultural activity, the proportion of edge habitat increases. Densities of predatory species such as the American crow, common grackle, raccoon, and opossum also increase. These species prey upon bird nests, eating both eggs and nestlings. Populations of the brown-headed cowbird, a brood parasite, also increase. Cowbirds never build their own nests but instead lay their eggs in the nests of other birds, which often raise cowbird young instead of their own. Large numbers of nest predators and cowbirds have an especially detrimental effect on the reproductive success of migratory songbirds. To breed, many of these species travel long distances from areas such as South and Central America all the way to the Northeastern United States. Because they expend a great deal of energy and time during migration, these species generally nest only once a year and lay fewer eggs than species that live in Pennsylvania year-round. Migratory forest songbirds are usually associated with large forest tracts, because only within extensive forested areas are interior habitat located far enough away from habitat edges.

Although some species require extensive areas of forest, others need a mixture of habitat types. The wild turkey, for instance, requires several habitat types. A flock of turkeys may use thousands of acres during the year to meet its needs. During the spring and summer, turkeys feed on grasses, forbs, seeds, and insects found in forest clearings. In fall, they feed in mature forests containing mast-producing trees, such as oak, beech, and cherry. Fruits of dogwood, grape, crabapple, and cherry also serve as fall food for turkeys. In winter, they rely on mast and fruits left over from autumn and on green plants and insects found in and around spring seeps, where groundwater emerges at the surface along hillsides and lower slopes. Landowners with small acreages cannot expect to provide all of the habitat requirements for wild turkeys. However, you may attract them to your land by providing mature, mast- and fruit-producing trees and shrubs, maintaining a forest clearing, and keeping spring seeps intact on your property.



Wild turkey and poults

WATER

Water is essential for the survival of all wildlife. Some species can obtain water from the food they eat and from dew. Others require a water source. Your woodland may have various types of wet areas. These are valuable to all wildlife species and essential to some species. Streams and rivers, forested wetlands, and spring seeps are three habitat types that supply water to wildlife in Pennsylvania forests.

Wooded areas adjoining streams and rivers are unique habitat known as riparian zones. These areas add diversity to the forest, attracting a myriad of amphibians and an abundance of waterfowl, such as the belted kingfisher, green heron, and Louisiana waterthrush. In addition, riparian zones protect streambanks from erosion and shade the water, thereby preventing stream warming.

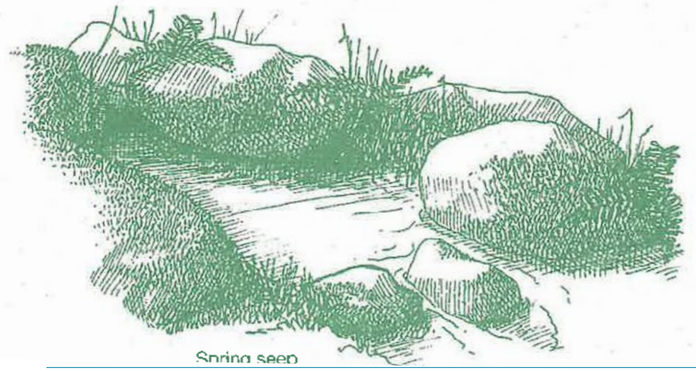
Forested wetlands not only supply water essential to wildlife but also provide food and abundant woody and herbaceous vegetation used for cover. The combination of increased availability of water, abundant and diverse foliage for nesting and cover, and increased invertebrate food supplies attracts a higher density of birds than do upland sites, including the common yellowthroat and the prothonotary warbler. Forested wetlands are important nesting and brood-rearing habitat for woodcocks, red-shouldered hawks, and barred owls, as well as black ducks, mallards, and wood ducks.

Many mammals likewise inhabit forested wetlands. Small mammals, such as meadow voles and shrews, are common in these areas, providing prey for larger mammals, hawks, and owls. Minks, weasels, raccoons, and beavers also make use of the resources found in forested wetlands. Black bears spend a great deal of time feeding on skunk cabbage and blueberries growing in wooded wetlands during spring and summer. In winter, white-tailed deer find protection in wet forest areas sheltered from the wind. Since snow is not as deep here as in the surrounding upland forest, deer can uncover forbs and grasses to eat.

Spring seeps are common in Pennsylvania forests. Seeps often remain free of snow throughout the winter since the temperature of the groundwater is above freezing. Vegetation and insect larvae found here provide food for wildlife in winter, when food is otherwise scarce or unattainable. The wild turkey, for example, relies on spring seeps for winter food when snowfall is heavy.

Spring peeper

Vernal ponds are small wetlands often found in clusters. While they typically are dry in the summer and fall, they contain water during the winter and spring. These ponds may be found in upland forested areas or may occur along streams and rivers, receiving a fresh supply of water when water levels rise and then recede. The ponds are critical to the reproductive cycle of many organisms in Pennsylvania. Fairy shrimp, caddisflies, fingernail clams, and other aquatic invertebrates have adapted their breeding cycles to these ponds. Many amphibians, including spotted salamanders, American toads, wood frogs, and spring peepers, court and lay eggs in these ponds, then return to the woods for the rest of the year. During the breeding season, thousands of individuals may be found in a pond at one time. Despite their small size, vernal ponds provide a rich supply of food for many organisms and may support the greatest biomass of vertebrates in the forest.



Spring seep

Raccoon

Forest Succession and Wildlife

If undisturbed, an open field over time will be invaded by shrubs, which in turn will be replaced by saplings, young trees, and eventually a mature forest. Foresters often refer to these phases as the grass and forbs stage, shrub and sapling stage, pole stage, and mature forest. In general, plant communities progress in an orderly and predictable manner known as forest succession. However, the rate of forest succession on any one property is difficult to predict and may vary with soil conditions, topography, frequency of natural disturbance, number of deer, and amount of competing vegetation.

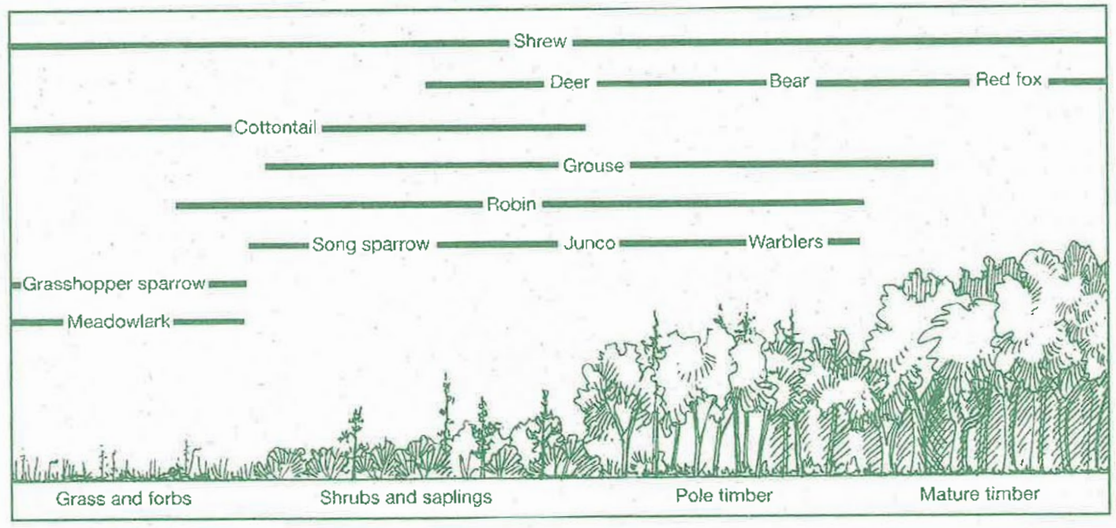
The abundance and kinds of wildlife also change as a forest matures, because the quantity and quality of food, water, cover, and space are changing. Young forests, for example, often have an abundance of berry-producing shrubs and brushy cover, but few hard mast (acorns, hickory nuts) or cavity trees. As a result, species that feed on acorns (e.g, squirrels) or nest in large decaying trees (e.g., pileated woodpeckers) are much more abundant in older forests.

Other kinds of wildlife, including the white-tailed deer, use several stages of plant succession. Deer need the cover provided by thickets of shrubs and saplings, but they also feed extensively on acorns found under trees in a mature forest and seek out succulent green vegetation and grains in agricultural fields. Providing the correct stage or stages of plant succession in the right amount and distribution is the key to attracting wildlife to your property. Whether you wish to manage your land for a variety of wildlife species or for a single species, you will need to know what stage(s) of forest succession each species depends on for food and cover. The table on page 9 lists various wildlife species and the stage(s) of succession each species requires to live.

VERTICAL AND STRUCTURAL DIVERSITY

As a forest changes through succession, its structure also changes. Vertical structure is important because in a forest with a well-developed overstory, understory, shrub, and herbaceous strata, a diverse array of plants and animals can coexist. Maintaining vertical diversity within the forest can help to guarantee that a large variety of wildlife will be present. Many wildlife species, particularly birds, divide the habitat vertically. For example, ovenbirds, scarlet tanagers, and chickadees are all found in mature forests, but ovenbirds feed mostly on the ground, tanagers prefer the canopy top, and chickadees like intermediate heights. More species are able to coexist in a forest with multiple layers than in a forest where all the trees are the same height. Vertical diversity is greatest in forests with a large variety of trees of different ages. Within similar forests, vertical diversity is greater in areas with few deer. Large deer populations often browse and remove the lower stratum of vegetation.

Structural diversity refers to the variety, size, and shape of both living and nonliving organisms. Large standing and fallen dead trees, plant species diversity, and vertical diversity all contribute to structural diversity in the forest. Many elements of structural diversity, such as rotting logs and snags, provide hiding places for wildlife and attract insects and fungi which serve as food for wildlife. These elements make a very large contribution to the species richness and ecology of an area.



Red-spotted newt

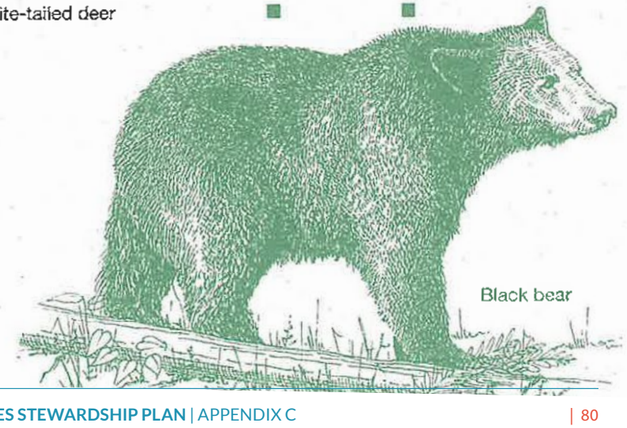
Black rat snake

Pileated woodpecker

Cottontail rabbit

PREFERRED FOREST SUCCESSIONAL STAGES USED BY SELECTED WILDLIFE SPECIES

SPECIES	GRASS AND FORBS	SHRUBS AND SAPLINGS	POLE STAGE	MATURE FOREST
Amphibians				
American toad	■	■	■	■
Gray tree frog		■	■	■
Red-back salamander			■	■
Slimy salamander			■	■
Red-spotted newt			■	■
Wood frog		■	■	■
Reptiles				
Eastern box turtle	■	■	■	■
Eastern garter snake	■	■	■	■
Northern redbelly snake			■	■
Smooth green snake	■	■		
Wood turtle	■	■	■	■
Black rat snake	■	■	■	■
Birds				
American woodcock	■	■		
Black-capped chickadee		■	■	■
Chipping sparrow	■	■		
Eastern meadowlark	■			
Grasshopper sparrow	■			
Great-horned owl	■			■
Ovenbird				■
Pileated woodpecker				■
Red-eyed vireo			■	■
Red-tailed hawk	■			■
Ruffed grouse	■	■		■
Rufous-sided towhee		■		
Song sparrow		■		
Wild turkey	■			■
Mammals				
Black bear				■
Cottontail rabbit	■	■		
Gray squirrel				■
Meadow vole	■			
Red fox	■			■
White-tailed deer	■	■		■



Black bear

Big brown bat

Management Objectives and Stewardship Plans

For help in developing a management plan that enhances wildlife habitat, you should contact a professional wildlife biologist. These resource professionals can help you evaluate the wildlife potential of your property and develop a workable management plan. Names of wildlife biologists who assist in developing forest stewardship plans are available from your local Bureau of Forestry service forester. The various goals a landowner may pursue when managing for wildlife are discussed below.

SPECIES OF SPECIAL CONCERN

When managing forests, you should give primary consideration to species and habitats that are rare in Pennsylvania. Species of special concern include the snow trillium (plant), giant swallowtail (insect), eastern mud salamander (amphibian), northern goshawk (bird), and northern long-eared bat (mammal). In all, more than 600 plant species are of special concern, along with about 150 vertebrate and 250 invertebrate species. These include aquatic species and species that inhabit open areas and wetlands, as well as woodland species. The Pennsylvania Game Commission, the Pennsylvania Fish and Boat Commission, and the Pennsylvania Bureau of Forestry can provide information on specific species or rare habitats that are present or have existed historically in your region. The Game Commission is responsible for managing threatened and endangered birds and mammals, while the Fish and Boat Commission is responsible for reptiles, amphibians, and aquatic species. The Bureau of Forestry manages threatened and endangered plants and maintains the Pennsylvania Natural Diversity Index (PNDI), which catalogs the existence of species of special concern throughout the state. Properties for which Forest Stewardship Plans are written are entered into the PNDI database to determine whether there is a record of a threatened or endangered plant or animal species existing on or near the site. If you think that you may have a species of special concern on your woodlands, you should confirm this with a resource professional and make every effort to protect the species and its habitat.

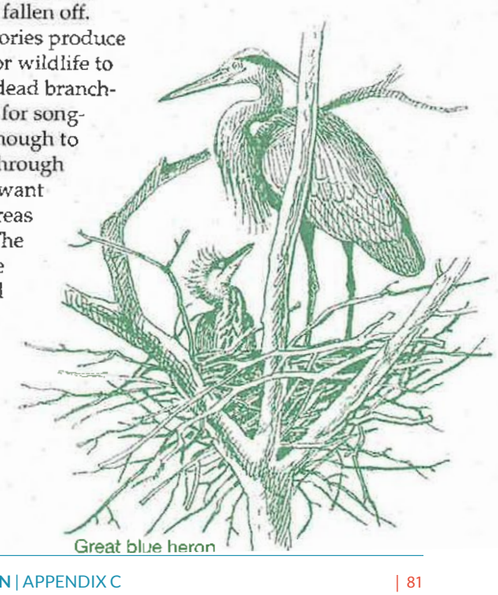
Habitats and communities of special concern also should be protected. Wetlands, a special habitat in Pennsylvania, perform many valuable functions. They control floods, improve water quality, and provide habitat for many species of special concern. Other areas of special concern might include a group of trees where great blue herons are nesting. If your woodlands are a nesting site, or rookery, for these birds, you should minimize disturbance around the nesting colony. You might have a stand of old-growth forest or a single old, large tree on your property. These trees, called wolf trees, are very valuable to wildlife. Cavities form in their trunks at points where branches have died and fallen off. Large old oaks and hickories produce an abundance of mast for wildlife to eat. Insects that invade dead branches of wolf trees are food for songbirds. If you are lucky enough to have a stream running through your property, you will want to protect the wooded areas adjacent to the stream. The best way to protect these riparian areas is to avoid harvesting timber near streams. Wetlands, riparian areas, heron rookeries, old growth forest, and wolf trees are just a few examples of unique or rare features that you may want to protect.

FEATURED SPECIES

After making sure you have taken species and habitats of concern into consideration, you may decide to manage your woodland or a portion of your woodland to benefit one or more featured species. For example, you may wish to increase the amount of habitat on your property suitable for the ruffed grouse, a native game bird. Ruffed grouse thrive in forests subject to periodic disturbance. Optimum grouse habitat may be created by clearcutting in small, dispersed patches. Good habitat has the following characteristics:

- both food and cover within a 5- to 15-acre area
- brushy areas to provide cover and supply summer and fall foods
- mature forest stands with an understory of grape, greenbriar, hawthorn, witch-hazel, and dogwood to provide food in fall, winter, and spring
- dense stands of saplings to provide brood cover

Another species you may wish to emphasize in your management objectives is the gray squirrel, which prefers deciduous forests with a variety of tree species to provide a varied food supply. A forest that contains many mature mast-producing trees (e.g., oaks and hickories) and a



Great blue heron

Wild grape

Gray dogwood

Hawthorn

mixture of other tree and shrub species to supply food throughout the year will support an abundance of squirrels. Squirrels also require den trees for breeding and escape cover. Trees nearing maturity that have one or two openings into a cavity are best. If den sites are scarce on your property, you may erect artificial nest boxes. For information on how to construct boxes, see the Pennsylvania Game Commission publication *Woodworking for Wildlife*.

Managing for a featured species often has tradeoffs. Species whose habitat requirements are similar to those of the featured species will benefit, while those with different habitats will not. If your property is large enough, you may be able to create a balance by managing different parts of your property for different species. If your property is small, you may want to discuss your plan with your neighbors to see if you can develop a larger cooperative plan.

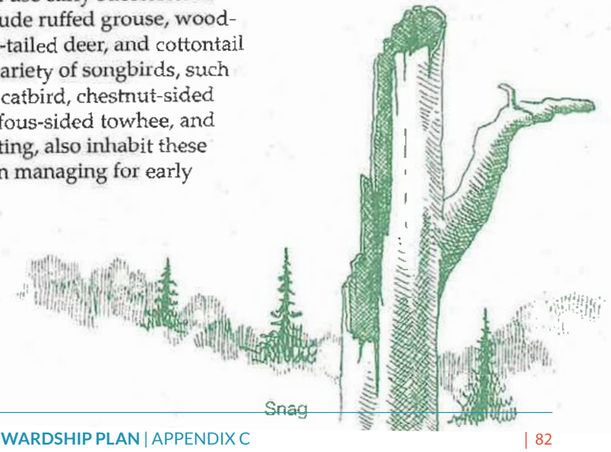
GROUPS OR GUILDS

Another option is to manage your forestland to emphasize a particular guild, or group of species that uses the same environmental resources in a similar way. Guilds may require the same cover type, age class, habitat component, or a combination of these factors. For example, you may wish to manage your property for species requiring early successional stages of forest habitat. This habitat, which consists of young trees, shrubs, and vines, is created by clearcutting a portion of forest. Species that use early successional habitat include ruffed grouse, woodcock, white-tailed deer, and cottontail rabbits. A variety of songbirds, such as the gray catbird, chestnut-sided warbler, rufous-sided towhee, and indigo bunting, also inhabit these areas. When managing for early

Gray squirrel

successional habitat, cutting must take place every five to ten years in order to maintain brushy cover and retard natural succession.

Another guild you may choose to emphasize in your management plan is migratory forest songbirds, which require large areas of forest. Unlike early successional species, many migratory forest songbirds, including the ovenbird, red-eyed vireo, wood thrush, and many forest warblers, require a different management approach. Many of these species are adversely affected by forest fragmentation and the resulting creation of edge habitat. Area-sensitive songbirds tend not to reproduce well along habitat edges. Management recommendations for these songbirds emphasize maintaining



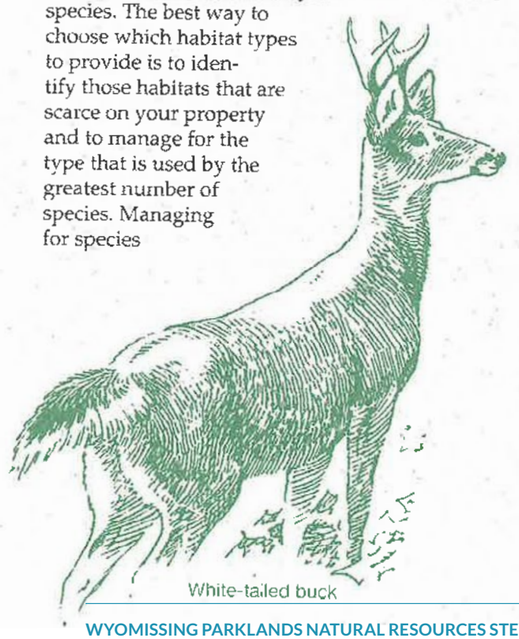
Snag

extensive areas of contiguous forest and minimizing creation of edge habitat. Maintaining forest tracts in compact shapes, such as a circle or square instead of linear patches of woods, maximizes forest interior habitat and minimizes edge. In addition, uneven-age management instead of clearcutting minimizes the creation of openings. If you plan to clearcut, you should cluster cuts near existing edges and openings to minimize the creation of new edge habitat.

Early successional species and area-sensitive species are just two guilds you may choose to manage on your property. Many other choices exist, including cavity-nesting species, mast-consuming species, canopy-nesting species, insectivorous species, ground-foraging species, bark-foraging species, and a host of other groups. Some guilds can be managed in conjunction with others, while some are mutually exclusive.

SPECIES RICHNESS

Forest landowners may choose to manage for species richness, or the greatest number of species. This goal is best achieved by creating a mosaic of age class and cover type combinations while also maintaining large areas of mature forest. By creating a diversity of habitat types, you can satisfy the needs of a variety of species. The best way to choose which habitat types to provide is to identify those habitats that are scarce on your property and to manage for the type that is used by the greatest number of species. Managing for species richness is difficult unless your property is very large. Also, while creating forest openings may result in a short-term increase in variety of wildlife, if cuttings cannot be sustained at ten-to-fifteen-year intervals, early increases in species richness will be short-lived.



White-tailed buck

ENHANCING WILDLIFE FOOD AND COVER

No matter which management objective you choose, the primary way to manage for wildlife is to alter the amount of food and cover present. Once you decide which wildlife species you will be managing for, you may enhance food sources already present on your property through habitat manipulation or you may plant additional native food sources. Practices that enhance wildlife foods are described in the section on cost sharing for wildlife. If enough food sources already grow on your land in sufficient quantities to support the species you have chosen, your best option may be a hands-off approach to management.

Providing a source of year-round cover is an excellent way to enhance your property for wildlife. In many parts of Pennsylvania, evergreen cover is in short supply. If your area has too few evergreens, you may wish to plant native conifers (e.g., white pine or hemlock) or selectively remove other trees that are shading the evergreens. This will release the conifers and allow them to grow more rapidly.

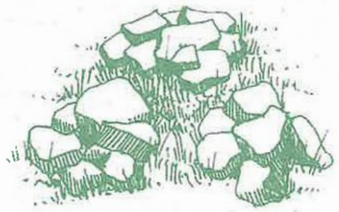
Maintaining or creating cavity trees is another way to improve the quality of cover on your property. Retain cavity trees throughout your woodlot. Large trees with large cavity holes are particularly valuable. If your property contains few cavity trees, you may maintain trees that have the potential to become cavity trees. One of the easiest ways to improve the cover on your property is to build brush piles. For more information on how to construct a brush pile, refer to the information in the box on this page.

In areas where woodlots are isolated from one another by agricultural fields or suburban developments, maintaining or establishing corridors of trees and shrubs that connect the forest patches will add additional food and cover and may facilitate movement of wildlife from one forested area to another. Corridors of trees and shrubs also can be planted to connect isolated patches of wildlife habitat. For most species, the wider the corridor, the better.

HOW TO BUILD A BRUSH PILE

Brush piles may be constructed using one of three types of bases. The first type consists of four large logs placed one foot apart and parallel to each other, with four more logs of the same size stacked perpendicular to the first logs. The second type of base is made by placing large stones in three piles that form a triangle. The third type of base is constructed of logs and stones by placing four large logs about one foot apart and parallel to each other, then placing large, flat rocks across the top of the logs. After you have built the base of the brush pile, add brush to the top starting with the larger limbs first, then adding smaller pieces until the pile is about 6 feet high and 6 feet wide.

Log base



Stone base

Log and stone base

Brush pile

INCREASING HUMAN/WILDLIFE INTERACTIONS

Regardless of which wildlife species or groups of species you decide to emphasize on your woodland, you may wish to increase opportunities for viewing wildlife by providing trails, forest openings, or nest boxes.

- *Trails:* One way to increase your chances of seeing wildlife is through a wildlife viewing trail. A well-planned trail can provide easy, quiet access to a variety of sites on your property so that you may observe wildlife unobtrusively. For convenience, the trail should form a loop beginning and ending in the same general location. Numerous bends and curves should be incorporated to add an element of surprise and increase the likelihood of flushing a grouse or catching a deer off guard. To maximize the variety of wildlife you may encounter, develop trails through various cover types and near key points of interest, such as a wetland or clump of evergreens. Logging roads may be incorporated as part of the trail.
- ***Forest openings:*** To provide wildlife food, old logging roads as well as small forest openings can be seeded with native grasses, such as little bluestem, broom-sedge, switchgrass, or Indian grass. These grasses attract wildlife and increase opportunities for human-wildlife interactions by providing forage for deer and seeds for birds and small mammals. In turn, small mammals attract birds of prey, such as hawks and owls. Insect life abounds in tall grasses and provides food for wild turkey and ruffed grouse, particularly in summer when poults feed almost exclusively on insects.
- ***Nest boxes:*** Providing nest boxes for cavity-nesting birds and animals is a popular activity for Pennsylvanians who enjoy viewing wildlife. Boxes may be placed at the interface between woodland and farmland, around stands of evergreen trees, along wooded stream bottoms, near woodland clearings, or within recent timber harvests. You may attract species such as the black-capped chickadee or the barred owl. Eastern bluebirds, gray and fox squirrels, house wrens, white-footed mice, screech owls, and flying squirrels also use nest boxes. For more information on construction and placement of nest boxes, consult the Pennsylvania Game Commission publication *Woodworking for Wildlife*.

INCORPORATING WILDLIFE INTO TIMBER HARVESTING PLANS

One of your objectives in owning forestland may be timber management. If this is the case, you may still take steps to benefit wildlife. Retaining clumps of conifers or mast-producing trees, for instance, will provide food as well as roosting and nesting cover for wildlife. Dead trees and live trees with cavities should be left to provide shelter and nest sites for species that use cavities or dead wood. Seeding log landings and roads will create excellent wildlife feeding areas. Leaving slash will provide cover for many species. By retaining buffer zones along streams and waterways, you can provide excellent wildlife habitat while protecting water quality. For more information on incorporating wildlife into timber harvesting plans, consult the Pennsylvania Game Commission publication *Timber Sales and Wildlife*.

Bluebird nesting box

Cost Sharing for Habitat Enhancement

Various forest management activities may be implemented to help ensure the perpetuation of a diversity of native wildlife populations. If improving your property for wildlife is one of your management objectives, you may be eligible to receive financial assistance through cost-share programs. Contact your Department of Conservation and Natural Resources Bureau of Forestry service forester or your local Natural Resources Conservation Service office.

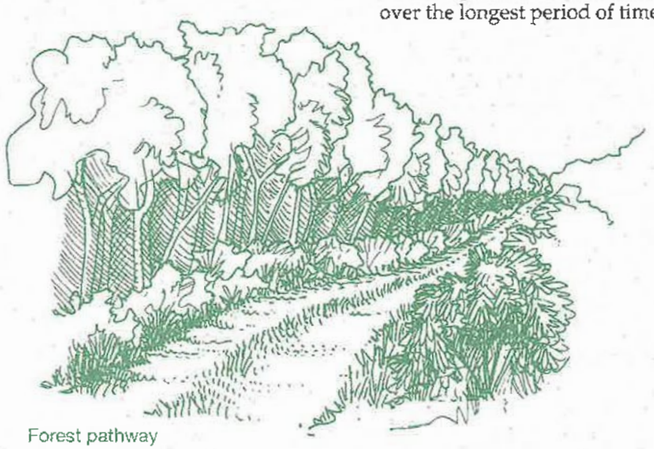
Summary

There is no one correct way to be a forest steward or to manage your forest for wildlife. An unlimited number of management options exist, none of which will benefit all wildlife species. Every management decision has trade-offs. For example, clearing a large portion of forest is not compatible with managing for high mast production to provide food for squirrels, blue jays, and turkeys. When deciding how to best manage your forest, try listing all of the positive and negative effects that each management alternative will have on wildlife before implementing your stewardship plan.

Whatever your specific interests, proper wildlife stewardship is based on managing forests to ensure that native species persist for the enjoyment of future generations. To succeed as a wildlife steward, view your property as just a small piece of a larger puzzle and strive for management options that will provide the most benefits over the longest period of time. Try to use your property to add to regional wildlife diversity whenever possible. This means managing your forest for habitat types, habitat features, and wildlife species that are scarce within Pennsylvania or the Northeast, even if that feature is common on your property. Avoiding or reducing permanent forest fragmentation also can enhance regional diversity. For example, establishing connecting corridors (e.g., fence rows or riparian corridors) between two areas of forest on your property or between areas of forest on your property and a neighbor's land can reduce the effects of fragmentation, as can planting to reduce edge.

Whether you start with a small project, such as putting up a birdhouse, or a major habitat-enhancement project, keep a record of changes you observe in the species of wildlife on your property. Evaluate the success of your project. Were you able to see more wildlife? Did the project benefit the species you expected it to benefit? Use this information to modify future plans.

Finally, always try to incorporate wildlife needs into any timber management plan. Many wildlife resource professionals in Pennsylvania can help you do this in a way that meets your economic objectives. By taking into account the needs of wildlife on your property, you will be rewarded with endless hours of recreational enjoyment and the satisfaction of knowing that you've helped to ensure that future generations benefit from the diversity of wildlife found in Pennsylvania forests today.



Forest pathway

Forest opening

Killdeer

Additional Reading

PENNSYLVANIA WILDLIFE

Brauning, D.W. (ed.) 1992. *Atlas of Breeding Birds in Pennsylvania*. University of Pittsburgh Press.

Brett, J.J. 1991. *The Mountain and the Migration—A Guide to Hawk Mountain*. Hawk Mountain Sanctuary Association.

Merrit, J.J. 1987. *Guide to the Mammals of Pennsylvania*. University of Pittsburgh Press.

Pennsylvania Birds. A quarterly journal focusing on Pennsylvania birds. For information on subscriptions, write Pennsylvania Birds, 2469 Hammertown Rd., Narvon, PA 17555-9726.

Santner, S.J., D.W. Brauning, G.P. Schwalbe, P.W. Schwalbe. 1992. *Annotated List of the Birds of Pennsylvania*. Ornithological Technical Committee. Available from Pennsylvania Birds. $6.00.* (Address listed above.)

Shaffer, L.L. 1991. *Pennsylvania Amphibians and Reptiles*. Available from the Pennsylvania Fish and Boat Commission, P.O. Box 6700, Harrisburg, PA 17106-7000.

The Pennsylvania Game Commission has numerous publications on Pennsylvania wildlife. For more information and/or a list of publications, write to The Pennsylvania Game Commission, 2001 Elmerton Avenue, Harrisburg, PA 17110-9797.

FORESTS AND WILDLIFE

DeGraaf, R.M., and D.D. Rudis. 1987. *New England Wildlife: Habitat, Natural History, and Distribution*. USDA Forest Service Northeastern Forest Experiment Station. Gen. Tech. Rep.108.

Harris, L.D. 1984. *The Fragmented Forest: Island Biogeography and the Preservation of Biotic Diversity*. University of Chicago Press.

Henderson, C.L. 1987. *Landscaping for Wildlife*. Minnesota Department of Natural Resources, St. Paul, MN 55155-4007.

Hunter, M.L. 1990. *Wildlife, Forests and Forestry*. Prentice-Hall.

Martin, A.C., H.S. Zim, and A. L. Nelson. 1951. *American Wildlife and Plants, A Guide to Wildlife Food Habits*. Dover Publications, Inc.

Rodiek, J.E., and E.G. Bolen (eds.). 1991. *Wildlife and Habitats in Managed Landscapes*. Island Press.

Golden, Petersen, and Audubon field guides are available at most bookstores.

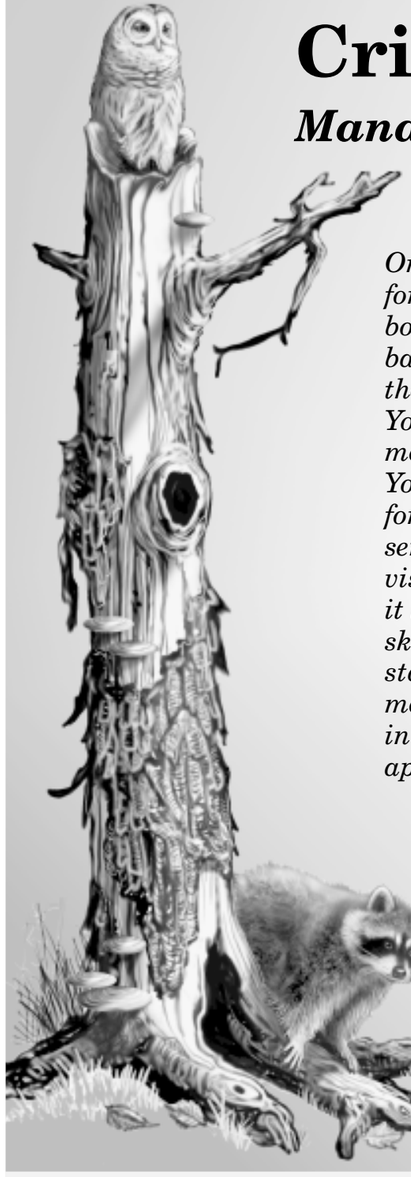
FOR MORE INFORMATION

Numerous publications on wildlife and other topics are available through the Natural Resources Extension office in Penn State's School of Forest Resources. Call 800-235-9473 to request a list of free publications or visit **rnrext.cas.psu.edu/publications.htm**.

Red fox

Appendix D: Vegetative Management

Dead Wood Management
Hazard Tree Monitoring
Invasive Plant Management
Invasive Plan Information Sheets
Mid Atlantic Meadow
Native Plant Materials



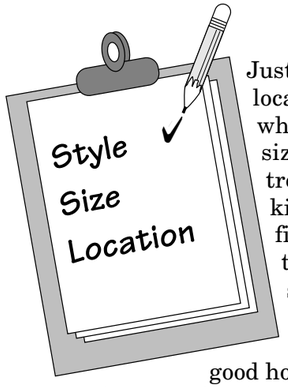
Critter Condos

Managing Dead Wood for Wildlife

On a sunset stroll through your woods, you find a forest full of activity...full of life…a snowshoe hare bounds for cover, a red squirrel scampers up a balsam fir, a blue jay scolds from a branch above. As the curtain of darkness falls, your senses heighten. Your nose intercepts the pungent, earthy odor of leaf mold, fungi, and rotting wood drifting on the breeze. Your ears snatch a few "who cooks for you, who cooks for you all?" notes of a barred owl. Suddenly, you sense movement overhead! Turning, your peripheral vision catches the floating form of a flying squirrel as it leaps and glides from a snag. The smooth, barkless skeleton of this dead tree stands stark and whitewashed in the moonlight. It's then you realize that in your forest, even dead things have appeal…a life of their own….

Snags. By night, they look ghostly in the misty, moonlit darkness. In reality they teem with life. Over 70 kinds of Wisconsin mammals, birds, reptiles and amphibians, not to mention swarms of insects, spiders, millipedes and other invertebrates use snags…dead or dying trees. These critter condos provide den, nest and feeding sites, as well as sites for food storage, perching, preening and courtship rituals. This publication illustrates the variety of dead wood that benefit wildlife and the ways you can manage for it.

The Critter's Criteria



Just as the style, size and location of housing affect where you live, the style, size and location of dead trees determine what kinds of wildlife you'll find in, on or under them. For example, snags—which are ***standing*** dead and dying trees —make good homes for cavity nesters such as woodpeckers, bluebirds, nuthatches and squirrels. ***Downed*** trees or logs provide great hiding places for salamanders, snakes, deer mice, weasels and chipmunks. If large enough, these can make good bear dens. Riverside snags, with their tangled mass of gnarled roots provide shelter for brown trout and burrowing sites for muskrats. Their upper limbs may be used for nesting by herons, egrets, bitterns and cormorants. When managing your land for snags, consider where you live in the state. This will determine what wildlife are most likely to inhabit the dead wood on your land. The more you know about dead wood and the types of wildlife that depend on it, the better you'll be at providing homes for wildlife—in essence, you'll be moving one step closer to becoming a wildlife realtor!

☑ **Style:** *Hard vs. Soft Snags*

Snags come in two styles: hard and soft. Both are important to wildlife. ***Hard snags*** have rotten centers, a solid exterior and usually a few limbs attached—they make the best den trees. As snags decay, the wood softens and becomes punky and the limbs gradually fall off. ***Soft snags***, with their pulpy wood fibers, make good forage sites for insect-eating birds and excellent nest sites for woodpeckers and songbirds such as black-capped chickadees.

A tree's characteristics determine its snag and cavity potential. For example, sugar maple, elm, black and white oak, hickory and butternut are excellent cavity trees with high wildlife value. These hardwood trees grow to large sizes, decay slowly, and produce hard, upright and long-lived snags. The beech tree, common along Lake Michigan and Green Bay, also makes a good cavity tree because it's prone to heart rot.

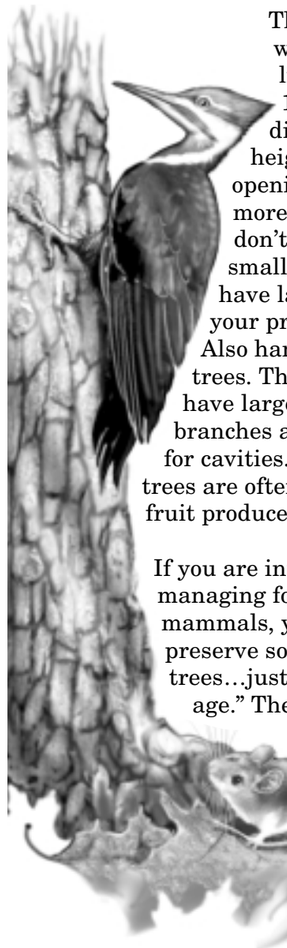
Softer trees, like aspen and birch, have short lifespans and rot quickly. These rapid growers make superior soft snags of high value to wildlife since they produce cavities more quickly than hardwoods and provide habitat for swarms of insects which feed many forest songbirds.

Snags of medium value to wildlife come from white ash, basswood, red maple, white pine, red oak, yellow poplar, box elder, black cherry and black walnut. Coniferous snags generally do not last as long as hardwoods, though pine and tamarack make excellent nest and perch sites for osprey when located next to water.

Ever "snag" your line while fishing? As frustrating as it is to lose a lure, every good angler knows that fallen logs in a pond or stream provide trout, bass and other fish with a sheltered, shady place to rest and feed. Downed logs in or near water are especially vital and should be spared at all costs. And while you're cutting your line free, you'll probably startle a few turtles lazily sun-bathing on a log…kerplop….

☑ **Size:** *Small vs. Large Snags*

Human condos come in all sizes and so do critter condos. In general, the larger the snag, the more kinds of wildlife it can host. While small snags are important in their own right, they can only host small creatures such as the red-breasted nuthatch, downy woodpecker, house wren, bluebird and white-footed mouse. But large snags can suit small *and* large wildlife such as pileated woodpeckers and raccoons. Imagine the size of the log den needed for a black bear!



The best den trees, which can be either living or dead, are 15 or more inches in diameter at breast height (DBH) with den openings 4 inches or more. However, please don't discount the smaller den trees. If you have large den trees on your property, keep them! Also hang on to "wolf" trees. These forest giants have large sprawling branches and great potential for cavities. In addition, these trees are often abundant nut and fruit producers.

If you are interested in managing for larger birds and mammals, you will need to preserve some of the larger trees…just let them die of "old age." The pileated woodpecker, Wisconsin's largest woodpecker, needs a tree at least 20-22 inches DBH in order to excavate a nest cavity. Pine martens also need very large trees.

Larger cavity dwellers need large trees. The pileated woodpecker needs a tree at least 20-22 inches in diameter in order to excavate a nest cavity. Small cavity dwellers, like this mouse, can utilize both large and small trees.

☑ **Location:** *Forests, Waterways and Fields*

Snags are most commonly associated with forests. Many a forest mammal from bat to bobcat, bear, pine marten, porcupine, red squirrel, and gray fox use snags for dens and lookouts. So do many forest birds. Woodpeckers are the primary excavators. They drill out new homes in snags. When abandoned, these cavities become residences for other creatures like saw-whet owls, nuthatches and great-crested flycatchers. Besides woodpeckers, the only other bird that is a primary excavator is the black-capped chickadee. However, these diminutive birds, which lack the powerful chisel-like beak of woodpeckers, can chip out a cavity only in soft snags.

Snags located near waterways and wetlands also offer great benefits to wildlife. Wood ducks, hooded mergansers, common goldeneyes and buffleheads need tree cavities for nesting. Herons, egrets, eagles and ospreys build their nests high atop snags standing in or near water. Snags also serve as lookout towers for keen sighted fish-eating birds, such as belted kingfishers.

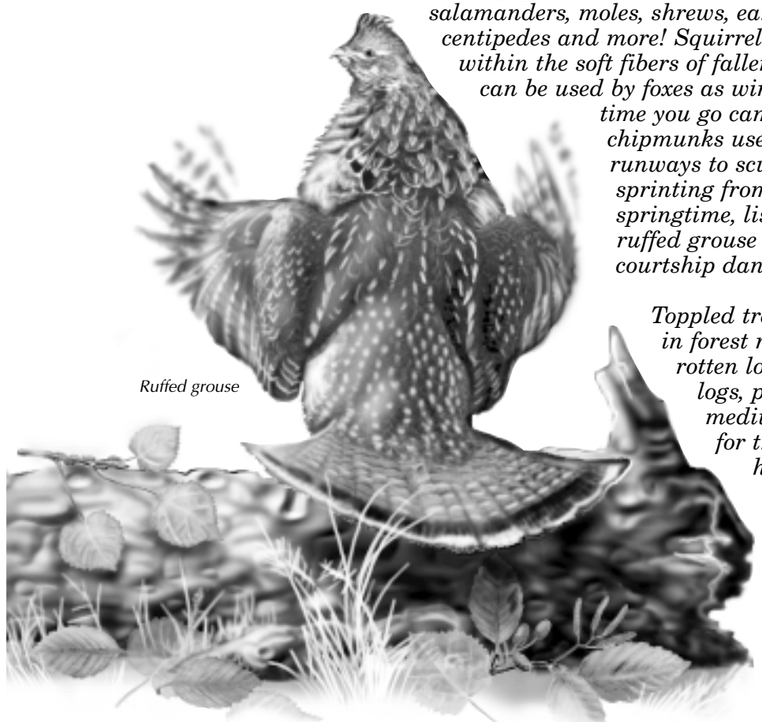
Snags located near open fields attract some types of hawks and owls. From high atop their lookouts, these birds use telescopic vision and radar-like hearing to detect mice, rabbits, squirrels and other prey. The flicker, unlike its woodland dwelling woodpecker relatives, prefers to nest in snags along woodland edges bordering farm fields or open grasslands. Kestrels and eastern bluebirds will often move into old flicker holes. Colorful bluebirds frequently nest in snags along farm fence rows and adapt well to wooden fence posts and nest boxes too.

Even backyard snags can attract house wrens, black-capped chickadees, red-bellied woodpeckers, and flying squirrels. If a snag poses no threat of dropping large branches on people—leave the snag in place. If you must cut a tree, leave it lie as a log.

Downed Wood: Let Sleeping Logs Lie

Once a snag has toppled over it doesn't lose its value to forest wildlife. Downed and rotting logs provide moist and earthy homes for salamanders, moles, shrews, earthworms, millipedes, centipedes and more! Squirrels will cache their food within the soft fibers of fallen trees. Hollow logs can be used by foxes as winter dens. The next time you go camping watch how chipmunks use downed logs as runways to scurry through the forest, sprinting from log to log. If it's springtime, listen for drumming ruffed grouse which perform their courtship dance atop mossy logs.

Toppled trees also are important in forest regeneration. Some rotten logs, known as nurse logs, provide a good growing medium, rich in nutrients, for tree seedlings to get a healthy start in life.



Ruffed grouse

Wisconsin Wildlife Dependent on Snags

Birds	Food	Nest	Perch
Wood Duck		✔	✔
Common Goldeneye		✔	
Bufflehead		✔	
Hooded Merganser		✔	✔
Common Merganser		✔	✔
Great Blue Heron		✔	✔
Black-crowned Night Heron		✔	✔
Double-crested Cormorant		✔	✔
Common or Great Egret		✔	✔
Belted Kingfisher			✔
Turkey Vulture		✔	✔
Merlin		✔	✔
American Kestrel		✔	✔
Barn Owl		✔	✔
Screech Owl		✔	✔
Barred Owl		✔	✔
Saw-whet Owl		✔	✔
Bald Eagle		✔	✔
Osprey		✔	✔
Red-tailed Hawk		✔	✔
Chimney Swift		✔	
Ruffed Grouse			✔
Common Flicker*	✔	✔	✔
Pileated Woodpecker*	✔	✔	✔
Red-bellied Woodpecker*	✔	✔	✔
Red-headed Woodpecker*	✔	✔	✔
Yellow-bellied Sapsucker*	✔	✔	
Hairy Woodpecker*	✔	✔	✔
Downy Woodpecker*	✔	✔	✔
Black-backed Woodpecker*	✔	✔	
Three-toed Woodpecker*	✔	✔	
Great-crested Flycatcher		✔	✔
Tree Swallow		✔	
Purple Martin		✔	✔
Black-capped Chickadee* (soft snags only)	✔	✔	✔
Boreal Chickadee*	✔	✔	✔
Tufted Titmouse		✔	
White-breasted Nuthatch	✔	✔	
Red-breasted Nuthatch	✔	✔	
Brown Creeper		✔	
House Wren		✔	

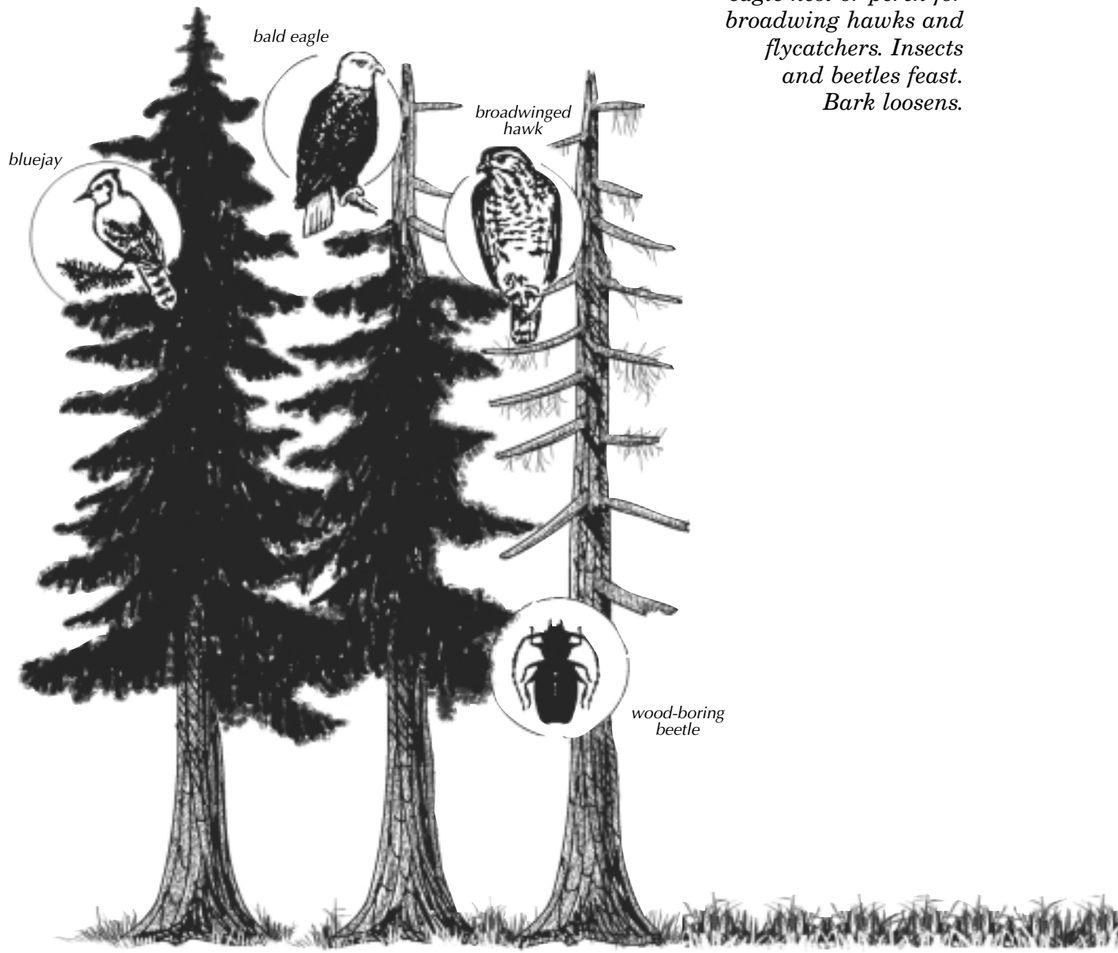
Birds, continued	Food	Nest	Perch
Winter Wren		✔	
Bewick's Wren		✔	
Carolina Wren		✔	
Eastern Bluebird		✔	✔
Prothonotary Warbler		✔	
Non-native Pest Birds			
Starling	✔	✔	✔
English Sparrow	✔	✔	✔
Mammals			
Opossum		✔	
Big Brown Bat		✔	
Little Brown Myotis Bat		✔	
Silver-haired Bat		✔	
Eastern Pipistrel		✔	
Red Bat		✔	
Hoary Bat		✔	
Black Bear	✔	✔	
Raccoon		✔	
Pine Marten		✔	
Fisher		✔	
Mink		✔(under logs)	
Gray Fox		✔	
Bobcat		✔	✔
Least Chipmunk		✔	✔
Eastern Chipmunk			✔ (logs)
Red Squirrel		✔	✔
Gray Squirrel		✔	✔
Fox Squirrel		✔	✔
Southern Flying Squirrel		✔	✔
Northern Flying Squirrel		✔	✔
Deer Mouse	✔ (stores food)		✔
White-footed Mouse		✔	
Porcupine		✔	
Snowshoe Hare		✔ (hollow logs)	
Reptiles and Amphibians			
Most Salamanders		✔ (under logs)	
Tree Frogs		✔	

***Primary Excavators:** Primary excavators drill their own cavities out of dead wood. Later these cavities can be used by other wildlife.

The Life Cycle of a Dying Tree

The decline of a tree begins when heart rot fungi invade the tree through a wound to the tree's bark. Slowly, the tree's core begins to rot—

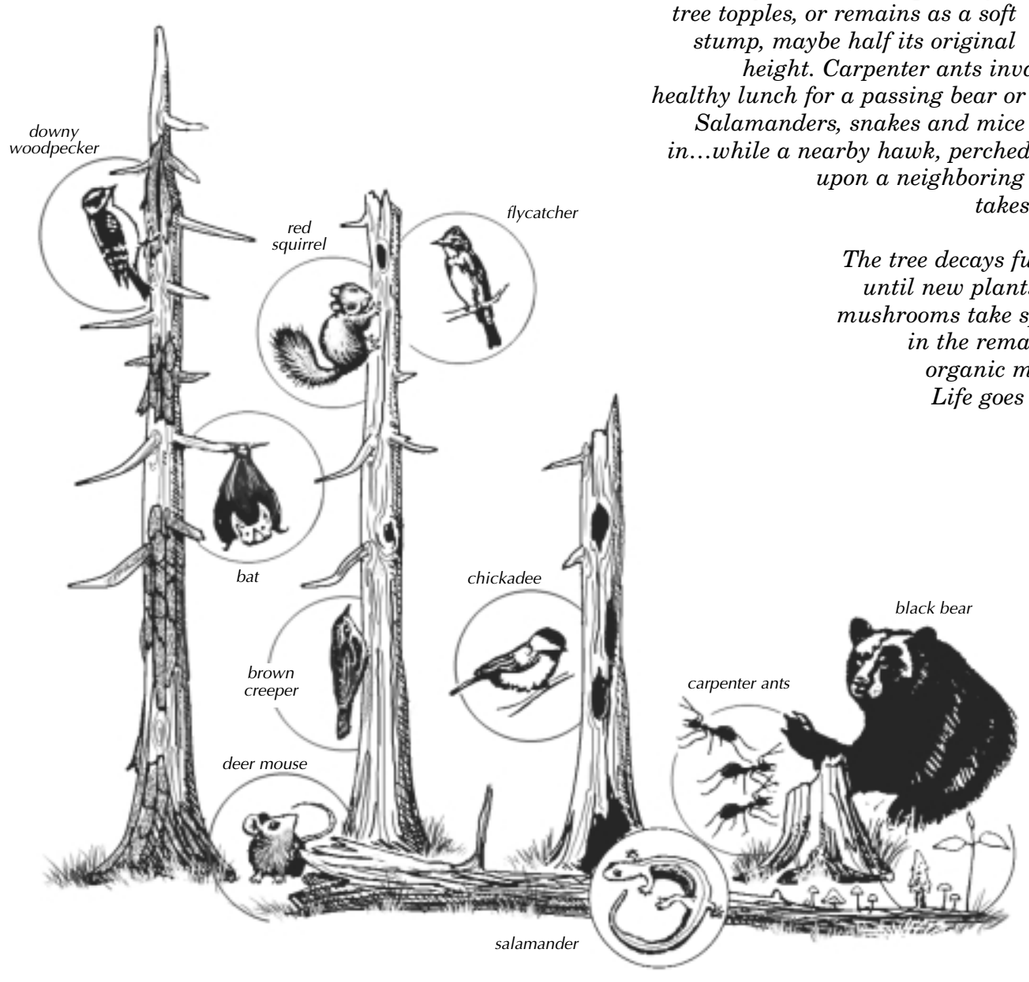
—barren branches appear, perhaps a good site for an eagle nest or perch for broadwing hawks and flycatchers. Insects and beetles feast. Bark loosens.



Woodpeckers soon follow, in search of food and potential home sites. Using their specialized bills, these birds chip away at the softened wood to create a cavity large enough for nesting. They raise their young, feed on the insects harbored within the decaying wood, and move on. The empty cavity then becomes home to another creature—perhaps an owl, squirrel, bluebird or bat.

Eventually, the battered ghost of a tree topples, or remains as a soft stump, maybe half its original height. Carpenter ants invade, a healthy lunch for a passing bear or coon. Salamanders, snakes and mice move in…while a nearby hawk, perched high upon a neighboring snag, takes note.

The tree decays further until new plants and mushrooms take sprout in the remaining organic matter. Life goes on….



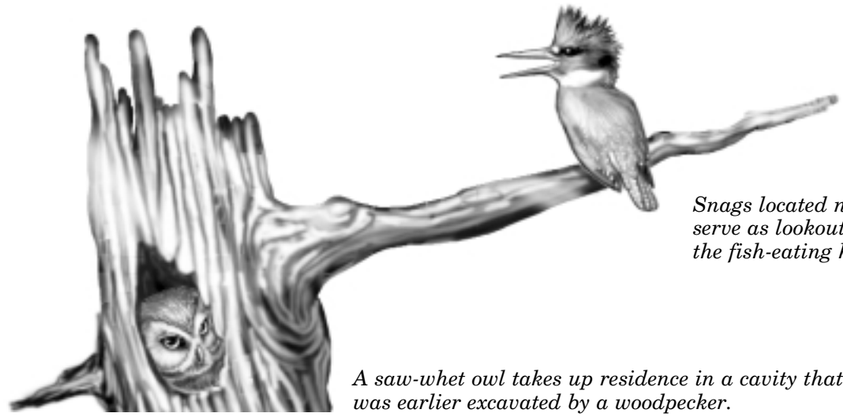
Insect Cafeterias

Snags teem with life. So, too, do diseased and fallen trees. Their loose bark and many nooks and crannies shelter a multitude of tiny creatures. Just turn over a rotting log and watch the insect activity. While the swarming, creeping, slithering tangle of ants, spiders, millipedes, centipedes, beetles, worms and slugs may seem unsettling to you, this ***insect cafeteria*** provides a nutritious lunch for many birds, mammals, reptiles and amphibians.

For example, pileated woodpeckers actively seek out elm and aspen trees infested with wood boring insects, and black bears lap up ants found in rotting logs. Brown creepers, small brown birds with curved beaks, search for insects hidden under loose bark as they spiral up the trunk. Other cavity dwellers are voracious insect eaters, though the insects they eat may not live in dead wood. For example, a house wren can feed 500 insects to its young every summer afternoon and a swallow can consume 1000 insects every 12 hours. In fact, these birds act as natural pesticides and help keep insect populations in check. So hang on to dead wood, it's good for wildlife and it does not always pose a threat to your woodland. For years, however, this was not the prevailing attitude.

In the past, loggers cut down all dead trees during timber harvests because they had limited value as timber, harbored forest insect pests, and were potential fire and safety hazards. Subsequently, cavity nesting bird populations have declined in recent years due to a loss of large trees with natural cavities.

Today, loggers, foresters and wildlife managers work together to protect these valuable trees and the insect cafeterias they harbor. It is now understood that insects and disease are natural parts of the forest and contribute to its stability, productivity and diversity of life.



Snags located next to water serve as lookout towers for the fish-eating kingfisher.

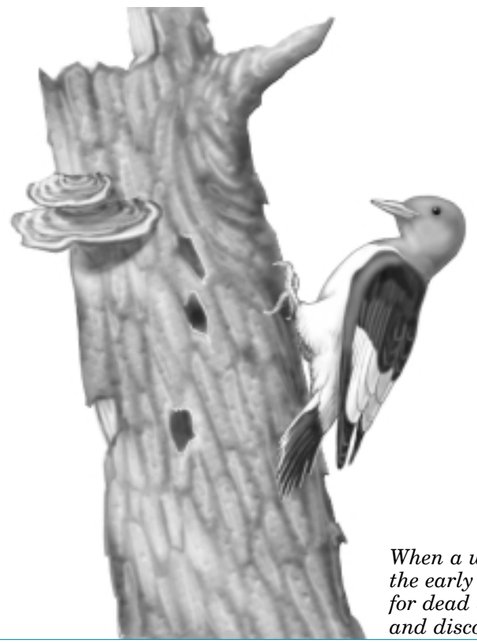
A saw-whet owl takes up residence in a cavity that was earlier excavated by a woodpecker.

Managing for Dead Wood

Seek Out Snags

Consider this, it takes about 40 years before completely cleared land becomes suitable for most woodpeckers and other snag dependent wildlife. It takes about 80 years before trees can support the larger cavity dwellers like raccoons and pileated woodpeckers. So, before you cut firewood or implement a timber stand improvement plan, you should identify existing *and future* snag and den trees.

Snags in advanced stages of decay are easy to identify—they stand out like skeletons. Diseased trees are a little harder to spot. Look for signs of injury or a rotten core—fungal heart rot. Dead branches, rotting branch stubs, fungal growth, old wounds, scars and discolored or soft bark are all signs of a dying tree. Also, look for woodpecker holes. Woodpeckers actually seek out trees with rotten cores. Always note the wolf trees.



When a woodpecker begins pecking away on a tree, it may be in the early stages of decay. Mark it as a future snag tree. Also look for dead branches and stubs, fungal growth, old wounds, scars and discolored or soft bark.

Create More Dead Trees

Look around you. If you find few snag or den trees on your property, create them yourself using some simple techniques.

To create a *snag*, select a living tree that's over a foot in diameter—the bigger, the better. Also, try to select a tree that's either diseased or severely deformed, or select those that are crowding more valuable trees that you would like to grow larger. Good trees for creating snags include sugar maple, black oak, white ash, elm and basswood. Take an axe and cut away a 3- to 4-inch band of bark around the entire circumference of the trunk. Make sure you remove the bark and cut well into the sapwood. This technique is known as *girdling*. It disrupts the flow of nutrients within the living layer of the tree found just underneath the bark. This causes the tree to die, and eventually become a snag.

Girdling disrupts the flow of nutrients within the living layer of the tree found just beneath the bark.

To create a *den tree*, cut off a 4- to 6-inch limb about 6 inches from the trunk, or chop out a section of bark 6 X 6 inches at the base of a suitable wolf tree. These open wounds should allow fungal disease to enter the tree and start the decay process. A natural cavity will form over the years. Elm, ash, boxelder, maple and basswood are especially prone to form natural cavities.

Since it takes several years for these practices to create suitable nest and den cavities, you may want to build and place nest boxes for birds and mammals until trees become available. Please realize, however, that properly locating and maintaining nest boxes is extremely important. Also, not all cavity nesters will use nest boxes. Chickadees, house wrens, wood ducks, purple martins, and eastern bluebirds readily accept them, whereas woodpeckers prefer to excavate their own nest cavity.

Save Snags When Cutting Timber

If you are managing your woodland for wildlife *and* timber production, consider the following rules of thumb:

- Preserve about one to six hard snags per acre and as many soft snags as possible.
- For every 20-acre woodlot, leave the following: four to five snags or den trees over 18 inches DBH, 30 to 40 snag or den trees over 14 inches DBH, and 50-60 snags over 6 inches DBH.
- Save at least one tree of any size per acre showing potential for den or snag tree development, especially those with broken tops, woodpecker holes or wounds.
- Never cut a wolf tree; they make excellent den trees.
- Check for wildlife before cutting a tree; avoid cutting inhabited trees.
- Leave most snags evenly spaced, though include a few patches where they are clumped together.
- Leave fallen snags on the ground to provide food and cover for wildlife.
- Cut green, rather than dead wood for firewood and cure for several years.

Management Techniques in Review

When managing your land for dead wood, keep in mind the following rules of thumb:

The Critter's Criteria:

Size: Bigger snags can accommodate more wildlife.

Style: Maintain hard and soft snags.

Location: Location often determines what wildlife will use it. Where you live in the state is also important.

Management:

Always plan for future snag and den trees.

Girdle diseased or deformed trees to create snags and

Manage for snags when timber cutting

Hazard Tree Monitoring Program

excerpted from

Stewardship Handbook
for Natural Lands in
Southeastern Pennsylvania

David B. Steckel
Holly M. Harper

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Natural Lands Trust

October 2008

should be used in preference to smaller ones and never use a dead tree. If markers are light-colored, dark trees should be used, and vice-versa. Markers should not be placed on trees or features that are important elements of a view or setting; they should be visible but not mar the visual character of the trail.

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

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

HAZARD TREE MONITORING PROGRAM

All landowners are required to make a reasonable effort to prevent trees within their property from causing injury or property damage (real or pretended ignorance does not diminish your responsibility or liability). This is best accomplished through a regular program of monitoring areas of high use such as public roads, adjacent properties with structures, and sites used for recreational (play areas, benches, boardwalk, bird blind, sleeping platforms, cabins) or educational (pavilion, bleachers, rustic amphitheater) activities. These areas should be monitored at least once each year and after major storm events. Ideally, the landowner should hire a certified arborist (list available from the International Society of Arboriculture, *see* **Resources**, *page 211 for contact information)* to perform the inspection. Private landowners who cannot afford an arborist or who wish to augment this annual inspection with their own

Holly Harper

A hazard tree situation

NATURAL LANDS TRUST HAZARD TREE PROGRAM

Policy

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

Implementation

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

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

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

Documentation

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

ongoing monitoring can attend workshops on hazard trees. Morris Arboretum *(see* **Resources**, *page 211 for contact information)* holds workshops on hazard trees on a regular basis. Public landowners could also consider training one or more staff members in the identification of hazard trees to reduce monitoring costs.

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

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

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

Regular monitoring followed by reasonable action will not only prevent potential injury or damage, it will help to significantly reduce the landowners liability if a tree does cause injury or damage.

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

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

On the previous page is the hazard tree program used by Natural Lands Trust on its 42-property preserve system in southeastern Pennsylvania and southern New Jersey.

Invasive Vegetation Management

excerpted from

Stewardship Handbook
for Natural Lands in Southeastern Pennsylvania

David B. Steckel
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Natural Lands Trust

October 2008

much higher edge-to-area ratio, and far less (or no) functional interior.

For many animal species, the area of contiguous habitat in a forest fragment must be above some threshold size for a population to sustain its viability for more than a few individuals. Minimum-area requirements vary greatly among species, but the total area of forest in a fragment is not all that matters. Many plants as well as animals are forest-interior specialists, unable to utilize the outermost zone of forest near the edge as habitat. The area inside a forest but near its edge is vulnerable to a host of detrimental outside influences, including increased wind, light, and heat, decreased humidity, and the influx of seeds of invasive introduced species. In general, ***fragmentation favors invasive species and works against native species***.

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

invasive species =
one that rapidly spreads and out-competes multiple native species

Invasive Plant Species

Another anthropogenic (caused by humans) problem encountered in the stewardship of natural lands in southeastern Pennsylvania—and increasingly recognized as a threat worldwide—is the presence of invasive plant species. Even though the occasional immigration of new species into plant communities is a normal process, the current high rate of introduction—fueled by the planting of exotic (non-native) species for horticulture, wildlife management, and erosion control—is threatening the integrity of native plant communities and the survival of native species.

Not all exotic species are invasive. Of the almost 1,000 non-native plant species known to have escaped to the wild in Pennsylvania (there are about 2,000 native species in the state), less than 5%—a few dozen—have become invasive so far. An invasive species is one that rapidly spreads and outcompetes multiple native species, chiefly because of the absence of the predators, pathogens, and herbivores that keep it in check in its native range. An invasive species displays one or more of the following characteristics:

- few predators, herbivores, and diseases
- adaptation to disturbance
- fast germination
- high population growth
- early reproductive maturity
- vegetative as well as sexual reproduction
- pollination by wind or multiple insect species
- wide tolerance to many habitat types
- fast growth rate
- long-range seed dispersal capability
- fruit used by wildlife or humans

Nationally, ***the destructive impact of invasive species on native biodiversity is exceeded only by direct habitat destruction and forest fragmentation***.

Most invasive plants are particularly well adapted to colonize disturbed areas. In southeastern Pennsylvania the division and clearing of land parcels associated with agriculture and more recent sprawl development have created countless miles of edge condition that is highly favorable to the proliferation of invasive species. The misguided promotion of several exotic species for erosion and livestock control and the region's rich horticultural legacy (often using exotic species) have provided plentiful seed sources for regional dispersal of numerous invasive exotic species.

The presence of invasive plant species complicates the goal of maintaining healthy native plant communities because invasive plants compete vigorously with preferred native species for "growing space," the major resources and conditions—light, water, nutrients, temperature, humidity, soil structure, and other factors—that support plant growth in any area. As a result, invasive species have the ability to displace native vegetation, halt or subvert the natural process of succession from field to forest, and homogenize the structural and wildlife food resources of a site. They can also alter nutrient cycling, local hydrology, and fire regimes.

These modifications to native plant communities reduce their habitat value for native fauna, particularly migratory songbirds, which nest within different vegetation layers, and insects, which are vital links in many of the food chains that make up the food web in ecosystems. Most native insect species (terrestrial and aquatic) are specialist feeders on just one native plant species or a narrow range of species. Exotic invasive plants rarely serve as a food resource for native insect species, which is one of the reasons why they are invasive. The higher the cover and species richness of native plants, the higher the total insect biomass is in a given area of land; conversely, the higher the cover of non-native plants, the scarcer insects are as a food resource for other wildlife. Insects are the richest source of fats and protein for birds, fish, and many small animals that, in turn, are food for larger animals. Where non-native plants are abundant, far less of the total plant biomass is converted, via the food chains that make up the food web, into animal biomass. Invasive plants have adverse impacts on virtually all native wildlife populations, both by degrading habitat directly and by reducing the total food supply.

The control of invasive plants will be a perpetual concern of land managers in the region. The extensive edge area and

Why invasives matter

invasives outcompete natives

resulting in

fewer natives in the natural area's species mix

resulting in

- **halting or subverting of natural succession**
- **lower diversity of food sources**

resulting in

- **degraded habitat for wildlife**
- **disruption of nutrient cycling, hydrology, fire regimes, and other vital ecosystem processes**

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

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 warm-season 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.

Dan Barringer

Autumn-olive *(Elaeagnus umbellata)*: Once promoted as a wildlife food along with its relative, Russian-olive *(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 shade-tolerant tree that is invading many forests throughout the region. Once established, its dense shade prevents virtually all plants from growing around it.

Dan Barringer

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

A more complete list of the invasive plants that have the most severe impacts on natural lands in the region can be found under **Invasive Vegetation Management** *(page 125)*. 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** *(page 217)*.

seed sources in our region and the prolific nature of these plants guarantee that ***even with complete eradication on a given property, invasive species can quickly reestablish themselves as a serious stewardship problem if not monitored and addressed on a regular basis***. A strategy for coexisting with these plants is needed—one that will minimize their effects on the aesthetics and ecological stability of a property, with a minimum of management effort. **Invasive Vegetation Management** *(page 125)* provides information on controlling invasive plants.

Water Resources

Our natural lands directly influence the quality and quantity of water that constitutes the system of streams, wetlands, and groundwater in the region. In general, streams in southeastern Pennsylvania developed (and their aquatic biota evolved) within forested landscapes. Forest cover moderates stream flow throughout the year by maximizing infiltration and groundwater recharge, shades the water surface (helping to maintain cool water temperatures for native fish and aquatic insects) and provides food (leaves) and structural debris (branches, trunks) for aquatic organisms. Streams in forested areas tend to be shallow and wide with rocky beds that serve as breeding and nesting sites for aquatic organisms. Removing forest cover along streams exposes the water surface to sunlight and eliminates preferred food resources. If the dominant cover type along the stream becomes sod-forming grasses (typical in agricultural landscapes) or impervious material, the stream loses the flexibility to wander; with increased surface water inputs during storm events, the stream begins to deepen and narrow its channel. As a result, the rocky streambed, so vital to aquatic organisms, is drastically reduced in surface area and often covered with silt.

The agricultural, suburban, and urban land-use pattern of the region has altered the natural balance of ground and surface water that defined the forested landscape prior to William Penn's arrival in 1682. Almost the entire region has been cleared of forest, plowed and grazed for agriculture, bulldozed for urban and suburban development, planted in lawns, or paved. Each of these actions generates unnatural rates and amounts of stormwater

Holly Harper

Broad flat areas adjacent to 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.

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

regeneration of shade intolerant species such as oak, ash and tuliptree is not encouraged. As a result, the forest becomes dominated by shade tolerant species, in our area mainly American beech, red maple, and sugar maple. The most extreme version of highgrading is called ***diameter-limit cutting*** in which every tree over a given diameter is harvested. This removes all the best trees (in an even-aged forest, the largest trees are those with the best genes) from the forest. This leaves the forest dominated by poor quality trees with limited potential for future economic return. Landowners are strongly discouraged from using highgrading—particularly diameter-limit cutting—to harvest timber.

When considering a timber sale, it is wise to confer with the local service forester from the Pennsylvania Bureau of Forestry. At no charge, the service forester will analyze your forest and tell you when and where it is appropriate to harvest trees. He or she can also inform you of any financial assistance that may be available for improving your forest, for example, creating a stewardship plan, tree planting, or control of invasive plants. When a harvest is appropriate, it is always best to engage the services of a private consulting forester to guide you through the process and ensure that you are getting the best price for your trees. 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.

INVASIVE VEGETATION MANAGEMENT

Management Strategy

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

Often the most difficult step in controlling invasive species is deciding what to do first. Creating a "plan of

Two rules of invasive plant management

1. **In general, the future rate of forest degradation is inversely proportional to the current level of degradation.**
2. **Management efforts should be focused on restoring that part of the plant community that controls the most growing space.**

Holly Harper

In natural lands management, the most efficient and effective strategy usually results from basing stewardship goals and strategies on a thorough understanding of the environmental forces in the area and adopting only those goals and strategies that work with, and not against, these forces.

attack" is critical in order to make the most efficient and effective use of limited stewardship resources. Although it may seem logical to address the most severely degraded areas first, this is not always the best use of resources. The following two rules can help focus management efforts.

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

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

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

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

Two points should be noted while planning an invasive species control program. First, invasive plant removal must be done properly or it can have catastrophic impacts to the health of natural lands and its wildlife. Removing trees such as Norway maple and groundcovers such as English ivy opens up the canopy and scarifies the soil, conditions that are ideal for the rapid establishment from seed of opportunistic species, a category that includes most invasive plants. Removing understory shrubs such as exotic shrub honeysuckles, privets, or linden viburnum can transform a forest stand that was a haven for migratory and resident birds and other animals to one devoid of understory cover and thus no longer a viable refuge (from predators), feeding, or breeding habitat for many species. Removal without replacement has numerous subtle effects but some effects can be dramatic, such as a striking decline in birds that were once common. In general, the restoration of a degraded community, particularly forest, should be done in a manner that removes only a small fraction (less than 10%) of the total biomass of any vegetation layer (canopy, subcanopy, shrub, ground) leaving wildlife plenty of space to find refuge and time to adjust to changing cover and food conditions. If the amount of invasive material is light and widely scattered throughout a forested area, the entire forest can be treated at the same time. However, if the shrub layer, for example, is heavily dominated by invasives it is best to treat the area over several years, waiting for existing native shrubs to fill in the

Invasive plant removal must be done properly or it can have catastrophic impacts.

available growing space or planting new ones. Invasive vines are the exception to this rule, because they grow on and not in place of native species and can weaken, kill, or topple trees. All invasive vines should be treated as soon as possible.

Replacement planting should be undertaken in the same year as invasive species removal. This will provide the native species with an edge in recapturing the growing space made available by weeding out invasive species. (It should be emphasized that successfully establishing native species after treating invasives will hinge on proper deer management—either restricting access to the plantings or establishing and maintaining the appropriate deer density.) Any site where plants to be removed comprise more than 25% of the cover within their forest layer (canopy, subcanopy, tall shrub and sapling, ground) will probably require planting to augment any natural regeneration. Removal should be undertaken at times of year when direct disturbance of wildlife is minimal, preferably late fall or winter. Replacement plantings should precede the onset of the spring breeding season

In general, the restoration of a degraded community, particularly forest, should be done in a manner that removes only a small fraction of the total biomass of any vegetation layer leaving wildlife plenty of space to find refuge and time to adjust to changing cover and food conditions.

because many birds return to the same sites year after year to reestablish territories and renest. To insure their survival and to maintain ecosystem integrity, replacement plants must be of native tree, shrub, or herbaceous species carefully selected to be appropriate to soil conditions and the community type at each individual restoration site within the natural area *(see* **Native Plant Materials**, *pages 172–200)*.

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

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

The second point is that any invasive species management program must be undertaken in concert with a serious effort to restore "natural" low deer density if deer are overabundant, that is, if ecosystem degradation by deer overbrowsing is evident. Without sufficient native regeneration, any long-term effort to restore native plant communities will be futile. If the deer density is not restored and maintained at a low enough level, perpetual reliance on planting will be a severe drain on stewardship resources and will require permanent, extensive use of unsightly measures (fencing, tree shelters) to protect plantings from deer browsing.

Management Options

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

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

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
akebia, five-leaved	*Akebia quinata*	woody vine or creeping shrub	physical removal; herbiciding bark or cut stem
angelica-tree, Japanese	*Aralia elata*	tree	physical removal (small seedlings); herbiciding bark or cut stem
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
celandine, lesser	*Ranunculus ficaria*	perennial spring-ephemeral herb	physical removal (small areas); herbiciding foliage
cherry, bird	*Prunus avium*	tree	physical removal (small seedlings); herbiciding cut stem
corktree, amur	*Phellodendron amurense*	tree	physical removal (small seedlings); herbiciding cut stem
crownvetch	*Coronilla varia*	herbaceous plant aggressively spreading in open areas	mowing; herbiciding foliage
garlic mustard	*Alliaria petiolata*	biennial herb	physical removal
gill-over-the-ground	*Glechoma hederacea*	herbaceous plant aggressively spreading in the forest	mowing; herbiciding foliage
goutweed	*Aegopodium podagraria*	perennial herb	mowing; herbiciding foliage
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
honeysuckle, Morrow's	*Lonicera morrowii*	shrub	physical removal; herbiciding bark or cut stem
hops, Japanese	*Humulus japonicus*	herbaceous plant aggressively spreading in open areas, particularly on floodplains	mowing; herbiciding foliage
jetbead	*Rhodotypos scandens*	upright shrub	physical removal; herbiciding bark or cut stem
ivy, English	*Hedera helix*	prostrate or climbing woody vine	physical removal; herbiciding foliage or cut stem

continued...

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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
knotweed, giant	*Fallopia sachalinensis*	very large Eurasian perennial herb	physical removal; herbiciding foliage
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
periwinkle	*Vinca minor*	creeping shrub	physical removal; herbiciding foliage
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
plumegrass, Japanese	*Miscanthus sinensis*	herbaceous plant aggressively spreading in open areas	physical removal; herbiciding foliage
porcelainberry	*Ampelopsis brevipedunculata*	woody vine	cutting; herbiciding foliage, bark, or cut stem
privet, border	*Ligustrum obtusifolium*	shrub	physical removal; herbiciding bark or cut stem
privet, common	*Ligustrum vulgare*	shrub	physical removal; herbiciding bark or cut stem
spurge, Japanese	*Pachysandra terminalis*	creeping shrub	physical removal; herbiciding foliage
stiltgrass, Japanese	*Microstegium vimineum*	herbaceous plant aggressively spreading in forest areas	physical removal; herbiciding foliage
strawberry, Indian	*Duchesnea indica*	herbaceous plant aggressively spreading in forest areas	physical removal
viburnum, doublefile	*Viburnum plicatum*	upright shrub	physical removal; herbiciding bark or cut stem
viburnum, linden	*Viburnum dilatatum*	upright shrub	physical removal; herbiciding bark or cut stem
viburnum, Siebold	*Viburnum sieboldii*	upright shrub	physical removal; herbiciding bark or cut stem
wisteria, Chinese	*Wisteria sinensis*	woody vine	herbiciding bark or cut stem
wisteria, Japanese	*Wisteria floribunda*	woody vine	herbiciding bark or cut stem

space. This approach is preferable wherever possible, although it may be limited as a practical alternative by the availability of workers and equipment relative to the size, quantity, and type of invasive species present.

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

Regardless of which means is employed, it is generally desirable to remove as much of the root system as possible to prevent resprouting, although removal of the crown is usually sufficient to prevent rapid reestablishment of the plant. In individual cases the success of these methods depends on the thoroughness with which the plant

Dan Barringer

An efficient method for removing unwanted shrubs or small trees involves replacing the loader bucket on a tractor with a Brush Brute to impale the base of the plant and then lift it out of the ground. When using this method, care must be taken to minimize soil disturbance.

is removed and the speed at which native vegetation can occupy newly available growing space.

It should be noted that physical removal, especially involving heavy equipment, can create soil conditions that favor the reestablishment of the species being removed or other invasives. For this reason, it is best to limit disturbance as much as possible and to be prepared to monitor the site and address any new invasive species problems promptly.

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. Cutting the plant with a pruner, handsaw, or lightweight chainsaw reduces its aboveground growing space without disturbing surrounding vegetation.

However, the entire root system and any uncut stems can resprout and reoccupy the growing space. For this reason, it is best to cut the plant as low as possible to the ground and to add an herbicide application (refer to **Herbicides**, below, for further details).

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

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

Cutting vines low to the ground and as high as possible at edge sites or within hedgerows will maximize the delay in their movement back into the canopy .

Dan Barringer

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, 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.

Mowing is often the most cost-effective method to control invasives in large open areas where physical removal is beyond the manpower available. The initial treatment may require the physical removal of plants (especially multiflora rose) too large to mow, which would interfere with future mowing operations and act as a seed bank from which the species could spread. For this same reason, it is advisable to remove any obstructions, such as fallen trees or rocks, around which invasive plants can become established and spread.

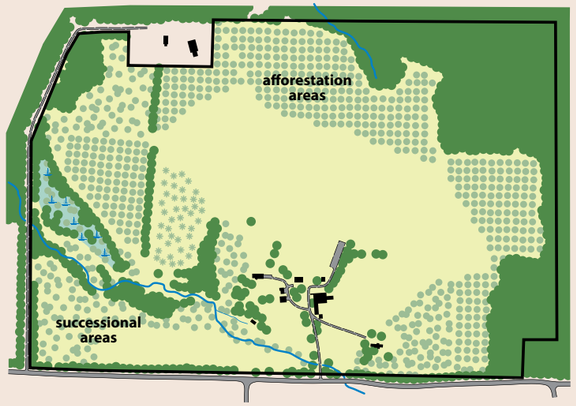
In most cases it is sufficient to combine invasive species control with annual meadow mowing. Areas heavily infested with vines may require more frequent mowing for several years to weaken the invasives and encourage competitive native grass species. Meadow areas heavily affected by invasives may warrant herbicide application (refer to **Herbicides**, below, for further details), followed by planting of natives.

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 *(see plan at right)*.

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

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



Dan Barringer

At Natural Lands Trust's Binky Lee Preserve we are using afforestation (planting in previously open areas) and natural succession to reduce edge.

Herbicides

In most cases the use of herbicides alone is not an effective long-term solution for controlling invasives. Difficulties in delivering adequate amounts to the target plants at the correct time in their growth cycle, the near-impossibility of avoiding collateral damage to native plants and other organisms, and the potential health risks to workers are all drawbacks to their use. In addition, inherent in the sole reliance on herbicides is a "once and done" attitude that is not conducive to the long-term control of invasives. 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*. Training and licensing for herbicide application is provided by the Pennsylvania Department of Agriculture.

To safely administer herbicides to the target plant it is best to cut it back as much

Dan Barringer

While the exclusive use of herbicides is not an effective long-term solution for controlling invasives, used appropriately, they can be an important tool in many situations.

as possible and wait for it to resprout prior to herbicide application. To control small trees, shrubs, or vines, an herbicide with glyphosate should be applied to the fresh sprouts two weeks after cutting. Larger plants can be most effectively controlled by applying an appropriate formulation of the herbicide triclopyr or glyphosate directly to the freshly cut stump or to the uncut stems of shrubs and trees with smooth bark (ailanthus, young Norway maple). This second method works best in fall when sap flow is into the roots. It should be noted, however, that there is some risk to nearby desirable trees from herbicide application. Research has shown that herbicides can be translocated through root grafts (a relatively common occurrence) into other trees. Care should be exercised in treating invasive trees in close proximity to highly desirable trees.

Fire

Fire has played an important part in shaping local plant and animal communities for thousands of years. Fire was a frequent occurrence within forests, following major disturbances such as windfalls or insect defoliation, and on the open grasslands, shrublands, and barrens scattered throughout the region. In addition, Native Americans living in the region used fire for thousands of years for numerous reasons, for example, to drive game, to rejuvenate food resources such as berry patches and pasture for game species, and to make travel easier and safer. Fire exclusion over the last century has modified the plant composition of forest communities. Many eastern forests are now in transition from an oak- and hickory-dominated canopy to a fire-sensitive red maple- and beech-dominated canopy.

The use of fire to control invasives by giving an advantage to native, fire-tolerant 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 *(see* **Prescribed Fire**, *page 145)* to undertake this activity.

As with herbicides, only properly trained individuals should utilize fire as a management tool. To be effective and safe, weather and fuel conditions must meet narrow parameters (the burn prescription). In this region it is usually best to burn in early spring—mid-March to mid-April for herbaceous invasives, late April to early May for woody invasives—a time when many natural fuels reach a peak of flammability but weather conditions typically make containment simpler. Furthermore, invasives usually sprout earlier than native species, making them

vulnerable to fire at a time when many natives are highly fire-tolerant. Before undertaking a burn it is also crucial to acquire any necessary permits, notify neighbors, and coordinate with local and state authorities and, of course, the local fire company.

Recommended Techniques and Procedures

The following are techniques and procedures for addressing different types of invasive plants. For more information, see *Invasive Plant Species* under **Additional Information Sources**, *page 217*.

Herbaceous Plant Removal

Equipment: Mower, herbicides, backpack sprayer

Herbaceous invasives (e.g., garlic mustard, Japanese stiltgrass, mile-a-minute, miscanthus, Japanese knotweed, giant knotweed) are probably the most difficult to control because they are mostly available for treatment during the growing season when desirable (native) plants are growing nearby. They also quickly colonize disturbed areas, including areas where invasive shrubs and trees have been removed. Small areas of herbaceous invasives can be pulled, dug, or mowed until they stop resprouting. In some cases they can be treated in late winter or early spring before native herbs appear. For example, the basal leaves of garlic mustard (an herbaceous biennial) can be sprayed with glyphosate on warm (above 40° F) days (see discussion of appropriate use of herbicides, *page 133*); early sprouts of mile-a-minute can be treated similarly. Large areas of invasive herbaceous plants can be sprayed with glyphosate during the growing season although care must be taken to avoid collateral damage to native

Darin Groff

The use of prescribed fire can control invasives by giving an advantage to desirable native species as seen here in the restoration of a serpentine woodlands.

species. Also, some evidence suggests that applying a pre-emergent (a chemical that prevents seed sprouting) can be helpful in heavily affected areas of mile-a-minute and Japanese stiltgrass.

Groundcover and Vine Removal

Equipment: Pruners, pruning saws, loppers, blade weedwhips, chainsaws, herbicides, backpack sprayer, wick applicator

Groundcovers can be pulled on a regular basis or herbicides can be used to control or eliminate patches (see discussion of

appropriate use of herbicides, *page 133*). Care must be given not to spray non-target species. For evergreen groundcovers (e.g., English ivy, pachysandra), a mixture of triclopyr and diesel fuel has been used successfully as a foliar spray on warm (above 45°) winter days.

The first priority in invasive species control is to remove vines affecting canopy trees. Cut woody vines both at ground level and at least 5 feet above ground level and remove from trees if removal won't cause damage. Immediately following cutting, large stumps should be painted with a systemic herbicide such as glyphosate or triclopyr.

It should be noted that even though invasive vines pose a significant threat to the forest, there may be native vine species within a natural area that have high food value for wildlife. Poison-ivy, Virginia creeper, and the five grape species native to our region should not be cut from trees unless they begin to seriously compromise the health of the tree. Among native vines, this is likely to happen only with grapes, which can eventually overtop the canopy of a tree. If overtopping or threatening to overtop a native tree, a grape vine should be cut but not treated with herbicide so that it can resprout. (The non-native wine grape and its hybrids occasionally escape from cultivation in our region, mainly in highly disturbed areas, but it is rarely seen in the wild and is not invasive.)

Shrub and Sapling Removal

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

Eliminate or control invasive shrubs and saplings by manually or mechanically pulling or by cutting. Stumps cut manually should be immediately painted with a systemic herbicide such as glyphosate or triclopyr (best done in late summer or fall when sap is flowing into plant roots). Thin-barked shrubs can also be treated with a 20–30% mix of triclopyr in basal oil applied in a band around the base of the trunk (best applied during the growing season). See discussion of appropriate use of herbicides, *page 133*.

Tree Removal

Equipment: Pruners, pruning saws, loppers, Weed Wrench, chainsaws, front-end loader, herbicides, backpack sprayer, wick applicator

In areas adjacent to structures or high-use locations, drop invasive and hazardous trees without damage to surrounding desirable trees and either let them lie or cut them into pieces to create brush piles for wildlife habitat *(see below)*. Trunks and limbs of Norway maple or black locust (considered invasive in some communities such as meadows and savannas) that are large (>6-inch diameter) and straight (>8-foot sections) may be useful for trail stabilization and restoration. Some other invasive tree species such as ailanthus will decay rapidly and are not useful for this purpose. Stumps of felled trees should be immediately treated with a systemic herbicide such as glyphosate or triclopyr (see discussion of appropriate use of herbicides, *page 133*). Ailanthus and black locust will root-sprout vigorously following cutting, even with herbicide treatment. Do not cut, but apply basal herbicide as described above. Other thin-barked trees such as young Norway maple can also be treated this way. Smaller limbs and related debris should be left to rot or fly-chipped on-site. In appropriate areas, larger (>6-inch) trees can be girdled to create snags for cavity-nesting wildlife. All dead trees, snags, or branches that do not pose a safety hazard or a threat to the ecological health or stability of the forest should be left in place for their wildlife habitat benefits.

To create a ***brush pile***, first build a base by placing four large logs, set 1 foot apart and parallel to each other, and then place four more logs of the same size, stacked perpendicular to the first logs. Add brush to the top and sides, starting with the larger limbs first, then adding smaller pieces until the pile is about 6 feet high and 6 feet wide.

Planting

It is particularly important to establish trees in forest gaps where invasives have been removed. This can be done through natural or artificial (planting) regeneration. The former is the preferred method because new seedlings are more likely to be derived from a gene pool that has evolved under the environmental conditions of the region over thousands of years. However, the prevalence of overabundant deer throughout the region often necessitates planting to more quickly establish desirable species.

Planting design should include enough space between planted trees to allow access to control competing vegetation, but close enough to quickly provide enough shade to help inhibit the regrowth of invasives. It should also be naturalistic in form, that is, straight lines or rows should be avoided, except when large equipment is required for maintenance. For best results, follow guidelines under **Planting Trees**, *page 168*.

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

Schedule

In general, late fall and winter are the most efficient and least arduous times to perform invasive species control. Problem areas are more easily traversed and cool-weather clothing gives added protection to the work crew. Systemic herbicides are also most effective in the fall when sap is flowing into the roots. The exception to this rule is for herbicide applications that target the foliage of invasives, such as spraying to control herbaceous plants (Canada thistle, mile-a-minute, common mugwort) in meadows or small shrubs (young autumn-olive, exotic honeysuckles, privets) in meadows or forests. Any heavy equipment use should be conducted when the ground is dry or frozen.

Plant trees and shrubs in early spring before they leaf out or in early fall to allow for root growth before the ground freezes. If needed, install flexible tree guards in August and remove in January, until the tree is large enough (2–3 inches in diameter) to withstand buck rubs.

Darin Groff

When planting to fill forest gaps, the trees and shrubs should be only wild-type (no cultivars) native species appropriate to the site conditions and they should be protected from deer damage with fencing, tree shelters (shown here), or flexible tree wraps.

Ongoing Management

Following initial treatment, an annual or biennial inspection and control schedule should be adopted to prevent initial conditions from recurring. After a thorough first treatment, regular but small-scale treatments are often sufficient to preserve the native diversity, ecosystem integrity, and aesthetic quality of a site.

Until natural regeneration becomes adequate in forest areas, the planting of trees and shrubs should continue on an as-needed basis to ensure that sufficient advance regeneration is available to replace canopy trees as they die. Reduce plant competition through selective cutting or herbicide application (see discussion of appropriate use of herbicides, *page 133*) on neighboring plants around the bases of trees during successive growing seasons until the canopy reaches 60% cover.

MEADOW MANAGEMENT

Most grasslands and meadows in eastern North America are short-lived ecosystems. Without repeated disturbance, woody cover (trees and shrubs) quickly returns. It is now believed that agriculture and burning by Native Americans, coupled with the more recent agriculture of European settlers, maintained extensive herbaceous openings in this region for thousands of years, and that feeding, wallowing, and trampling by now-extinct "megaherbivores"—mammoths, mastodons, giant ground sloths, horses, tapirs, peccaries, and others—created and maintained a patchwork of meadows and grasslands for millions of years before that, until their demise upon arrival of humans to our region about 13,000 years ago. As a result, numerous native plant and animal species, particularly birds and butterflies, are completely dependent upon these habitats and are now threatened as they decline.

Most meadows in southeastern Pennsylvania have an agricultural past—old hayfields or pasture—and are dominated by non-native cool-season grasses planted for centuries as fodder, such as tall fescue, perennial ryegrass, Kentucky bluegrass, orchard grass, and timothy. Cool-season grasses, so named because

Most grasslands and meadows in eastern North America are short-lived ecosystems. Without repeated disturbance, woody cover (trees and shrubs) quickly returns.

Bill Moses

Grasslands and meadows are historical components of the regional landscapes that offer food, cover, and nesting sites for small mammals, butterflies, and several threatened bird species.

Invasive Plants in Pennsylvania

Golden, Yellow Groove & Giant Timber bamboo

Phyllostachys aurea, P. aureosulcata and P. bambusoides

Golden bamboo
James R Allison, Georgia DNR

Timber bamboo Frank Jurcik, Bugwood

Yellow groove bamboo
Caryn Rickel, Institute of Invasive Bamboo Research

Background:

Bamboo species are enormous members of the grass family *Poaceae*, and are often introduced as an ornamental or visual screen. They can be classified as either clumping or running, with running species producing long rhizomes that spread aggressively. Golden, yellow groove, and timber are all running bamboo species.

Range:

These bamboo species are native to Asia. Unfortunately, they can now also be found throughout the Southeastern region of the United States, and are being planted more often in the Mid-Atlantic region.

Habitat:

These three bamboo species thrive in full sun, but will grow well in sparsely wooded secondary forests. The most vigorous growth occurs in moist, deep, loamy soils, where these bamboo can spread rapidly.

Description and Spread:

At a height of 30 to 75 feet, these bamboo species tower over most other grasses. The hollow culms (stems) often have 2 stems per node, while native switch cane has only one stem per node. Golden bamboo often turns yellowish in sunlight; timber bamboo is often a dark green; and yellow groove bamboo have a distinctive stripe along the culm. Running bamboo species spread predominately through vegetative growth. Despite containment efforts, their rhizomes will often find their way out of confinement to infest nearby areas.

Ecological Threat:

Due to the thick, tall nature of the colonies it produces, bamboo virtually eliminates all understory plants that stand in its way. In effect, it leaves little appropriate habitat for wildlife, sharply decreasing biodiversity. Once established in an area, it is quite difficult to remove.

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How to Control this Species:

<u>Physical</u>

Small infestations, or areas where herbicides are not permitted, can be controlled mechanically by cutting and mowing as close to the ground as possible. This will need to be repeated several times throughout the growing season since bamboo readily re-sprouts. Monitoring and retreatment over the course of several growing seasons is essential in order to ensure that energy reserves in the rhizomes are exhausted.

<u>Chemical</u>

Large areas of bamboo, where risks to non-target species are minimal, can be treated with foliar applications of five percent glyphosate mixed in water. Canes should first be cut and herbicides applied to newly expanded leaves. Alternatively, a 25 percent solution of glyphosate mixed in water can be applied to freshly cut stumps.

Invasive Plants in Pennsylvania

Japanese and European barberry

Berberis thunbergii and *B. vulgaris*

Leslie J. Mehrhoff, Univ. of Connecticut

Background:

Japanese barberry was introduced into the United States as an ornamental plant in 1875. It was promoted as a substitute for European barberry, the latter which was found to be a host for the black stem grain rust. European barberry was originally planted by settlers for hedge-rows, dye and jam-making. Japanese barberry is still widely planted for landscaping and hedges.

Range:

Japanese and European barberry, native to Japan and Europe respectively, can now be found throughout the northern half of the U.S., particularly the Northeast.

Description:

Both species are dense, spiny shrubs with oval leaves, which are serrate in European barberry and often red-tinged in Japanese barberry. The spines of European barberry are three-pronged. In mid-spring to early summer, drooping clusters of pale yellow flowers develop, turning into bright red berries.

Leslie J. Mehrhoff, Univ. of Connecticut

Habitat:

Barberry is shade tolerant, drought resistant and adaptable to a variety of wooded habitats, wetlands and disturbed areas. Japanese barberry is a more pressing problem than its European relative.

Biology and Spread:

Barberry produces a large number of seeds that have a high germination rate. Seeds are dispersed by birds and small mammals, which feed on the berries. Barberry can spread vegetatively by rooting from branches touching the ground.

Ecological Threat:

Barberry forms dense stands in natural habitats including forests, open woodlands, wetlands and meadows. Once established, it displaces native plants and reduces wildlife habitat and forage, increasing pressure on natives by white-tailed deer. It has been found to alter the pH and biological activity of soil. Barberry is also a human health hazard, not only because it has sharp spines, but also because it acts as a nursery for deer ticks, which can transmit Lyme disease.

Leslie J. Mehrhoff, Univ. of Connecticut

How to Control this Species:

Physical

Barberry is easy to identify in spring because it is one of the first shrubs to leaf out.

Using thick gloves, small plants can be pulled by hand, while larger plants should be dug up. Be sure to remove the entire root system and to bag and dispose of any plant material, including fallen fruits.

Mowing or cutting is not advisable except to make removal easier.

This plant is sensitive to fire; prescribed burns and weed torches are good options.

Chemical

Systemic herbicides, such as glyphosate and triclopyr, are effective in managing barberry.

Herbicide can be applied as a basal bark or cut stump application. Late summer during fruiting may be the best time to apply herbicide, but early spring applications may avoid non-target impacts.

Large thickets of barberry can be controlled with foliar spray applications. Triclopyr only targets broadleaf species, but glyphosate is non-selective.

B. thunbergii seedling- Deric Case, DCNR - BOF

Look-A-Likes:

American barberry (*Berberis canadensis*), an uncommon plant of open hillside slopes thought to be extirpated from Pennsylvania, could be mistaken for an invasive barberry.

Will Cook, Duke Univ.

Invasive Plants in Pennsylvania

Burning Bush

Euonymus alatus

Leslie J. Mehrhoff, UConn
www.forestryimages.org

Background:

Burning bush, also commonly known as winged euonymus, was introduced into the United States in 1860 for use as an ornamental shrub. Its attractive, bright red fall foliage and desirable form has made this shrub a popular ornamental and an easy go-to plant used by landscape designers. As a result, it is commonly planted along interstate highways, as hedges and in foundation plantings.

Range:

Native to northeastern Asia, winged euonymus has escaped throughout the Northeast and Midwestern United States.

pennsylvania
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
www.dcnr.state.pa.us

Description:

Burning bush is a fast-growing, deciduous shrub that may reach five to 15 feet in height. Its green stems usually have prominent, corky wings. Elliptic leaves with finely serrated margins are arranged in opposite formation and turn a brilliant purplish-red to scarlet in the fall. Flowers are small and yellowish-green, becoming fruits that split to expose four red-orange seeds in late fall.

Barry Rice, Sarracenia,
James H. Miller, USDA Forest Service
www.forestryimages.org

Habitat:

Winged euonymus quickly escapes into woodlands, mature forests and open fields. It is highly adaptable to a variety of soil types and pH levels, although it generally doesn't do well in dry areas. It is tolerant of full shade.

Biology and Spread:

This shrub is a prodigious seed producer. Many germinate where they fall, close to the mother plant, creating a dense bed of seedlings. Others are carried by birds, allowing infestations to spread rapidly.

Ecological Threat:

Winged euonymus easily outcompetes native plants with its large, dense silhouette. Lacking pests and tolerant of deep shade, this shrub can force itself into moist forested sites, creating large thickets that displace native herbs and shrubs. This displacement has negative consequences for both aquatic and terrestrial ecosystems.

Leslie J. Mehrhoff, UConn
www.forestryimages.org

How to Control this Species:

Physical

Seedlings, up to two feet tall, can be easily hand-pulled, especially when the soil is moist.

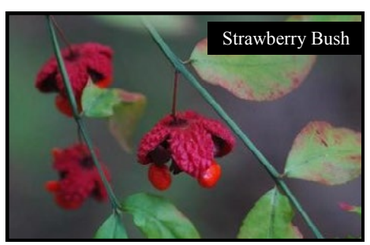
Larger plants must be dug out with a spading fork, pulled with a weed wrench, or cut. The stump must be ground out or the re-growth clipped; be sure to remove a majority of the root system.

Chemical

Glyphosate can be applied as a foliar spray or painted on cut stumps.

Look-A-Likes:

Winged euonymous may be confused with other species of euonymous, including our native strawberry bush (*Euonymus americana*). Saplings of native sweetgum (*Liquidambar styraciflua*) also have winged stems.



Karan A. Rawlins, University of Georgia
www.forestryimages.org

Native Alternatives:

A wide variety of native shrubs provide beauty and wildlife value to the landscape, including:

Dow Gardens
www.forestryimages.org

Chris Evans, River to River CWMA
www.forestryimages.org

Rob Routledge, Sault College
www.forestryimages.org

Vern Wilkins
www.forestryimages.org

James Miller & Ted Bodner, SWSS
www.forestryimages.org

References:

Center for Invasive Species and Ecosystem Health: http://www.invasive.org/browse/subinfo.cfm?sub=3023

U.S. National Park Service: http://www.nps.gov/plants/alien/pubs/midatlantic/eual.htm

For More Information:

DCNR Invasive Species Site: http://www.dcnr.state.pa.us/conservationscience/invasivespecies/index.htm

DCNR Invasive Exotic Plant Tutorial for Natural Lands Managers: http://www.dcnr.state.pa.us/forestry/invasivetutorial/winged_euonymus.htm

Invasive Plants in Pennsylvania

Callery or Bradford pear

Pyrus calleryana

Dan Tenaglia, Missouriplants.com

Background:

Callery pear is native to Asia and was brought to Maryland in 1918 as rootstock for cultivated pears. A non-spiny seedling was selected and named "Bradford." This tree became the second most popular tree in America by the 1980s.

Range:

Reports of this tree as invasive in southeast Pennsylvania are starting to surface, but further south in Maryland, Virginia and beyond they have been dealing with this issue for much longer. These trees can also be found throughout the south and Midwest.

Biology and Spread:

The "Bradford" variety of pear was supposed to produce sterile fruits, but more recent cultivars were created to resist splitting by wind and snow. These trees were able to cross pollinate and produced viable seeds that are spread by wildlife. It also spreads vegetatively.

Description:

This ornamental, deciduous tree can grow up to 40 feet in height. The shiny green leaves are alternate, simple and two to three inches long. Their margins are wavy with a slightly-toothed margin.

Chuck Bargeron, Univ. of Georgia

The overall shape of the tree is often described as tear-dropped or spade-like. The bark is scaly and gray-brown in color. Abundant small, malodorous, white flowers appear in spring before the leaves emerge. Fruits are under half an inch in diameter and green to brown in color.

Britt Slattery, US Fish and Wildlife Service

Habitat:

Typically found along roads, rights-of-way and old fields where they have escaped from landscape plantings. Callery pears will tolerate a wide range of soil conditions and pollution. It prefers full sun but will tolerate partial shade.

Ecological Threat:

Naturalized callery pears compete with native early successional trees in old fields and hedgerows.

How to Control this Species:

Manual and Mechanical

Seedlings and shallow-rooted trees can be pulled when soil is moist. Small trees will need to be dug up or pulled out with a Weed Wrench tool to ensure removal of all roots.

If cutting down the tree is not possible, it can be girdled during the spring or summer by cutting through the bark all around the trunk, about six inches above the ground.

Chemical

Cutting the tree, followed by an immediate application of a triclopyr or glyphosate herbicide to the cut stump, is the most practical means of control.

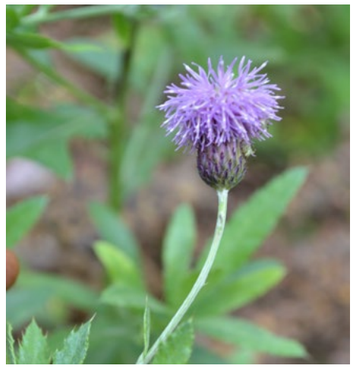
Herbicide can also be applied to a girdled tree if total removal of the tree is not possible.

Invasive Plants in Pennsylvania

Canada thistle

PA Noxious Weed

Cirsium arvense



Brett Pifer, DCNR - BOF

Background:

Canada thistle was probably introduced into the United States by accident in the early 1600s. By 1954, it had been declared a noxious weed in 43 states. It is considered one of the most tenacious and economically important agricultural weeds and is becoming increasingly recognized as a problem in natural areas.

Range:

Despite its name, Canada thistle is native to temperate regions of Eurasia. In North America, it is distributed throughout Canada and the northern United States, from northern California to Maine and south to Virginia.

Description:

Canada thistle is an erect herbaceous perennial with an extensive creeping rootstock. Its leaves are irregularly lobed with spiny, toothed margins. Rose-purple or sometimes white flower heads appear in terminal clusters from June through October. The small seeds have feathery plumes.

Brett Pifer, DCNR - BOF

Habitat:

This plant does best in open and disturbed upland areas, but also invades wet places with fluctuating water levels, such as stream bank meadows. It is commonly found in barrens, glades, meadows, prairies, fields, pastures and waste places.

Biology and Spread:

Canada thistle produces an abundance of feathery seeds, which are quickly dispersed in the wind. The seeds can remain viable in the soil for up to 20 years or more. The fibrous taproot is capable of sending out lateral roots, which sprout shoots at frequent intervals.

Ecological Threat:

Once established in an area, Canada thistle crowds out and replaces native plants, changing the structure and species composition of plant communities and reducing diversity. This thistle outcompetes native plants through shading, competition for soil resources and possibly through the release of toxic allelochemicals.

Deric Case, DCNR-BOF

How to Control this Species:

Because Canada thistle is a perennial and spreads primarily by its root system, the entire plant must be destroyed for effective control.

Control efforts may be more successful when Canada thistle is under environmental stress, such as during droughts and floods, or after a very severe winter.

Canada thistle is stubborn and difficult to remove. Management practices that limit soil disturbance and encourage diverse native plant communities will help prevent establishment of this species.

Physical

For light infestations, black plastic sheeting can be used to smother this thistle. Repeated and frequent pulling or hand-cutting will eventually starve under-ground stems. This should be performed at least three times each season.

Mowing does not kill Canada thistle unless repeated monthly for up to four years. This method is not recommended for natural areas.

Late spring burns, between May and June, are detrimental to this invasive.

Chemical

In areas interspersed with desirable native plants, targeted application of a systemic herbicide, such as glyphosate, works well. For extensive infestations in disturbed areas, a broad application may be more effective. Repeated applications are usually necessary in order to exhaust the seed bank.

Herbicide treatment is best done in late summer or fall when plants are in the rosette stage.

Varying the type of herbicide used will prevent clone colonies from becoming resistant.

Look-A-Likes:

Native species of thistle (*Cirsium* sp.), some of which are rare, could be confused with Canada thistle. Before control is attempted, the thistle species in question should be accurately identified.

Deric Case, DCNR -BOF

If You Find This Plant:

Canada thistle is on the **Pennsylvania Noxious Weed Control List**. It is illegal to sell, transport, plant or otherwise propogate this species. If you believe that you have found a new population of this plant, please contact:

Botany/Weed Specialist
Pennsylvania Dept of Agriculture Phone 717-787-7204

Invasive Plants in Pennsylvania

Chinese silvergrass

Miscanthus sinensis Anderss.

James Miller, USDA Forest Service,

Background:

This grass was brought to the U.S. from Asia in the late 1800s as an ornamental landscape plant. It is also referred to as Eulalia, zebra grass and *Miscanthus*. Some cultivars of this plant are being used as a biofuel crop.

Range:

It can be found throughout the eastern U.S., Colorado and California. There is a large population along the PA Turnpike near Valley Forge.

Habitat:

This grass will grow many places but prefers well-drained soils and full sun to reach maximum height. It is common on old home sites but also found along roadsides, old fields and forest edges.

Description:

Growing up to 12 feet tall, this densely-bunched grass grows upright with silvery midveins on the leaves. The flowering stalks can reach 15 feet or more in length and contain numerous bristled seeds (*see photo below*).

Chris Evans, River to River CWMA

How to Control this Species:

Manual control of this species is NOT recommended. Digging out the plants will most likely result in re-sprouts because of the abundant rhizomes.

Chinese silvergrass can be effectively controlled with several readily available herbicides such as a two-percent solution of glyphosate in water during the fall or a four-percent solution in the late spring. Be sure to follow the label and all state herbicide requirements.

Biology and Spread:

This species spreads primarily through its vigorous roots and rhizomes. The viability of its seeds is in question.

James Miller, USDA Forest Service

Ecological Threat:

Chinese silvergrass can escape from landscape plantings into natural areas, particularly disturbed sites, where it displaces native vegetation. It is extremely flammable, so the risk of wildfires increases in areas with this grass.

Look-A-Likes:

Our native big bluestem grass (Andropogon gerardii) may be confused with Chinese silvergrass due to its large size. Big bluestem's distinguishing feature is the three-prong flower spike that looks like a turkey's foot. Sugarcane plumegrass (Saccharum giganteum) is another look-a-like.

Invasive Plants in Pennsylvania

Crown-vetch

Coronilla varia

Deric Case, DCNR - BOF

Background:

Crown-vetch was introduced throughout North America in the 1950s for erosion control, particularly along roadways. It is still being sold and used in many states that have not officially declared it to be invasive.

Range:

Crown-vetch is native to Europe, Asia and Africa. Since its introduction to the U.S., it has spread throughout the country.

Habitat:

Crown-vetch prefers disturbed, open areas, especially with gravelly or sandy soils. Openings and disturbed areas such as fields, waste areas, roadsides and embankments are perfect habitats for this species.

Description:

Crown-vetch is an herbaceous vine that usually forms sprawling mats or thickets up to three feet tall. The leaves are alternate and pinnately compound, with 15 to 25 pairs of leaflets. The pea-like flowers range in color from white to pink or purple, and bloom during the summer. It has a branched, fibrous root system.

Deric Case, DCNR - BOF

Biology and Spread:

Crown-vetch spreads through both seeds and rhizomes. The rhizomes can extend up to 10 feet, and an individual plant can cover 70 to 100 square feet within four years.

Ecological Threat:

Crown-vetch's main impact is the displacement of native plant species from their habitats. Although it can provide forage for some species, it prevents native flowers and shrubs from establishing in open areas. This, in turn, can be detrimental to native animals and insects which rely upon those native plants or the conditions they provide for food or shelter.

How to Control this Species:

Crown-vetch can be controlled with a variety of methods, although some may prove more successful than others.

Manual control can be effective on younger or smaller populations. This can include pulling entire plants (making sure to include as much of the rhizomatous roots as possible). Mowing is another potential method of controlling crown vetch. The mowing should occur in late spring and then multiple times through the growing season, for several consecutive years.

Prescribed burning can also be effective when conducted in late spring and for several consecutive years.

For areas where crown vetch has established large, dense populations, chemical controls can be used. Glyphosate, triclopyr and metsulfuron were shown in experiments to be effective at treating crown vetch. Herbicides can also be used after removing the aerial portion of the plant by mechanical means, which may improve results.

Look-A-Likes:

Many plants in the pea family, like the native American vetch (Vicia americana) - **shown below** - can look similar to crown-vetch, so be sure to positively identify this species prior to controlling it.

Dave Powell, USDA Forest Service

Invasive Plants in Pennsylvania

European black alder

Alnus glutinosa

Robert H. Mohlenbrock. USDA NRCS. 1995.

Background:

European black alder was introduced in colonial times. It tolerates low-lying, wet soils and has been planted for use as shelter belts, reclamation areas, landscaping and biomass production.

Range:

Native to Europe and western Asia, North Africa and Asia Minor. In North America, it is locally naturalized in the northeastern United States and maritime Canada.

Description:

A deciduous tree with narrow pyramidal or columnar shape, typically multi-stemmed. It grows 40 to 60 feet tall and 20 to 40 feet wide. Leaves are simple and alternate, two to four inches long and three to four inches wide, rounded with a crenate or shallow toothed margin. Flowers are catkins, four inches long. Fruit are egg-shaped nutlets that mature in October. Bark is greenish-brown and young stems are smooth. Buds are stalked, purplish and valvate.

Biology and Spread:

It reproduces primarily by seed; vegetative reproduction (root-suckering) is rare. Seeds are wind dispersed (for short distances of 100 to 200 feet) and water dispersed (possibly for long-distances).

Ecological Threat:

This plant's ability to disperse by water and establish monospecific stands causes it to colonize wetland soils and displace native plants. Its ability to fix nitrogen allows it to establish on sites with very poor soils.

USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *An illustrated flora of the northern United States, Canada and the British Possessions. 3 vols.* Charles Scribner's Sons, New York. Vol. 1: 613.

Habitat:

This tree grows well on acid soils; growth is reduced on alkaline and near-neutral soils. It prefers low-lying soils with high fertility and moisture, often along stream, flood-plains, as well as lake and marsh edges.

Look-A-Likes:

The native alternatives listed above do resemble European alder in their foliage and fruit. However, European alder is taller and less shrub-like, often appearing as a small to medium-sized tree.

Paul Drobot, Univ. of Wisconsin,Stevens Point

How to Control this Species:

Manual

Cutting of stems, with herbicide treatment of stumps, will help prevent stump sprouting.

Chemical Control

Treat this species using readily available herbicides such as a 50 percent solution of glyphosate and water. Follow the label and all state herbicide regulations.

Biocontrol

Many insects and diseases have been observed on European alder. Those known to cause significant damage include striped alder sawfly (*Hernichroa crocea*), European alder leafminer (*Fenusa dohrnii*), alder flea beetle (*Altica ambiens alni*) and woolly alder aphid (*Prociphilus tessalatus*).

Invasive Plants in Pennsylvania

Garlic mustard

Alliaria petiolata

Deric Case, DCNR -BOF

Habitat:

This invasive is frequently found in moist, shaded soil of river floodplains, forests, edges and openings, especially in disturbed areas. Garlic mustard is associated with calcareous soils and does not tolerate high acidity.

Background:

Garlic mustard was likely introduced into the United States by early European settlers for culinary or medicinal purposes. It was first recorded in Long Island, New York in 1868.

Description:

Garlic mustard is a cool season biennial herb with triangular to heart-shaped leaves. Leaves give off an odor of garlic when crushed. First-year plants appear as a rosette of leaves that remain green through winter, maturing the following spring. Button-like clusters of white flowers give way to erect, slender pods by May. Dead stalks of dry, brown seedpods hold viable seed throughout the summer.

Deric Case, DCNR - BOF

Deric Case, DCNR - BOF

Biology and Spread:

Garlic mustard plants develop rapidly, each individual producing thousands of seeds that scatter nearby. Because white-tailed deer find garlic mustard distasteful, they further its expansion by eliminating native competition, as well as by exposing the soil and seedbed through trampling.

Ecological Threat:

Highly shade-tolerant, garlic mustard is capable of invading high-quality, mature forests. To the detriment of spring ephemeral wildflowers, garlic mustard quickly forms monocultures by monopolizing resources. Its allelopathic compounds inhibit seed germination of other species.

Toothwort (*Dentaria* sp.), the host plant of the rare West Virginia white butterfly (*Pieris virginiensis*), is one of the spring ephemerals outcompeted by garlic mustard. The butterfly is drawn to lay its eggs on garlic mustard, a fatal mistake for its offspring. Garlic mustard may also disrupt the mutualistic relationship between native trees and mycorrhizal fungi.

How to Control this Species:

Physical

Because garlic mustard seeds can remain viable in the soil for five years or more, effective management is a long-term commitment. The goal of management is to prevent further seed production and to nip pioneering colonies in the bud.

For small infestations, hand-pulling is extremely effective. Larger infestations may be controlled by cutting. This should be done when the plant is in flower. All plant material should be removed from the site following treatment, since seeds can still develop on cut stems.

Chemical

For heavy infestations, where the risk to non-target species is minimal, the systemic herbicide glyphosate may be useful.

Herbicide can be applied at any time of the year, including winter (to kill overwintering rosettes) as long as the temperature remains above 50° Fahrenheit, and rain is not expected for at least 8 hours.

Chemical control is best done in late fall when most native plants are dormant.

Prevention

Infestations may be prevented by monitoring and removing pioneering plants. Disturbances, such as foot traffic, overgrazing and erosion, should be minimized.

A regular burning regime in fire-adapted oak woodlands can also prevent infestations.

Deric Case, DCNR - BOF

photo right: garlic mustard seedling

Look-A-Likes:

Many native white-flowered plants occur alongside garlic mustard, and may be mistaken for it. These include tooth-worts, sweet cicely (*Osmorhiza claytonia*) and early saxifrage (*Saxifraga virginica*).

Brett Pifer, DCNR -BOF

photo above: early rosettes of Alliaria petiolata

Brett Pifer, DCNR - BOF

Invasive Plants in Pennsylvania

Japanese angelica-tree

Aralia elata

Kelly Sitch, DCNR-BOF

Background:

Japanese angelica-tree is native to Japan, Korea, Manchuria and far eastern Russia. It was first introduced in 1830 as an ornamental species, but has begun to spread to natural areas through dispersal by birds.

Range:

This is a relatively new invasive species in Pennsylvania that is generating more attention as it's being found in the natural environment. Currently, it is known to occur in southern PA, as well as several northern counties. Due to its striking similarity to our native *Aralia spinosa*, it may often be over-looked.

Description:

This is an upright deciduous shrub or tree that can reach heights of 40 feet, with a spreading, multi-stemmed form. Thick stems and the trunk have sharp prickles and spines. The leaves are bi– or tri -pinnately compound with pubescence underneath. Cream white flowers in large panicles appear in late summer and ripen into small purplish-black fruits.

Habitat:

Japanese angelica-tree may be found in wood edges, open areas, thickets and disturbed grounds, especially near urban areas. It is common in the Philadelphia, New York City and Long Island areas, and becoming increasingly frequent in the Piedmont region of northern Delaware.

Ecological Threat:

Where observed, this species acts more aggressively than the native *A. spinosa*, replacing other native vegetation and reducing biodiversity. In places, this species is displacing *A. spinosa* and hybridization between the two species may also be occurring.

John M. Randall, The Nature Conservancy,

Biology and Spread:

Records of the North American native *Aralia spinosa* in Maryland and Delaware are now thought to have really been *Aralia elata*.

Japanese angelica-tree acts aggressively by sprouting from root sprouts, forming large competitive thickets. It spreads into uninvaded areas through bird dispersal of the berries.

How to Control this Species:

Because this species is not widely spread throughout the United States, very little treatment information is available.

According to the New Jersey Invasive Species Strike Team, Japanese angelica tree is best treated with herbicide, as it will prolifically sprout from only using mechanical treatments. Late season applications with glysophate on the foliage or triclopyr ester on cut stumps is recommended for best control.

Brett Pifer, DCNR - BOF

Chris Evans, River to River CWMA

Chris Evans, River to River CWMA

Look-A-Likes:

The non-native Japanese angelica-tree can be very difficult to distinguish from the native A. spinosa (devil's walking stick). Both species have spines covering most of the plant, compound leaves, white flowers, black berries, and can grow to 40 feet tall.

The structure of the inflorescence is the most obvious distinguishing characteristic between the two. On Japanese angelica-tree, the flower is shorter, branching and with no central axis. On *A. spinosa*, the flower is longer with a distinct central axis.

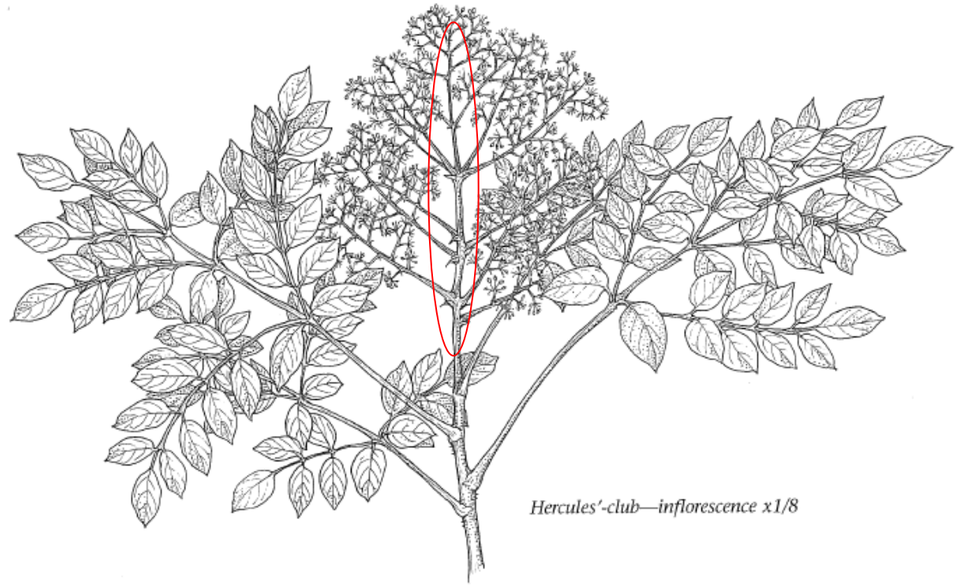
Above: Aralia elata leaf underside
Below: Aralia elata close-up of leaf underside

Brett Pifer, DCNR - BOF

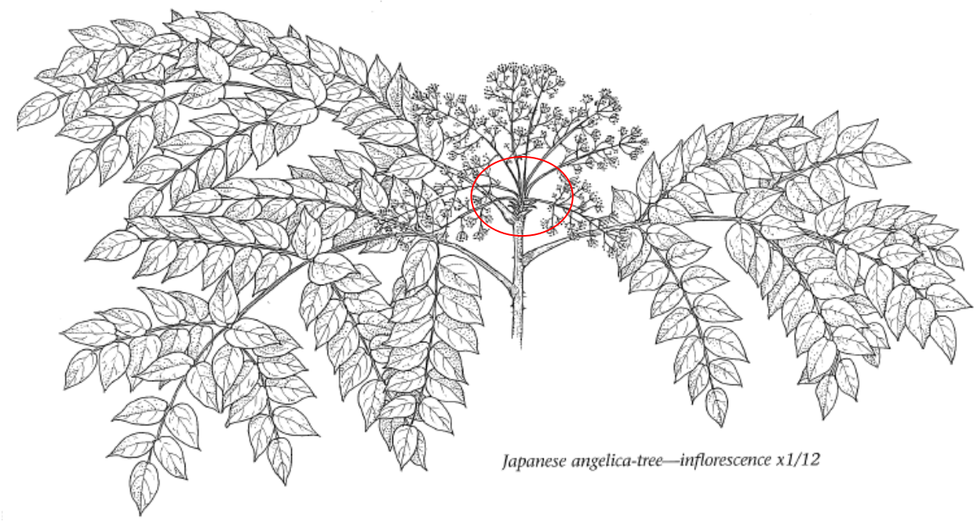
Brett Pifer, DCNR - BOF

Aralia elata stem

Brett Pifer, DCNR - BOF



These two species are most easily identified when in flower and fruit. As demonstrated by these drawings from *Trees of Pennsylvania* by Ann Rhoads and Tim Block, the inflorescence of Hercules' club(above) is generated from an erect, central stem. However, the inflorescence of Japanese angelica- tree (below) radiate out from a central location and hang down on top of the leaves, but there is no central stem.



Japanese angelica-tree (*Aralia elata*)

angelica-tree in flower (August) – note the fountain-shaped flowering pattern with no central stem.

Long, black spines at leaf axis present early in growing season

Japanese angelica-tree (*Aralia elata*)

Devil's walkingstick in flower (August) – note the upright flowering pattern and central stem.

Japanese Angelica Tree Treatment Guidance

Angelica tree can only be certainly differentiated from devil's walkingstick during the flowering season (August).

If one or two small stems are found, these seedlings can be hand-pulled or dug; however, care must be taken to remove all root material or root suckers are likely. In any location where seedlings are pulled, monitor the site for new seedlings or re-sprouts from missed root fragments.

Both basal and foliar treatments for Angelica tree have been successful. Foliar applications should take place late July or August. A mix of 5% roundup with Oust at 0.2 oz per gallon can be applied. Care must be taken to achieve complete coverage. Angelica tree can be treated by basal bark application of triclopyr (garlon) and oil (pre-mixed sold as Pathfinder II). Each seedling/stem should be treated individually.

If the population is found late in the season, consider removing the flower/fruits from the stems if the population is small.

Invasive Plants in Pennsylvania

Japanese honeysuckle

Lonicera japonica Thunb.

Deric Case, DCNR - BOF

Background:

Also known as Chinese honeysuckle, this Asian plant was first introduced into Long Island, NY in 1806. It has been planted as an ornamental, for wildlife habitat and for erosion control, especially on farms.

Range:

Japanese honeysuckle is very common on the eastern third of the U.S. from Southern Maine to Florida. Isolated patches can also be found from Texas west to California, in Washington state and Hawaii.

Brett Pifer, DCNR - BOF

Habitat:

This vine can be found in a variety of habitats including forests, wetlands and disturbed habitats like farm fence rows, roadsides and rights-of-way.

Biology and Spread:

This vine spreads both vegetatively through runners and roots as well as by seeds within the black fruits. Birds and other wildlife readily consume the fruits.

Ecological Threat:

The vines can girdle and kill small saplings and form dense mats in tree canopies, shading native vegetation below.

Regardless of the chosen control method, repeated monitoring and sprout removal may be necessary.

Description:

This evergreen to semi-evergreen woody vine can grow up to 80 feet in length. It has opposite leaves that are typically oval in shape, although the leaves close to the ground may be lobed (*see photo right*). Fragrant white to yellow flowers appear from the leaf axils between April and July. Small, shiny black fruits develop in the fall.

Brett Pifer, DCNR - BOF

Charles Bryson, USDA, www.invasive.org

How to Control this Species:

Manual and Mechanical

For small patches, repeated pulling of entire vine and root system may be effective, especially when the soil is moist. Mowing is NOT recommended, as it stimulates growth and leads to denser mats of vegetation.

Prescribed burning will remove the above-ground growth but will not kill the rhizomes, leading to re-sprouts. Grazing by goats has been used in the past but has a similar effect as mowing does, increasing the chance of root sprouts.

Chemical

There are several systemic herbicides that will work on Japanese honeysuckle including glyphosate and triclopyr. Apply a two percent glyphosate or triclopyr and water mix to the vine's leaves from spring through fall (fall is best). A 25 percent solution of herbicide and water can be applied using the cut stump method.

Invasive Plants in Pennsylvania

Japanese hops

Humulus japonica

Chris Evans, River to River CWMA

Background:

This vine is native to China, Japan, Korea and Taiwan. It was brought to the U.S. in the mid-to-late 1800s as an ornamental and as a medicinal plant. This is not the type of hops used for beer making.

Range:

Japanese hops is found in scattered counties throughout New England, the Mid-Atlantic and Midwest states, and as far south as Alabama.

Chris Evans, River to River CWMA

Description:

Japanese hops is an annual, climbing or trailing vine that can grow up to 35 feet in length in one growing season. Leaves are opposite along the vine and have an average of five lobes with toothed margins and a rough surface. The stem is covered with prickles (see photo lower left). Female flowers appear in mid summer as cone-shaped clusters that hang down (called hops), while male flowers are upright and stem-like.

Leslie Mehrhoff, Univ. of Connecticut

Habitat:

Disturbed habitats like scoured river banks, roadsides and rights-of-way are prime habitat, although it will also colonize forest edges and fields. It prefers moist soil and full sun. It will grow in sandy, loamy or clay soils.

Biology and Spread:

This vine spread vegetatively by its fast growth rate and through abundant small seeds that can be spread by rivers and streams. The seed bank lasts approximately three years.

Ecological Threat:

Japanese hops can form dense patches that outcompete and smother native vegetation.

How to Control this Species:

The plants may be pulled in late spring and early summer, before they flower and set seed, typically prior to August. When pulling, remove as much of the roots as possible, as the plant may resprout. Bag and discard all plant material.

Combining a pre-emergent with later application of a glyphosate herbicide may provide longer-lasting control. The herbicide should be applied to the leaves, ideally when the rootstock is accumulating energy reserves (July through September).

Look-A-Likes:

Common hop (Humulus lupulus) has five varieties, three of which are native to the U.S. (vars. lupuloides, neomexicanus and pubescens). The other two are native to Europe (var. lupulus) and eastern Asia (var. cordifolius), respectively. Common hop leaves have either no lobes or three lobes, as opposed to Japanese hops' five or more lobes.

Japanese hops may also resemble the native bur cucumber (Sicyos angulatus), but that plant lacks prickles, has tendrils and the lobes are less pronounced.

Charlie McDonald, US Forest Service

Invasive Plants in Pennsylvania

Japanese stiltgrass

Microstegium vimineum

James H. Miller, USDA Forest Service

Description:

Japanese stiltgrass is an annual that typically grows one to three feet in height. Despite its branching, sprawling, mat-like manner, it resembles a small, delicate bamboo. Leaves are narrow and lance-shaped with a distinctive, pale, silvery stripe of reflective hairs on the upper surface. Flower spikes appear in September.

James H. Miller & Ted Bodner, SWSS

Biology and Spread:

Stiltgrass reproduces exclusively by seed. One plant may produce 100 to 1,000 seeds that typically fall close to the parent plant. Seeds may be carried by water during heavy rains or move about in contaminated hay, soil or mud stuck in footwear. Stilt grass seeds remain viable in the soil for five or more years and germinate readily.

Ecological Threat:

When Japanese stiltgrass invades a site, it can quickly crowd out native plant species. Invasions can also change soil nutrient cycling processes, inhibit tree survival and growth, and reduce light availability. After it dies back in late fall, it forms a thick layer of smothering thatch that is slow to decompose. Because stilt grass is relatively unpalatable, it may encourage heavier deer browsing on native plant species.

Background:

Japanese stiltgrass was first documented in Tennessee in 1919. Its introduction into the United States was accidental, likely a result of its use as a packing material for porcelain.

Range:

Native to Asia, this successful invasive has colonized most of the eastern United States, as far west as Texas.

Habitat:

Japanese stiltgrass occurs in a variety of habitats, including moist ground of open woods, floodplain forests, wetlands, uplands, fields, thickets, road-sides, and ditches. It readily invades areas subject to regular disturbance. Stilt grass appears to prefer moist, acidic to neutral soils that are high in nitrogen.

Deric Case, DCNR - BOF

How to Control this Species:

Physical

Japanese stiltgrass is quite shallow-rooted and can be easily pulled by hand, especially when the soil is moist. Pulling is easiest in late summer when plants are mature. Stilt grass can also be mowed. Follow up monitoring and treatment will be necessary for years.

Hand pulling and mowing should be done in late summer when the plants are just about to flower. Performing these activities earlier in the summer months encourages flowering and early seed dispersal.

Chemical

For extensive infestations, a systemic herbicide can be used quite effectively. Using an herbicide leaves the plants and soil in place, minimizing the likelihood of additional germination of stilt grass seed.

Grass-specific herbicides, such as quizalofop, limit damage to native plants.

Be careful when treating stiltgrass in wetland sites. Make sure you use an herbicide suitable for wetlands.

Look-A-Likes:

The native perennial Virginia cutgrass (*Leersia virginica*) is quite similar. Japanese stilt- grass may also be confused with some smartweeds (*Persicaria* spp.).

Leslie Mehrhoff, Univ. of Connecticut

Brett Pifer, DCNR - BOF

Kelly Sitch, DCNR - BOF

Left photo: Example of the persistence of the previous year's growth is shown. This is a good winter indicator.

Right photo: New growth in spring denoted by **yellow arrows**. Previous year's growth, which is also a good way to locate this plant, is marked by **red arrows**.

Deric Case, DCNR - BOF

Invasive Plants in Pennsylvania

Japanese and giant knotweed

Fallopia japonica Sieb. & Zucc. and
Fallopia sachalinensis F. Schmidt ex Maxim.

Leslie Mehrhoff, Univ. of Connecticut

Background:

Both species of knotweed were introduced into North America for ornamental use and for forage and erosion control in the late 1800s.

Range:

Both Japanese and giant knotweed come from Japan. They can be found throughout much of the United States and Canada, as well as Europe.

Habitat:

These plants are found at sites with varying combinations of sun, moist soil and human disturbance, such as stream and river banks, wet meadows, roadsides, railroad and utility rights-of-way, vacant lots and waste places.

Brett Pifer - DCNR BOF

Description:

Both are annual, herbaceous perennials with erect, hollow stems that are light green, smooth, jointed and swollen at the nodes (resembling bamboo).

Early in the season, new shoots can grow three to four inches per day. Knotweed grows three to 12 feet tall. The two species are known to hybridize, so ID can some-times be difficult. The shape of the leaf base is the best characteristic—Japanese knotweed leaves are squared-off, giant knotweed's are heart -shaped.

The plant's greenish white flowers are functionally unisexual, grow approximately four inches in length and appear from August to October. The fruits are papery and contain a three-sided shiny, brown seed.

Biology and Spread:

Knotweeds spread primarily by rhizomes. The rhizomes can be dispersed by natural causes, such as flooding and erosion, and also by man-made disturbances to the soil. Cut or broken stems will also root if left on moist soil or put directly into water. It produces only small amounts of viable seed that are dispersed mainly by gravity, wind and water.

Kelly Sitch, DCNR - BOF

Ecological Threat:

Knotweeds are capable of quickly forming dense stands where they can crowd out native vegetation. Thickets can clog small waterways and displace streamside vegetation, increasing bank erosion and lowering the quality of riparian habitat for fish and wildlife. Once established, these stands are very difficult to eradicate.

How to Control this Species:

The key to successful knotweed mgmt. is controlling the rhizomes.

<u>Manual and Mechanical</u> Mechanical methods alone are largely ineffective. It may be possible to grub or pull single plants if they are not well established and soil conditions allow for complete rhizome removal. Small portions of the rhizome system not removed have the potential to resprout.

The herbaceous stems of knotweed can be cut or mowed quite easily. Cutting alone will not control the plant but when performed after June 1 will significantly reduce the height of the regrowth.

<u>Chemical</u>

Several herbicides, such as glyphosate, are effective in controlling this species. If the plants grow in a wetland, be sure to use an aquatic approved herbicide. Check label directions and state requirements.

Foliar herbicide applications made after July 1 and before the first killing frost are most effective at injuring the rhizomes. During this time of year carbohydrates produced in the leaves are moved to the rhizomes for growth and storage. Foliar applied herbicides move through the plant with the carbohydrates.

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Japanese knotweed (*Polygonum cuspidatum*)

Japanese knotweed in flower (Photo by Kelly Sitch, DCNR - BOF).

Japanese knotweed sprouts early in growing season

Japanese knotweed (*Polygonum cuspidatum*)

Previous year's Japanese knotweed stems in winter & early spring.

Japanese knotweed Treatment Guidance

Small populations of knotweed (1-5 plants) can be considered for digging and hand removal. Be advised that the taproots of knotweed are very extensive and often branch, exercise caution while digging these plants. Consider an herbicide application to the roots if they break off when pulling or become difficult to remove.

The most effective means to treat knotweed is to cut the plants and treat with glyphosate eight weeks later. Typically this cutting occurs in late May or June and treatment is conducted eight weeks following cutting, this helps to reduce root/rhizomes reserves prior to spraying.

If there is no mowing or cutting, treatments should take place after July 1st and end by mid-September, this should be a high volume application. Depending on the glyphosate formulation, a surfactant may be necessary (Glyphomate 41 does not need an additional surfactant).

Invasive Plants in Pennsylvania

Mile-a-minute

PA Noxious Weed

Persicaria perfoliata

Brett Pifer, DCNR - BOF

Background:

Also known as devil's tear-thumb, mile-a-minute has been introduced into the U.S. from the Philippines several times between the late 1800s and the 1930s. It arrived in Pennsylvania in contaminated nursery stock in York.

Range:

A native of eastern Asia, this vine is not yet widespread in the U.S. but is very common is the southern two-thirds of Pennsylvania, as well as parts of WV, VA, MD, DE, NJ, NY, CT, MA, RI and NH.

Brett Pifer, DCNR-BOF

Description:

This is an herbaceous, annual vine with delicate, highly branched stems that are covered by small, curved spines. The **alternate leaves are triangular, light green, one to three inches wide and barbed on the underside**. Round leaf-like structures called ocreae surround the stem. It is from there that the inconspicuous flowers and fruits arise. From mid-July though the first frost, **green fruits appear, turning a metallic blue color** as the season goes on.

Habitat:

This plant readily colonizes disturbed areas along forest edges, wetlands, stream banks and roadsides. It needs regular sunlight to thrive and prefers high soil moisture.

If You Find This Plant

Mile-a-minute is on the Federal and PA Noxious Weed List. It is a violation of the Noxious Weed Control Law to sell, transport, plant or otherwise propagate a listed species, like mile-a-minute, within the Commonwealth. If you believe that you have found a new population of this plant, please contact:
Botany/Weed Specialist
Pennsylvania Dept of Agriculture
Phone: 717-787-7204

Biology and Spread:

Its fast growth is one way that the plant spreads, but its seeds are the primary means. Birds and other wildlife eat the fruits and spread the seeds in their droppings. Seeds are also buoyant for up to nine days in water and can be spread by streams and floods.

Ecological Threat:

Because this plant can grow up to six inches a day, it can quickly smother native vegetation and climb into the tree canopy where it restricts light availability to plants below. It can be a pest plant on tree farms and for horticultural crops where the soil is not regularly tilled.

Look-a-Likes:

There are several other vines with triangular-shaped leaves that may be confused with mile-a-minute, including halbard-leaved tearthumb (Polygonum arifolium), climbing false buckwheat (Polygonum scandens), wild morning glory (Ipomoeae pupurea) and hedge bindweed (Calystegia sepium). The presence of spines and ocreae will let you know that it is indeed mile-a-minute.

D. Case, DCNR - BOF

How to Control this Species:

Manual and Mechanical
Hand-pulling of vines is possible, especially when the soil is wet, but be sure to wear thick gloves. Removal should be done prior to fruit formation. Repeated mowing will prevent the plant from flowering and thus reduce or eliminate fruit and seed production. Monitor the site for several years to ensure no seeds germinate.

Chemical
A systemic herbicide like glyphosate will work on mile-a-mine, especially when used with a surfactant that will help to penetrate the leaves' waxy coating. Apply the herbicide in the summer, before fruits appear.

Biocontrol
A weevil, *Rhinocominus latipes*, is being used on various test plots in Pennsylvania and elsewhere to control mile-a-minute. These small insects feed on the leaves and bore into the stems. While they will not completely eliminate the plant they help keep it in check and reduce fruit production.

Photos by Luke Ulsamer, DCNR - BOF

MAM growing out of silt sock

Mile-a-minute early growth (late May – early June)

Mile-a-minute (Persicaria perfoliata)

Leslie Mehrhoff, Univ. of Connecticut

Mile-a-minute late season (late September-early October)

Mile-a-minute weevils

Mile-a-minute (Persicaria perfoliata)

Mile-a-minute cotyledons and first leaves (late May – early June)

Mile-a-minute Treatment Guidance

Large populations of this species are best controlled with pre-emergent application, such as Oust, during March or April. Be advised that any pre-emergent applications will likely effect non-target species in the application area.

For very small populations, hand pulling and digging may be effective. Small plants pull out by the roots easily early in the growing season. As the season progresses and plants become larger, root material can be more difficult to remove completely. Due to barbs on mature plants, gloves are recommended for pulling plants. Plants can be pulled until fruits mature (begin to turn blue).

Both tricolpyr (Garlon 3A) and glyphosate (Glyphomate 41) can be used as a foliar application during the growing season. A surfactant should be used as well. Garlon 3A targets only broadleaf plants, which may be more desirable if mile-a-minute is growing with other non-target species. The extent of the population should be flagged and considered for pre-emergent treatment the following growing season.

Mile-a-minute weevils also provide control of large mile-a-minute populations where herbicides may not be practical. Field trials indicate that the weevils take several years to control large populations

Invasive Plants in Pennsylvania

Multiflora rose

Rosa multiflora

PA Noxious Weed

Deric Case, DCNR - BOF

Background:

Multiflora rose was introduced into the United States as ornamental rootstock from Japan in 1866. Beginning in the 1930s, the U.S. Soil Conservation Service promoted it for use in erosion control and livestock fencing. It was also encouraged in wildlife plantings and as a crash barrier along highways. Recognition of its tenacious and unstoppable growth habitat came too late, and it is now considered a noxious weed in many states.

Range:

Native to Asia, multiflora rose now occurs throughout most of the United States, especially the eastern half.

Deric Case, DCNR - BOF

Description:

Multiflora rose is a dense, thorny shrub, reaching up to 15 feet in height, with arching canes (stems) that are capable of rambling up trees. Its leaves are pinnately compound, divided into seven to nine leaflets, and finely serrate. Clusters of fragrant white to pink flowers appear in May or June. Small bright red hips (fruit) develop during the summer and remain on the plant through winter.

James H. Miller, USDA Forest Service

Habitat:

This invasive shrub has a wide tolerance for various soil, moisture and light conditions. It can be found in dense woods, along stream banks and roadsides, and in open fields and prairies.

Biology and Spread:

It is estimated that a single plant may produce a million seeds per year, which may remain viable in the soil for up to 20 years. The hips are readily eaten by birds, which are the primary seed dispersers. New plants can also be formed by rooting from the tips of canes touching the ground.

Ecological Threat:

Multiflora rose forms impenetrable thickets that exclude native plant species. This shrub grows very prolifically in riparian areas, where its inedible leaf litter can change the composition of the aquatic macroinvertebrate community. Its occasional habitat of climbing can weigh down trees, making them susceptible to breakage.

Deric Case, DCNR - BOF

How to Control this Species:

Physical

Frequent cutting or mowing, three to six times per growing season, for two to four years, is effective in achieving high mortality. Be careful—the strong thorns have been known to puncture rubber tires.

Scattered populations may be eliminated by complete removal of the plants. Be sure to remove all root material because this shrub readily re-sprouts.

In areas where multiflora rose is detected early, prescribed fire may limit its establishment.

Chemical

Application of herbicides, such as glyphosate or triclopyr, on freshly cut stems is an effective control method since it destroys the root system and prevents re-sprouting. This may be done during the dormant period, which reduces the likelihood of damaging desirable species.

A foliar spray of fosamine can be used from July through September, but die-back will not be apparent until the following summer. Fosamine will only affect woody species.

Biological

Biological control is currently under investigation. Rose-rosette disease, a native viral pathogen, is spread by a mite, and is slowly spreading eastward from the west. The European rose chalcid, a seed-infesting wasp, promises to reduce seed viability. Unfortunately, both of these measures have the potential to impact native rose species.

If You Find This Plant:

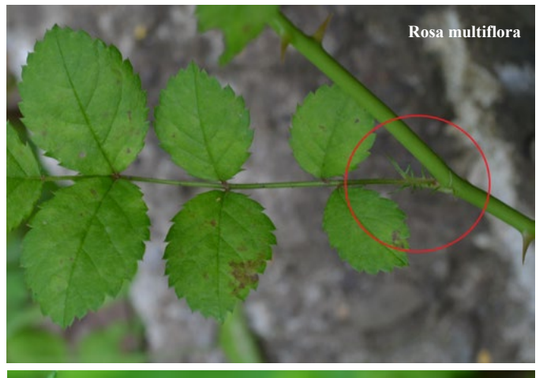
Multiflora rose is on the Pennsylvania Noxious Weed Control List. It is illegal to sell, transport, plant or otherwise propogate this species. If you believe that you have found a new population of this plant, please contact:
Botany/Weed Specialist
Pennsylvania Dept of Agriculture
Phone 717-787-7204

Look-A-Likes:

Multiflora rose could easily be confused with other rose species (both native and non-native), especially when not in bloom. This is a concern, since some native species are of conservation interest.

PA native rose species: Rosa virginiana

Brett Pifer, DCNR - BOF



Multiflora rose has stipules that are conspicuously fringed (as shown in the photo to the left).

photos to the left by: Brett Pifer, DCNR - BOF

PA native rose species have stipules with entire margins or with sessile or stipitate glands, but are <u>not</u> fringed (as shown in the picure to the left).

Invasive Plants in Pennsylvania

Russian and Autumn olive

Elaeagnus angustifolia and *E. umbellata*

James H. Miller, USDA Forest Service

Background:

Both Russian and autumn olive were introduced into the United States in the 1800s. Prized for their silvery foliage, hardiness and plentiful berries, these shrubs were planted as ornamentals, for erosion control and wind-breaks, and in wildlife food plots.

Range:

Russian olive, native to Eurasia, can be found scattered throughout the eastern U.S. and is a problem further west. Native to east Asia, autumn olive has naturalized extensively throughout the eastern half of the United States. Autumn olive is the more common of the two species in Pennsylvania.

Description:

Russian and autumn olive are large, multi-stemmed shrubs that can reach upwards of 20 feet in height. Their most distinctive characteristic is a dusting of silvery scales covering young stems, leaves, flowers and fruit. Small yellow or white flowers become edible fruits in late summer and fall, which are red in autumn olive and orange in Russian olive.

Leslie J. Mehrhoff, Univ. of Connecticut

Habitat:

Both species are found along streams, fields, roadsides, sparse woodlands, disturbed sites and open areas. Russian olive does particularly well in sandy floodplains. Neither species does well in densely forested areas.

Biology and Spread:

Both species are spread by birds and other wildlife that feed on the fruit. These shrubs grow rapidly and are able to produce fruit as early as three years of age.

Ecological Threat:

These shrubs are highly competitive against native species, shading out shorter plants. Their nitrogen-fixing capabilities may adversely affect the nitrogen cycle of native communities that depend on infertile soils. Although Russian and autumn olive provide a plentiful source of berries for birds, their fruits are actually quite low in nutrients. Ecologists have found that bird species richness is higher in riparian areas dominated by native vegetation.

How to Control this Species:

Physical

Young seedlings can be pulled by hand when the soil is moist enough to ensure complete removal of the root system.

Small saplings can be pulled sufficiently with a weed wrench. Larger individuals can be cut at ground level or girdled.

Cutting is an initial control measure and should be followed by herbicide treatment to prevent re-sprouting.

Chemical

Use a systemic herbicide, such as triclopyr. Glyphosate is not an effective chemical to control Russian and autumn olive.

Herbicide should be applied immediately to cut stumps to prevent regeneration. It can also be applied to girdle wounds or directly to the lower bark using the basal bark method.

E. umbellata flowering: Deric Case, DCNR - BOF

Look-A-Likes:

Russian and autumn olive may be confused with invasive bush-honeysuckles (*Lonicera* spp.) or native deciduous hollies (*Ilex* spp.)

The Dow Gardens Archive

Invasive Plants in Pennsylvania

Oriental bittersweet

Celastrus orbiculatus Thunb.

Jessica Sprajcar, DCNR

Background:

Also known as round-leaved and Asiatic bittersweet, this vine was introduced from China into the U.S. around 1860 as an ornamental.

Range:

Oriental bittersweet can be found throughout New England and the Mid-Atlantic states, down to Louisiana and up through the Midwest as far north as Wisconsin. It is not known to occur further west than that.

Description:

Oriental bittersweet is a deciduous, climbing, woody vine that can grow up to 60 feet in length. Vines can grow up to four inches in diameter. The alternate, elliptical leaves are light green in color, finely toothed and two to five inches in length. Fruits are round and yellow, splitting to reveal bright red berries through the fall and winter months.

Leslie Mehrhoff, Univ. of Connecticut

Habitat:

Commonly found on old home sites, in fields and forest edges, and along roadsides and train tracks. While it prefers open, sunny sites it can tolerate shade.

Biology and Spread:

Birds and other wildlife readily consume the large number of berries, spreading seeds far and wide. Humans also spread the seed through the use of bittersweet vines and berries for craft projects. The plant also spreads vegetatively through rhizomes and root suckers.

Ecological Threat:

This vine is able to girdle and kill trees or break their branches off from the weight of the vines. When it grows into the canopy it can shade out natives. Oriental bittersweet has also been shown to hybridize with the American bittersweet, leading to a loss of genetic identity.

Nancy Loewenstein, Auburn Univ.

How to Control this Species:

Manual and Mechanical

Because the seeds of bittersweet are so numerous and can remain viable in the soil for several years, all control efforts will require multiple years to be effective.

Small populations, especially of vines not high up in canopy, can be pulled by hand or dug out prior to fruiting. If fruits are present, all material should be bagged and disposed of.

Vines in trees can be cut close to the ground. The vines will re-sprout, however, unless and herbicide is immediately applied to the cut stump.

Weekly mowing will prevent the vines from fruiting, but less frequent mowing will promote root sprouts.

Chemical

Because Oriental bittersweet looks so much like the native American bittersweet, be absolutely sure you have properly identified the species before doing any control work.

Systemic herbicides like glyphosate and triclopyr can successfully manage bittersweet. It is most effective when stems are cut or mowed and the herbicide is applied to the cut area immediately.

For cut stump applications, a 50% solution of glyphosate and water can be applied as long as the air temperature is above 40 degrees F. A 25 percent solution of triclopyr and water can be applied when the air temperature is above 60 degrees F.

For foliar application, a two percent solution of glyphosate or triclopyr and water, plus a 0.5 percent non-ionic surfactant, can be sprayed on the leaves when the air temperature is above 65 degrees F.

Look-A-Likes:

Oriental bittersweet closely resembles the native American bittersweet (*Celastrus scandens*), but American bittersweet has flowers and fruits at the ends of its branches, rather than in the axils of the leaves, like the Oriental variety.

Brett Pifer, DCNR - BOF

Oriental bittersweet along state forest road: Deric Case, DCNR - BOF

Invasive Plants in Pennsylvania

Empress or Princess tree

Paulownia tomentosa (Thunb.) Sieb. & Zucc. ex Steud.

Jessica Sprajcar, DCNR

Description:

This deciduous tree can grow up to 60 feet in height with a trunk diameter of up to two feet. Leaves are very large (six to 12 inches long), alternate along the stem, and are hairy on the underside. The bark is rough, gray-brown and interlaced with shiny, smooth areas. Showy, fragrant, violet flower clusters bloom in the spring. Thin, pecan-shaped fruit capsules open in the fall and persist well into winter.

Biology and Spread:

Once a tree reaches the age of eight to 10, it is capable of producing twenty million seeds that are spread by wind and water. Trees also have the ability to sprout prolifically from buds on the stems and roots, allowing it to survive fire, cutting and other disturbances. Sprouts can grow up to 15 feet in a single season.

Ecological Threat:

This aggressive tree can take over certain habitats, displacing native vegetation.

Background:

Also known as Royal paulownia, this tree is native to eastern Asia. It was first introduced into North America around 1840 for ornamental purposes and for wood carving. Plantations of this tree are still grown in the U.S. for export to Japan, where the wood is highly prized.

Range:

This tree can be found from southern New England through the Mid-Atlantic states to parts of the south. Its range extends to Arkansas, a few counties in Texas and scattered locations in Washington state.

Tuscarora State Forest District

Habitat:

Paulownia usually invades roadsides, streambanks, forest edges and other disturbed habitats. It tolerates infertile and acidic soils and drought.

James Allison, Georgia DNR

How to Control this Species:

Manual and Mechanical

Seedlings can be hand pulled, especially when the soil is moist. Be sure to remove all roots to prevent resprouts.

Cutting and girdling are not suggested, as they may encourage the tree to send up root suckers. Cutting should only be used in conjunction with an herbicide treatment or as an emergency treatment to prevent seed production.

Chemical

Seedlings and small trees can be controlled by applying a two percent solution of glyphosate or triclopyr and water plus a 0.5 percent non-ionic surfactant to thoroughly wet the leaves.

Larger trees can be killed by cutting the tree and immediately applying a 50 percent solution of glyphosate or triclopyr and water to the outer 20 percent of the stump. A basal bark application of 25 percent triclopyr with 75 percent horticultural oil will also work, as long as the ground is not frozen.

Look-A-Likes:

Princess tree may be confused with the native Northern catalpa (*Catalpa speciosa*). Both trees have similar size, leaf and flower structure. However, paulownia has a hollow pith, while catalpa is solid and whitish. Catalpa leaves are whorled and more pointed at the tip. Catalpa fruits are much longer (eight to 18 inches) than paulownia's (one to 2 inches).

Paul Wray, Iowa State Univ.

Invasive Plants in Pennsylvania

Poison hemlock

PA Noxious Weed

Conium maculatum

Deric Case, DCNR-BOF

Background:

In the 1800s, poison hemlock was brought to the United States from Europe as an ornamental. In ancient times, it was probably used to poison Socrates, a famous Greek philosopher.

Range:

Poison hemlock is native to Europe, western Asia and North Africa. It is now wide-spread throughout much of North America.

Habitat:

This plant commonly occurs in dense stands along roadsides, field margins, irrigation ditches and waste areas. It also invades native plant communities in riparian woodlands, open floodplains and along stream banks.

Ecological Threat:

Poison hemlock can be a tenacious weed, particularly in moist sites. As a pioneer species, it quickly colonizes disturbed sites, displacing natives. All parts of the plant, especially the seeds, are extremely poisonous to humans and livestock.

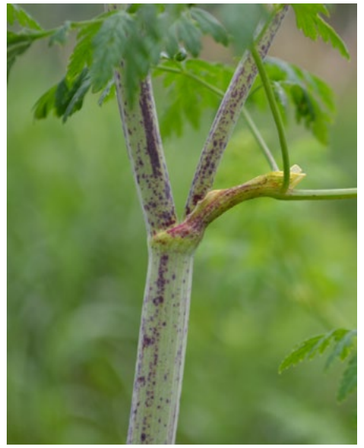
Description:

Poison hemlock is a biennial herb with hollow, purple-spotted stems (see photo to right) that can reach eight feet in height. Its finely dissected leaves emit a foul, parsnip-like odor when crushed. Plants begin as a rosette of leaves and flower in the second year of growth. The small, white flowers are borne in umbrella-shaped clusters (see photo to left).

Deric Case, DCNR - BOF

Biology and Spread:

A single poison hemlock plant can produce over 30,000 seeds. These seeds can adhere to farm machinery, vehicles, fur and clothing, as well as be carried by water, and to a limited extent, wind. Poison hemlock is capable of rapid establishment, particularly in disturbed sites.



Brett Pifer, DCNR - BOF

Look-A-Likes:

Poison hemlock is sometimes confused with the invasive giant hogweed (*Heracleum mantegazzianum*) and our native water hemlock (*Cicuta maculata*), which is also highly toxic. Water hemlock can be distinguished by its solid-purple stem (see photo below).

If You Find This Plant

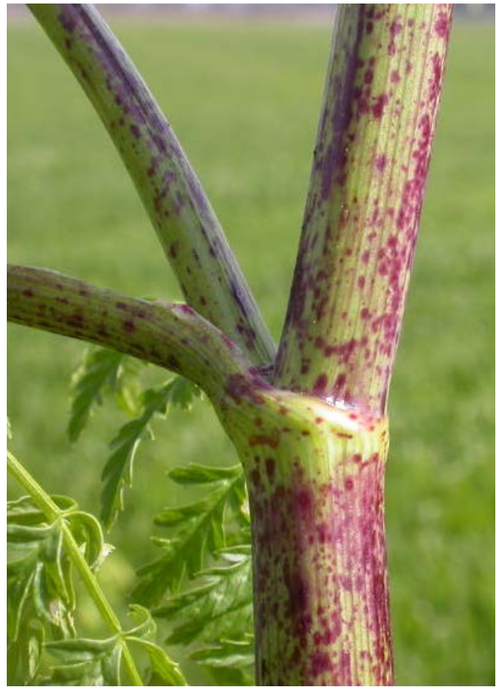
Poison hemlock is on the **Federal and PA Noxious Weed List**. It is a violation of the Noxious Weed Control Law to sell, transport, plant or otherwise propagate a listed species, like poison hemlock, within the Commonwealth. If you believe that you have found a new population of this plant, please contact: **Botany/Weed Specialist Pennsylvania Dept of Agriculture Phone: 717-787-7204**

Poison hemlock (*Conium maculatum*)

Poison hemlock basal rosette sprouts in Spring.

Desiccated poison hemlock stems in mid-Summer and Fall.

Poison hemlock (*Conium maculatum*)



Stem comparison, from left to right: Poison hemlock (Photo by Oregon State Univ.) & Wild parsnip.

Poison hemlock Treatment Guidance

Special care should be taken while handling poison hemlock, all parts of this plant are toxic.

The most effective treatment of poison hemlock is to target the 1st year or early spring basal rosettes with a mixture of Garlon and 2,4-D with an added surfactant. Use 1.0 ounce of Garlon + 2.0 ounces of 2,4-D + 0.5 ounce of surfactant per gallon of water. This treatment is much more effective than treating bolted, flowering stems.

During the summer, the drying dead adult plants are easily observed. If this is the case, this site should be documented and treatment of the rosettes can take place in fall or the next growing season. If population is small, seed heads can be cut and bagged (in heavy, black plastic bags) and disposed of properly in a landfill after several weeks of baking in the sun.

Invasive Plants in Pennsylvania

Porcelain berry

Ampelopsis brevipedunculata

Jessica Sprajcar, DCNR

Background:

Also known as amur perppervine, this vine is native to Japan and northern China. It was brought to the U.S. in 1870 as an ornamental and landscaping plant.

Range:

Found in scattered locations thoughout southern New England, the Mid-Atlantic states and parts of the South and Midwest.

Brett Pifer, DCNR - BOF

Description:

This deciduous, woody vine can climb to heights of 20 feet or more. The alternate leaves are simple and variable—from heart shaped to palmately lobed (three to five lobes). Leaves have coarsely toothed margins. Inconspicuous flowers appear in mid to late summer. Fruits appear in the fall. They change color from light purple to green to blue as the season advances.

Brett Pifer, DCNR - BOF

Biology & Spread:

Birds and other wildlife eat the fruits and spread the seeds to new locations. Fruits may also be spread by water.

Habitat:

Porcelain berry prefers moist, rich soils and full sunlight, although it can tolerate partial shade. It invades stream-banks, forest edges and disturbed areas—anywhere that is not permanently wet.

How to Control this Species:

Because this plant can grow so quickly and has seeds that may be viable in the soil for several years, monitoring and follow-up are necessary.

Hand pulling the vines in the fall or spring will prevent flower buds from forming the following season. For vines that are too large to pull, cut them near the ground and treat with a systemic herbicide like triclopyr or glyphosate.

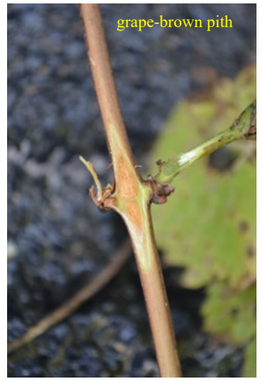
From summer to fall, apply a water-based solution of 2.5 percent triclopyr to the leaves or cut vines. If the basal bark method is preferred, apply a 20 to 30 percent solution of triclopyr mixed with a basal oil to the base of the vine in a two to three feet long section.

Ecological Threat:

This vine grows quickly, forming thick mats that cover native vegetation. It can also climb into the trees and shade out young shrubs and seedlings.

Look-A-Likes:

Porcelain berry resembles our native grapes. The easiest way to tell them apart is to look at the pith (interior) of the vine. Porcelain berry's pith is white, wild grape's is brown. Grape bark peels or shreds, while porcelain berry bark does not.



Brett Pifer, DCNR - BOF

Invasive Plants in Pennsylvania

Privets
(Japanese, Border, Chinese and Common)

Ligustrum japonicum, L. obtusifolium, L. sinense and *L. vulgare*

Troy Evans, www.bugwood.org

Background:

These four species of privets were originally imported for use in landscaping around 1860. They are still often used in hedges and landscaping.

Range:

The various privets are originally from Japan, China and Europe. They have spread through the eastern United States, from New Hampshire and Michigan in the north to Florida and Texas in the south.

Description:

Privets are deciduous or semi-evergreen shrubs that often form dense thickets. They have opposite or whorled stems that are brown to gray with slightly rough bark. Privets produce white flowers from April to June, which are followed by green drupes from July to March. These fruit gradually ripen to a dark purple or black color in the winter. It is often difficult to differentiate between the four privets to the species level, particularly when they are not flowering.

Rebekah Wallace, Univ. of Georgia

Habitat:

Privets are often found in bottom-land forests, fence-rows, fields and rights-of-way. They seem to prefer disturbed areas with rich soil.

Biology and Spread:

Privets mainly spread to new areas via their seeds. Oftentimes, these are distributed by birds, which have eaten the fruit. Once introduced to an area, privet can regenerate from root and stump sprouts, making it difficult to eradicate.

Ecological Threat:

Privets can form dense thickets, which reduce light and moisture availability for native shrubs and wild-flowers. This decreases plant diversity and impacts the animals which depend on them for food and shelter.

Deric Case, DCNR - BOF

How to Control this Species:

Once established in an area, privet can be difficult to control or remove.

With smaller populations, hand removal can be used. However, fragments of root that are left behind in the ground can re-sprout.

Larger areas can also be treated with herbicides such as glyphosate. Herbicide can be applied to the leaves, or painted on cut stems or stumps. Once the herbicide is applied, disturbances to the privet should be avoided for approximately one year, in order for the herbicide to travel through the privet's root systems.

No biological controls are currently known for privet. Studies show that controlled burning does not appear to have a lasting effect on privet populations, so it is not recommended as a control option.

privet berries

Brett Pifer, DCNR - BOF

privet flower cluster

Deric Case, DCNR - BOF

Look-A-Likes:

There are a large variety of shrub-sized, berry-producing, deciduous alternatives to privets for landscaping purposes. These include species such as spicebush (*Lindera benzoin*), chokeberry (Photinia spp.) and dogwoods (*Cornus* spp.). These species will all provide higher quality food and cover for wildlife.

Jessica Sprajcar, DCNR

Chris Vans, River to River CWMA

Deric Case, DCNR - BOF

Invasive Plants in Pennsylvania

Purple loosestrife

PA Noxious Weed

Lythrum salicaria

Brett Pifer, DCNR - BOF

Background:

Purple loosestrife was intentionally introduced into North America in the early 1800s as an ornamental, as well as accidentally by way of discarded ship ballast. It is now banned as a noxious weed in most states.

Range:

Native to Eurasia, purple loosestrife can now be found throughout much of the United States, especially in the northern and western regions.

Description:

Purple loosestrife is a perennial herb with square, woody stems, which may grow anywhere from four to 10 feet high, depending on conditions. Its lance-shaped leaves occur in opposite or whorled arrangements. Magenta-colored flower spikes are present throughout much of the summer.

Eric Coombs, Oregon Dept. of Ag.

Habitat:

Purple loosestrife prefers open wetlands, and is capable of invading freshwater wet meadows, tidal and non-tidal marshes, river and stream banks, pond edges, reservoirs and ditches. It is a hardy plant that can tolerate a range of soil pH, as well as drought.

Biology and Spread:

With an extended flowering season, from June to September, and an unusually high number of flowering stems, each purple loosestrife plant is capable of producing two to three million seeds per year. Research has shown that cultivars, advertised as sterile, are capable of producing viable seed. This plant can also reproduce vegetatively by underground stems at a rate of one foot per year.

Ecological Threat:

An enthusiastic invader of wetlands, purple loosestrife outcompetes native plants, including some federally endangered orchids, forming dense homogeneous stands. These monocultures reduce habitat for waterfowl, clog waterways, disrupt nutrient cycling and collect debris, eventually displacing the entire wetland.

Brett Pifer, DCNR - BOF

How to Control this Species:

Prevention

Early detection and prevention are the best approaches to managing purple loosestrife. Monitoring watersheds yearly to identify new infestations is critical, and can be most easily conducted in late July and August when the plant is in full bloom.

Clean seed and plant parts from animals, equipment and clothing before entering wetland areas.

Prevent nearby infestations from going to seed. Use native competitors as barriers.

Physical

Hand-pulling is only effective for seedlings with small roots.

Mowing is not recommended, but may reduce the production of seeds.

Flooding kills seedlings; established plants must be inundated for weeks. Unfortunately, this also kills desirable vegetation.

The site may need to be replanted with native, competitive vegetation.

Chemical

Glyphosate is effective against purple loosestrife. Be sure to use an herbicide permitted for wetland use. Herbicides can be applied directly to cut stems to reduce collateral damage.

Biocontrol

Although they will not eradicate purple loosestrife, biocontrols can reduce the severity of an infestation. Four species of beetles from Europe, which are fairly host-specific on purple loosestrife, are currently available for control efforts.

Look-A-Likes:

From a distance, purple loosestrife may resemble some native flowering plants, such as blazing star (*Liatris* sp.), pictured below/right, and obedient plant (*Physostegia virginiana*). These also make great native garden alternatives.

Brett Pifer, DCNR - BOF

Brett Pifer, DCNR - BOF

If You Find This Plant:

Purple loosestrife is on the **Pennsylvania Noxious Weed Control List**. It is illegal to sell, transport, plant or otherwise propogate this species. If you believe that you have found a new population of this plant, please contact:
Botany/Weed Specialist Pennsylvania Dept of Agriculture Phone 717-787-7204

Invasive Plants in Pennsylvania

Reed canary grass

Phalaris arundinacea

Brett Pifer, DCNR - BOF

Background:

Both Eurasian and native ecotypes of reed canary grass are thought to exist in the United States. Invasive populations may be descendants of non-native cultivars or ecotypes, although this is not clear. Aggressive strains have been planted throughout the United States since the 1800s for forage and erosion control.

Habitat:

Reed canary grass can be found growing in most types of wetlands, including marshes, alluvial meadows, stream and river banks, shores and ditches. This plant does best in fertile, moist, organic soils in full sun. It has been known to occasionally grow in dry soils in partial shade in upland habitats.

Description:

Reed canary grass is large and coarse, reaching up to nine feet in height. Its flat, blue-green leaves are roughly textured. In June and July, large flower plumes are produced, which are green with a purplish tinge, eventually becoming light tan in color. The stems do not remain standing though the winter.

How to Control this Species:

Physical

Small patches may be effectively dug up or hand pulled. They may also be covered by black plastic for at least one growing season. Be watchful of rhizomes spreading beyond the edge of the plastic.

Mowing twice yearly (early to mid-June and early October) can help control dense stands.

Disrupting the roots every two to three weeks weakens established plants and depletes the seed bank.

Chemical

In small populations, glyphosate can be applied directly to cut stems to avoid collateral damage to native plants nearby.

Herbicide is best applied in early spring when most native species are dormant.

Before applying herbicide, remove dead leaves from the previous year to maximize growing shoot exposure. Use a formulation of glyphosate designed for wetlands.

Range:

This wetland grass is native to temperate regions of Europe, Asia and North America. Non-native strains have become naturalized throughout much of the northern half of the United States, and are still being planted on steep slopes and created wetlands.

Biology and Spread:

Although it produces few viable seeds, which are wind, water, animal and machine-dispersed, reed canary grass manages to colonize new sites quite easily. Once established in a wetland, it spreads aggressively by way of rhizomes.

Ecological Threat:

Reed canary grass forms large, monotypic stands that harbor few other plant species and are little use to most native wildlife. It constricts waterways by promoting silt deposition, yet may also encourage

erosion of soil beneath its dense mats in places where water flows rapidly.

Overtime, it builds up a tremendous seed bank that will erupt when sites are treated for this invasive.

Look-A-Likes:

Reed canary grass could be confused with many grasses, including the non-native orchard grass (*Dactylis glomerata*) and native bluejoint grass (*Calamagrostis canadensis*).

Reed canary grass (*Phalaris arundinacea*)

Closeup of Reed canary grass plant (Photo by Field Biology of Southeastern Ohio)

Early flowering form of Reed canary grass (Photo by Chris Evans)

Reed canary grass (*Phalaris arundinacea*)

Reed canary grass growing on ROW edge.

Reed canary grass Treatment Guidance

If found in "trace" populations, hand pull or dig out the plants. When attempting to remove reed canary grass, it is essential to remove the entire rhizome carefully to ensure no re-sprouting occurs.

Larger populations must be cut or mowed, then allowed to re-sprout prior to herbicide treatment, thus depleting the rhizome reserves. Herbicides must be applied following re-sprouting, but prior to stems reaching 12 inches in height. Gyphosate (a broad spectrum herbicide) can be applied if non-target species are absent (glyphosate will impact all vegetation present) or Poast Plus (sethoxydim), a grass specific herbicide that controls annual and perennial grasses, can be used to reduce impacts to non-target herbaceous vegetation in the vicinity of reed canary grass.

Invasive Plants in Pennsylvania

Shrub Honeysuckles

(Amur, Morrow's, Bells, Standish, and Tartarian)

Lonicera maackii, L. morrowii, L. x bella, L. standishii, and *L. tatarica*

Chuck Bargeron, University of Georgia, www.bugwood.org

Background:

Shrub or bush honeysuckles were introduced to North America for use in landscaping, erosion control and wildlife cover. Unfortunately, these plants then spread throughout much of the country.

Range:

The nonnative bush honeysuckles are native to eastern Asia, Europe and Japan. Currently, they can be found in a variety of habitats from the Great Plains to southern New England, and south to Tennessee.

pennsylvania DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
www.dcnr.state.pa.us

Description:

Nonnative bush honeysuckles grow to heights of six to 20 feet. Their stems are thornless with a hollow brown pith. Their leaves are opposite and egg-shaped. Their flowers, which bloom from May to June, are fragrant, tubular and less than an inch long. They range in color from white to yellow to pink to red. The berries are small and red or yellow.

Leslie J. Merhoff, University of Connecticut, www.bugwood.org

Habitat:

Nonnative bush honeysuckles are relatively shade-intolerant, and often occur in disturbed woods or edges, roadsides and abandoned fields where more light is available. Morrow's and Bell's honeysuckles are capable of invading bogs, fens, lakeshores and sandplains.

Biology and Spread:

Nonnative bush honeysuckles produce large numbers of small fruits, particularly when growing in open sunlight. These are eaten by birds, which then spread the seeds in their droppings. Once a population establishes, vegetative sprouting continues the spread of these plants.

Ecological Threat:

These invasive species compete with native plants for sunlight, moisture and pollinators. And while birds eat the fruit, it is poorer in fats and nutrients than fruits from native plants, so the birds do not get enough nutrients to help sustain long flights during migrations.

Leslie J. Merhoff, University of Connecticut, www.bugwood.org

How to Control this Species:

The two main methods of controlling nonnative bush honeysuckles are mechanical and chemical. Smaller populations can be removed by hand, making sure to include the roots. Larger populations should be cut to ground level at least once per year, in either early spring or late fall.

Glyphosate can be sprayed onto the leaves, or could also be applied to cut stems in order to kill the root system.

No biological controls are known that would target solely nonnative bush honeysuckle species. In open areas, prescribed fire may help to eradicate this species. In order to optimize this approach, however, the burn should be conducted prior to late summer in order to prevent seed dispersal.

Look-A-Likes:

Native bush honeysuckles exist throughout North America. The natives generally have solid stems, as opposed to the hollow pith of the invasive ones. Be very cautious when buying so-called "native" honeysuckles from a nursery or online.

Native Alternatives:

There are a large variety of shrub-sized, berry-producing, deciduous alternatives for landscaping purposes. These include species such as spicebush (*Lindera benzoin*), dogwoods (*Cornus* spp.) and chokeberry (*Aronia* spp.). These species will all provide food and cover for wildlife.

Photo: Jessica Sprajcar, DCNR

Photo: Chris Vans, River to River CWMA, www.forestryimages.org

Photo: Richard Webb, www.forestryimages.org

References:

Invasive Exotic Plant Tutorial for Natural Lands Managers: http://www.dcnr.state.pa.us/forestry/invasivetutorial/bush_honeysuckles.htm

University of Wisconsin, Invasive Plants of Wisconsin: http://www.uwgb.edu/biodiversity/herbarium/invasive_species/lonxbe01.htm

Plant Conservation Alliance's Least Wanted List: http://www.nps.gov/plants/alien/fact/loni1.htm

University of Connecticut Plant Database: http://www.hort.uconn.edu/plants/index.html

Robert W. Freckmannn Herbarium: http://wisplants.uwsp.edu/scripts/detail.asp?SpCode=LONTAT

Invasive Plants in Pennsylvania

Shattercane and Johnsongrass

Sorghum bicolor ssp. x drummondii and S. halapense

PA Noxious Weeds (both species)

Jil Swearingen, NPS

Background:

Johnsongrass has naturalized throughout the world but is thought to be native to the Mediterranean region. Shattercane, also known as Sudangrass, is originally from Africa. Both grasses were first introduced into the U.S. in the early 1800s as forage crops.

Range:

Shattercane can be found in scattered patched in PA, FL, AL, TX, HI, the Midwest and Southwest. Johnsongrass is more commonly found across the U.S.

Description:

Johnsongrass (*on left*) is a tall **perennial** grass that can grow up to eight feet tall. The leaves are two-feet in length and arranged alternately along the stout, hairless stem. The leaves have a distinct, white midrib. Flowers occur in loose, spreading, purple panicles.

The Ohio State Univ.

Shattercane (*shown above*) is an **annual** grass that grows four to twelve feet tall. The large panicles of round, shiny black or red seeds shatter easily, hence its name. It can look very similar to corn seedlings. Both of these plants are on the Pennsylvania Noxious Weed List, meaning it is illegal to plant, sell or transport them.

Biology and Spread:

Johnsongrass spreads aggressively via its rhizomes. Shattercane does not have rhizomes; it spreads only via seeds, which are spread by wind, water and livestock and can remain viable in the soil for two to three years.

Habitat:

Johnsongrass can adapt to a variety of habitats including open forests, old fields, roadside ditched and wetlands. Shattercane is a common weed of cultivated fields.

Ecological Threat:

Both Johnsongrass and shattercane can form dense colonies that displace native vegetation, restrict tree seedling establishment, and compete with food crops.

Bonnie Harper-Lore, FHA

How to Control this Species:

The prolific seed production and ability to grow in a wide range of habitats for both species, and the extensive rhizome system and sprouting ability of fragmented rhizomes in Johnsongrass, make these species difficult to control.

Manual

For light infestation, clumps and individual plants may be hand pulled in June, just after a rain when the ground is soft. All plant parts should be removed from the area. Broken stems and roots left in the ground should be dug up. For heavy infestations, cut the plants by mowing or tilling.

Chemical

These grasses can be effectively controlled using any of several readily available general use herbicides, such as glyphosate. Herbicide treatment may need to be repeated for several years to ensure good control. Follow the herbicide label and all state herbicide requirements.

If You Find This Plant:

Shattercane and Johnsongrass are on the Pennsylvania Noxious Weed Control List. It is illegal to sell, transport, plant or otherwise propogate both of these species. If you believe that you have found a new population of this plant, please contact:
Botany/Weed Specialist
Pennsylvania Dept of Agriculture Phone 717-787-7204

Look-A-Likes:

There are other Sorghum species that resemble shattercane and Johnsongrass, including *S. almum* (another invasive species in the Midwest). Without being familiar with grass structures it can be difficult to tell the various Sorghum species apart.

Univ. of Florida, Weeds of the EAA

Invasive Plants in Pennsylvania

Tree-of-heaven

Ailanthus altissima

Leslie Mehrhoff, Univ. of Connecticut

Background:

Also known as Chinese sumac, stinking sumac and tree of hell, this tree is native to China. It was brought to Philadelphia in 1784 by an amateur gardener. By 1840 it was commonly available from nurseries. Ailanthus is the subject of the well known book, "A Tree Grows in Brooklyn," by Betty Smith.

Range:

Tree of heaven is very common in the northeast and Midwest, through parts of the southeast, southwest and west coast.

Kelly Sitch, DCNR - BOF

Description:

This rapidly growing tree can reach a height of 80 feet, with up to a six-foot diameter trunk. Leaves are pinnately compound with 10 to 41 leaflets with smooth leaf margins. When crushed, the leaves and other plant parts have a rancid smell like cat urine or burnt peanut butter.

Flowering occurs in early summer, when large clusters of yellowish flowers develop above the leaves, Fruit produced on the female trees are tan to reddish, single winged, papery seeds, called samaras. They may remain on the tree throughout late fall.

Habitat:

Ailanthus is extremely tolerant of poor soils and will even grow through cracks in pavement. Trees are not shade tolerant. They will quickly colonize forest edges, fields and roadsides.

Ecological Threat:

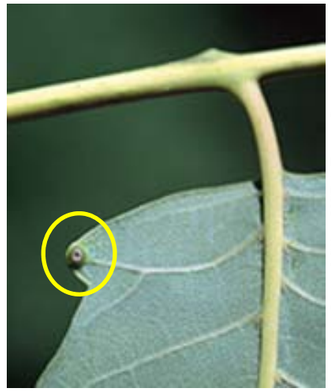
This tree produces chemicals in its roots that prevent the establishment of other plant species nearby. Its fast growth limits habitat for other species. Its root system may be extensive and has been known to cause damage to sewer lines and building foundations.

Biology and Spread:

Tree of heaven spreads by hundreds of thousands of seeds per tree and through vegetative sprouting. A cut or injured ailanthus tree may send up dozens of root suckers and resprouts, creating large clonal colonies.

Look-A-Likes:

The native trees most likely to be confused with ailanthus are the sumacs (Rhus spp.). One way to tell them apart is the small glands on the underside of ailanthus leaves (see photo below). Staghorn sumac leaves do not have this gland, but have toothed leaf margins, while ailanthus' leaf edges are smooth. Sumac fruits are fuzzy and red.



James Miller, USDA Forest Service

Young ailanthus may also be confused with black walnut (Juglans nigra) because of the compound leaves and shield-shaped leaf scars. However, the flowers, seeds and smell of ailanthus should give it away.

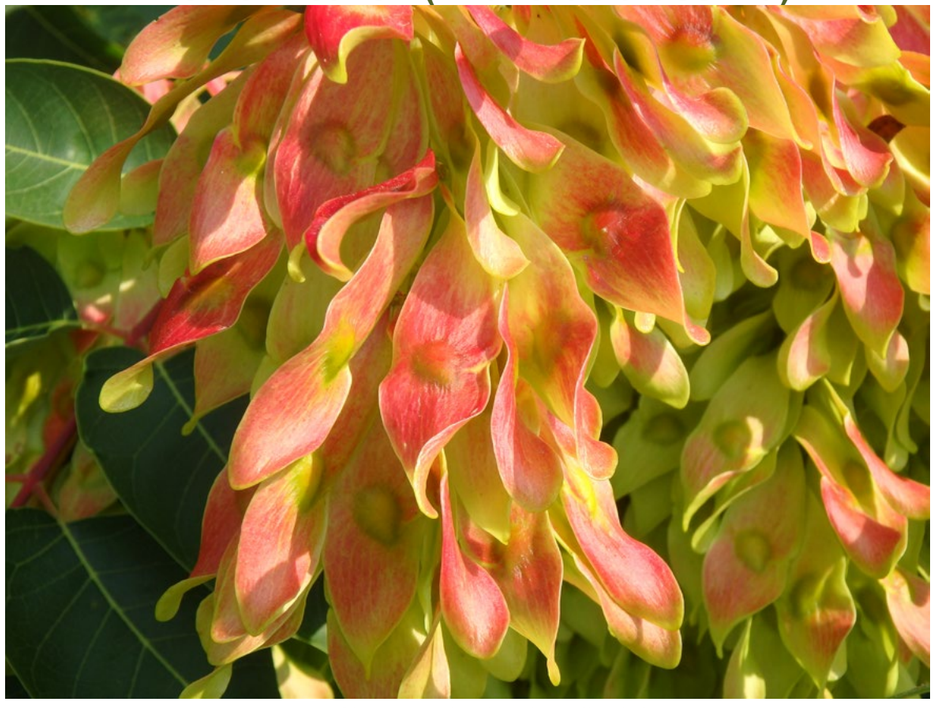
John Cardina, The Ohio State Univ.

Tree-of-heaven (*Ailanthus altissima*)

Tree-of-heaven sprout (Photo by Brett Pifer, DCNR - BOF)

Tree-of-heaven in flower.

Tree-of-heaven (*Ailanthus altissima*)



Tree-of-heaven seeds (Photo by Kelly Sitch)

Tree-of-heaven Treatment Guidance

Unless the seedling is extremely small (less than 6-8 inches tall), cutting or breaking of Ailanthus stems should **not** be considered an effective treatment for an infestation.

Herbicide applications should take place from July 1st until Ailanthus leaves turn colors in the fall. One potential treatment method is basal bark application of triclopyr and oil (pre-mixed sold as Pathfinder II).

Hack and squirt can also be effective, given that each stem is not entirely girdled or damaged (a small portion should be left intact) while treating.

A native biocontrol measure developed from a *Verticillium* fungus is currently being field tested and may soon be available. Initial results indicate that this control is extremely effective at controlling tree-of-heaven.

Native Plant Materials

excerpted from

Stewardship Handbook
for Natural Lands in
Southeastern Pennsylvania

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Natural Lands Trust

October 2008

Native Plant Materials

Nearly 1,600 vascular plant species are known to be native to the greater southeastern Pennsylvania region (the roughly 15 counties that lie south and east of Blue Mountain or Kittatinny Ridge). They include almost 1,350 herbaceous species (wildflowers, grasses, sedges, rushes, ferns), 133 shrubs, 102 trees, and 19 woody vines. Here we suggest a relatively small fraction of those species for use in natural land restoration and landscaping. For natural land restoration we highlight 134 wildflowers; 48 grasses, sedges, and rushes; 19 ferns; 68 shrubs; 62 trees; and 2 woody vines in tables on pages 173–190. A shorter list of plants that provide wildlife benefits and horticultural values can be found on pages 191–198. All species were selected for their ability to thrive under a range of environmental conditions and for their commercial availability (see sources of native plants on page 198), mainly from nurseries and seed suppliers who specialize in plants that are native to southeastern Pennsylvania and immediately adjacent areas of Pennsylvania, New Jersey, Delaware, and Maryland. Don't be discouraged if the availability of some of these plants is limited. Your interest will encourage nurseries to increase their supply.

The plants we recommend for restoration projects are sorted into three major habitat categories: ***forest***, ***shrubland***, and ***meadow***. Within each major category are separate lists of trees, shrubs, and herbaceous species, and each of those groups is further broken down into height classes, based on the maximum height that each species could attain under ideal growing conditions. Maximum height is particularly important in meadow plantings. Most native meadow species have low tolerance of shade and require full sun for at least a part of every day to survive. If species of markedly different heights are planted together, the shorter species are likely to fail due to shade suppression. In any given patch of meadow, the mix of species planted from seeds or plugs should range across no more than two consecutive size categories (the overall planting can be a mosaic of patches of different heights).

All of the shrub and herbaceous species listed under "Native Forest Plants" have intermediate to high tolerance of shade. The list of upper canopy trees includes a mixture of species with low, intermediate, and high shade tolerance, but all native upper canopy tree species—including those that are highly shade tolerant—should be planted where they will get at least some full sun every day. (Subcanopy trees species generally are more tolerant of shading, but will also benefit from some direct sun exposure while they become established; a few have low shade tolerance and thrive best in savannas or open woodlands, including pitch pine, Virginia pine, black jack oak, post oak, sassafras, and black willow.) Seedlings and saplings of even

the most shade tolerant tree species tend to grow extremely slowly or not at all in deep shade. Shade tolerance does not allow young trees of upper canopy species to grow to full size in the shade; it merely enables them to survive many years in a suppressed state until adult trees in the canopy above them die. The natural course of forest canopy renewal takes place when old trees fall or die, opening up a canopy gap that admits enough sunshine to fuel a growth spurt of the advance regeneration (established seedlings and saplings), which soon fill the gap. If the gap is large enough to provide sufficient sunlight, it often becomes a race to fill the gap between shade tolerant tree species, which are already established and have a head start but have slower maximum growth rates, and shade intolerant tree species, which must start from seed but generally grow much more rapidly. Owners or managers of natural lands can choose the winners in this race by judicious weeding and by planting tree seedlings or saplings of upper canopy species far enough apart that none will shade or otherwise interfere with each other's growth.

FOREST TREES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
*maximum height: 70–140 feet or more (**upper canopy**)*		
Acer rubrum	red maple	dry to wet
Acer saccharinum	silver maple	moist to wet
Acer saccharum	sugar maple	dry to moist
Betula lenta	sweet birch, black birch	dry to moist
Betula nigra	river birch	moist
Carya cordiformis	bitternut hickory	moist
Carya laciniosa	shellbark hickory	moist to wet
Carya ovata	shagbark hickory	dry to moist
Carya tomentosa	mockernut hickory	dry to moist
Celtis occidentalis	common hackberry	dry to moist
Fagus grandifolia	American beech	moist
Fraxinus americana	white ash	moist
Fraxinus pennsylvanica	red ash, green ash	moist to wet
Gleditsia triacanthos	honeylocust	moist
Juglans nigra	walnut	moist
Liquidambar styraciflua	sweetgum	moist to wet
Liriodendron tulipifera	tuliptree	moist
Nyssa sylvatica	blackgum, sourgum, tupelo	dry to wet
Pinus echinata	shortleaf pine	dry

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

FOREST TREES, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
*maximum height: 70–140 feet or more (**upper canopy**)*		
Pinus strobus	white pine	dry to wet
Platanus occidentalis	American sycamore	moist to wet
Prunus serotina	black cherry	moist
Quercus alba	white oak	dry to moist
Quercus bicolor	swamp white oak	moist to wet
Quercus coccinea	scarlet oak	dry to moist
Quercus falcata	southern red oak	dry to moist
Quercus montana [=*Quercus prinus*]	chestnut oak	dry
Quercus palustris	pin oak	moist to wet
Quercus phellos	willow oak	moist to wet
Quercus rubra	northern red oak	dry to moist
Quercus velutina	black oak	dry to moist
Tilia americana	basswood	moist
Tsuga canadensis	eastern hemlock	moist
Ulmus americana	American elm	moist to wet
Ulmus rubra	slippery elm	moist to wet
*maximum height: 30–65 feet (**subcanopy**)*		
Amelanchier arborea	shadbush, serviceberry, juneberry	dry to moist
Amelanchier laevis	shadbush, serviceberry, juneberry	dry to moist
Aralia spinosa	devil's walking-stick, Hercules'-club	moist
Asimina triloba	pawpaw	moist
Carpinus caroliniana	American hornbeam, musclewood	moist
Cercis canadensis	redbud	rich
Cornus florida	flowering dogwood	moist
Diospyros virginiana	persimmon	dry to moist
Ilex opaca	American holly	moist
Juglans cinerea	butternut	moist
Magnolia virginiana	sweetbay magnolia	moist to wet
Malus coronaria	sweet crabapple	dry to moist
Morus rubra	red mulberry	moist

FOREST TREES, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
*maximum height: 30–65 feet (**subcanopy**)*		
Ostrya virginiana	hop-hornbeam	dry to moist
Pinus rigida	pitch pine	dry
Pinus virginiana	Virginia pine	dry
Quercus marilandica	blackjack oak	dry
Quercus stellata	post oak	dry
Salix nigra	black willow	wet
Sassafras albidum	sassafras	dry to moist
Viburnum lentago	nannyberry	moist

FOREST SHRUBS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: 20–25 feet		
Alnus serrulata	smooth alder	wet
Amelanchier canadensis	shadbush, juneberry, serviceberry	moist
Cornus alternifolia	alternate-leaved dogwood	moist
Euonymus atropurpureus	wahoo	moist to wet
Prunus americana	wild plum	moist
Prunus virginiana	choke cherry	dry to moist
Viburnum prunifolium	black-haw	wet
maximum height: 10–15 feet		
Cephalanthus occidentalis	buttonbush	wet
Clethra alnifolia	sweet pepperbush	wet
Cornus amomum	silky dogwood	wet
Cornus racemosa	gray dogwood	wet
Cornus rugosa	round-leaved dogwood	dry
Corylus americana	American filbert	dry to moist
Corylus cornuta	beaked hazelnut	dry to moist
Hamamelis virginiana	witch-hazel	dry to moist
Ilex verticillata	winterberry, black-alder	wet

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

FOREST SHRUBS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: 10–15 feet		
Kalmia latifolia	mountain-laurel	dry to moist
Lindera benzoin	spicebush	moist
Photinia melanocarpa [=*Aronia melanocarpa*]	black chokeberry	dry to wet
Photinia pyrifolia [=*Aronia pyrifolia*]	red chokeberry	moist to wet
Physocarpus opulifolius	ninebark	moist to wet
Rhododendron arborescens	smooth azalea	moist
Rhododendron maximum	rosebay rhododendron	moist to wet
Rhododendron periclymenoides	pinxter-flower	dry to moist
Rhododendron viscosum	swamp azalea	wet
Salix discolor	pussy willow	moist to wet
Sambucus canadensis	American elder	moist to wet
Sambucus racemosa	red-berried elder	moist
Staphylea trifolia	bladdernut	dry to moist
Vaccinium corymbosum	highbush blueberry	dry to wet
Viburnum cassinoides	witherod	moist to wet
Viburnum dentatum	southern arrow-wood	wet
Viburnum recognitum	northern arrow-wood	wet
Viburnum trilobum	highbush-cranberry	wet
maximum height: 5–7 feet		
Amelanchier stolonifera	low juneberry, low shadbush	dry to moist
Dirca palustris	leatherwood	dry to moist
Euonymus americanus	hearts-a-bursting	moist
Gaylussacia frondosa	dangleberry	dry to wet
Hydrangea arborescens	sevenbark, wild hydrangea	dry to moist
Ribes americanum	wild black currant	moist to wet
Rosa palustris	swamp rose	wet
Rubus idaeus	red raspberry	dry to moist
Rubus occidentalis	black-cap, black raspberry	dry to moist
Spiraea alba	meadow-sweet	moist to wet

FOREST SHRUBS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: 5–7 feet		
Spiraea latifolia	meadow-sweet	moist to wet
Taxus canadensis	American yew	moist
Vaccinium stamineum	deerberry	dry
Viburnum acerifolium	maple-leaved viburnum	moist
maximum height: 2–4 feet		
Diervilla lonicera	bush-honeysuckle	dry
Gaylussacia baccata	black huckleberry	dry to wet
Spiraea tomentosa	hardback, steeple-bush	moist to wet
Vaccinium angustifolium	low sweet blueberry	dry to moist
Vaccinium pallidum	lowbush blueberry	dry to moist

FOREST VINES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
Lonicera sempervirens	trumpet honeysuckle	moist
Parthenocissus quinquefolia	Virginia-creeper	moist

FOREST PERENNIAL WILDFLOWERS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***tall*** *(6–8 feet)*		
Actaea racemosa [=*Cimicifuga racemosa*]	black cohosh	dry to moist
Aralia racemosa	spikenard	moist
Polygonatum biflorum	Solomon's-seal	dry to moist
maximum height: ***intermediate*** *(3½–5 feet)*		
Arisaema triphyllum	jack-in-the-pulpit	moist
Eurybia divaricata [=*Aster divaricatus*]	white wood aster	dry to moist

FOREST PERENNIAL WILDFLOWERS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***intermediate*** *(3½–5 feet)*		
Eurybia macrophylla [=*Aster macrophyllus*]	bigleaf aster	dry to moist
Eurybia schreberi [=*Aster schreberi*]	Schreber's aster	dry to moist
Maianthemum racemosum [=*Smilacina racemosa*]	false Solomon's-seal, Solomon's plume	dry to moist
Medeola virginiana	Indian cucumber-root	moist
Polygonatum pubescens	Solomon's-seal	dry to moist
Sanicula odorata	yellow-flowered sanicle, fragrant snakeroot	moist
Solidago caesia	bluestem goldenrod	dry to moist
Solidago flexicaulis	zigzag goldenrod	moist
Symphyotrichum cordifolium [=*Aster cordifolius*]	blue wood aster	dry to moist
Triosteum aurantiacum	wild-coffee	moist
maximum height: ***short*** *(1½–3 feet)*		
Actaea pachypoda	doll's-eyes	dry to moist
Allium tricoccum	ramps, wild leek	dry to moist
Aquilegia canadensis	wild columbine	dry to moist
Aralia nudicaulis	wild sarsaparilla	dry to moist
Aristolochia serpentaria	Virginia snakeroot	dry to moist
Caulophyllum thalictroides	blue cohosh	dry to moist
Dicentra eximia	wild bleeding-heart	dry to moist
Geranium maculatum	wild geranium	dry to moist
Hybanthus concolor	green-violet	moist
Hydrophyllum canadense	Canadian waterleaf	moist
Hydrophyllum virginianum	Virginia waterleaf	moist
Lysimachia quadrifolia	whorled loosestrife	dry
Mertensia virginica	Virginia bluebells	moist
Oclemena acuminata	wood aster	moist
Osmorhiza claytonii	sweet-cicely	moist
Osmorhiza longistylis	anise-root	moist

FOREST PERENNIAL WILDFLOWERS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***short*** *(1½–3 feet)*		
Phlox divaricata ssp. *divaricata*	eastern wild blue phlox	dry to moist
Podophyllum peltatum	mayapple	moist
Polemonium reptans	spreading Jacob's-ladder	moist
Scutellaria serrata	showy skullcap	moist
Thalictrum dioicum	early meadow-rue	moist
Trillium cernuum	nodding trillium	moist
Trillium erectum	purple trillium, wakerobin	moist
Trillium flexipes	declined trillium	moist to wet
Trillium grandiflorum	large-flowered trillium	moist
Uvularia perfoliata	bellwort	moist
Uvularia sessilifolia	bellwort	moist
Zizia aptera	golden-alexander	moist
Zizia aurea	golden-alexander	moist
maximum height: ***very short*** *(up to 1 foot)*		
Asarum canadense	wild ginger	moist
Hydrastis canadensis	goldenseal	moist
Iris cristata	dwarf crested iris	dry to moist
Jeffersonia diphylla	twinleaf	dry to moist
Maianthemum canadense	Canada mayflower	moist
Mitchella repens	partridge-berry	moist
Sanguinaria canadensis	bloodroot	dry to moist
Thalictrum thalictroides	rue anemone	dry to moist
Tiarella cordifolia	foamflower	moist

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FOREST GRASSES, SEDGES, AND RUSHES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***tall*** *(6–8 feet)*		
Scirpus cyperinus	wool-grass	wet
maximum height: ***intermediate*** *(3½–5 feet)*		
Carex crinita	fringed sedge, short-hair sedge	wet
Carex folliculata	northern long sedge	wet
Carex gynandra	nodding sedge	wet
Carex lurida	lurid sedge, shallow sedge	wet
Carex scoparia	broom sedge	moist to wet
Carex stipata	stalk-grain sedge, owlfruit sedge	wet
Carex tribuloides	blunt broom sedge, bristlebract sedge	wet
Chasmanthium latifolium	Indian wood-oats	moist
Elymus hystrix	bottlebrush-grass	moist
Glyceria canadensis	rattlesnake mannagrass	wet
Glyceria melicaria	slender mannagrass	wet
Glyceria striata	fowl mannagrass	wet
Leersia virginica	whitegrass	moist to wet
maximum height: ***short*** *(1½–3 feet)*		
Carex intumescens	greater bladder sedge	wet
Carex pensylvanica	Pennsylvania sedge	dry to moist
Carex plantaginea	plaintain sedge	dry to moist
Carex platyphylla	broad-leaf sedge	dry to moist
Carex vulpinoidea	fox sedge, brown fox sedge	wet
Cyperus esculentus	yellow nutsedge	moist to wet
Juncus tenuis	path rush	dry to moist

FOREST FERNS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***intermediate*** *(3½–5 feet)*		
Athyrium filix-femina	lady fern	moist
Dennstaedtia punctilobula	hay-scented fern	moist
Deparia acrostichoides	silvery glade fern	moist
Diplazium pycnocarpon	narrow-leaved glade fern	moist
Dryopteris goldiana	Goldie's wood fern	moist
Dryopteris marginalis	marginal wood fern	moist
Matteuccia struthiopteris	ostrich fern	moist to wet
Onoclea sensibilis	sensitive fern	wet
Osmunda cinnamomea	cinnamon fern	wet
Osmunda claytoniana	interrupted fern	moist to wet
Osmunda regalis	royal fern	wet
maximum height: ***short*** *(1½–3 feet)*		
Adiantum pedatum	northern maidenhair fern	dry to moist
Asplenium platyneuron	ebony spleenwort	dry to moist
Dryopteris carthusiana	spinulose wood fern	moist to wet
Dryopteris intermedia	evergreen wood fern	moist
Polystichum acrostichoides	Christmas fern	dry to moist
Thelypteris noveboracensis	New York fern	moist to wet
Woodwardia areolata	netted chain fern	moist to wet

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

SHRUBLAND TREES AND SHRUBS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: 30–40 feet		
Aralia spinosa	devil's walking-stick, Hercules'-club	moist
Asimina triloba	pawpaw	moist
Betula populifolia	gray birch	dry
Cercis canadensis	redbud	dry to moist
Chionanthus virginicus	fringetree	moist
Cornus florida	flowering dogwood	moist
Juniperus virginiana	eastern red-cedar	dry to moist
Malus coronaria	sweet crabapple	dry to moist
Pinus pungens	Table Mountain pine	dry
Quercus marilandica	blackjack oak	dry
Rhus typhina	staghorn sumac	dry
Salix bebbiana	long-beaked willow, gray willow	dry to moist
Viburnum lentago	nannyberry	moist
maximum height: 20–25 feet		
Alnus serrulata	smooth alder	wet
Amelanchier canadensis	shadbush, juneberry	moist
Cornus alternifolia	alternate-leaved dogwood	moist
Euonymus atropurpureus	wahoo	moist to wet
Prunus americana	wild plum	moist
Prunus virgininana	choke cherry	dry to moist
Rhus copallina	winged sumac, shining sumac	dry
Salix eriocephala	heart-leaf willow	moist to wet
Salix exigua	sandbar willow	wet
Salix lucida	shining willow	wet
Viburnum prunifolium	black-haw	wet
maximum height: 10–15 feet		
Celtis tenuifolia	*dwarf hackberry, Georgia hackberry*	*dry*
Cephalanthus occidentalis	*buttonbush*	*wet*
Clethra alnifolia	*sweet pepperbush*	*wet*
Cornus amomum	*silky dogwood*	*wet*

SHRUBLAND TREES AND SHRUBS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: 10–15 feet		
Cornus racemosa	gray dogwood	moist to wet
Cornus rugosa	round-leaved dogwood	dry
Corylus americana	American filbert	moist
Corylus cornuta	beaked hazelnut	dry
Hamamelis virginiana	witch-hazel	moist
Ilex verticillata	winterberry, black-alder	wet
Kalmia latifolia	mountain-laurel	dry to moist
Lindera benzoin	spicebush	moist
Photinia melanocarpa [=*Aronia melanocarpa*]	black chokeberry	dry to wet
Photinia pyrifolia [=*Aronia pyrifolia*]	red chokeberry	moist to wet
Physocarpus opulifolius	ninebark	moist to wet
Quercus ilicifolia	scrub oak, bear oak	dry
Quercus prinoides	dwarf chestnut oak, dwarf chinkapin oak	dry
Rhododendron maximum	rosebay rhododendron	moist to wet
Rhododendron viscosum	swamp azalea	wet
Rhus glabra	smooth sumac	dry
Salix discolor	pussy willow	moist to wet
Salix humilis	upland willow, sage willow	dry to moist
Salix sericea	silky willow	wet
Sambucus canadensis	American elder	moist to wet
Sambucus racemosa	red-berried elder	moist
Staphylea trifolia	bladdernut	dry to moist
Vaccinium corymbosum	highbush blueberry	dry to wet
Viburnum cassinoides	witherod	moist to wet
Viburnum dentatum	southern arrow-wood	wet
Viburnum recognitum	northern arrow-wood	wet
Viburnum trilobum	highbush-cranberry	wet

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

SHRUBLAND TREES AND SHRUBS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: 5–7 feet		
Amelanchier stolonifera	low juneberry, low shadbush	dry to moist
Comptonia peregrina	sweet-fern	dry
Dirca palustris	leatherwood	dry to moist
Euonymus americanus	hearts-a-bursting	moist
Gaylussacia frondosa	dangleberry	dry to wet
Hydrangea arborescens	sevenbark, wild hydrangea	dry to moist
Myrica pensylvanica	bayberry	dry to moist
Ribes americanum	wild black currant	moist to wet
Rosa palustris	swamp rose	wet
Rosa virginiana	wild rose, pasture rose	moist
Rubus idaeus	red raspberry	dry to moist
Rubus occidentalis	black-cap, black raspberry	dry to moist
Spiraea alba	meadow-sweet	moist to wet
Spiraea latifolia	meadow-sweet	moist to wet
Taxus canadensis	American yew	moist
Vaccinium stamineum	deerberry	dry
Viburnum acerifolium	maple-leaved viburnum	dry to moist
maximum height: 2–4 feet		
Diervilla lonicera	bush-honeysuckle	dry
Gaylussacia baccata	black huckleberry	dry to wet
Rosa carolina	pasture rose	dry
Spiraea tomentosa	hardback, steeple-bush	moist to wet
Vaccinium angustifolium	low sweet blueberry	dry
Vaccinium pallidum	lowbush blueberry	dry

MEADOW PERENNIAL WILDFLOWERS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***very tall*** *(9–10 or more feet)*		
Coreopsis tripteris	tall tickseed	moist to wet
Eutrochium fistulosum [=*Eupatorium fistulosum*]	hollow-stemmed joe-pye-weed, trumpetweed	moist to wet
Helianthus giganteus	swamp sunflower	wet
Rudbeckia laciniata	cutleaf coneflower	wet
maximum height: ***tall*** *(6–8 feet)*		
Angelica atropurpurea	purple-stemmed angelica	moist to wet
Apocynum cannabinum	Indian-hemp	moist to wet
Asclepias incarnata	swamp milkweed	wet
Asclepias syriaca	common milkweed	moist to wet
Baptisia australis	blue false-indigo	moist to wet
Boltonia asteroides	aster-like boltonia	moist to wet
Eupatorium perfoliatum	common boneset	wet
Eutrochium purpureum [=*Eupatorium purpureum*]	joe-pye-weed, sweet-scented joe-pye-weed	dry to wet
Filipendula rubra	queen-of-the-prairie	moist
Helenium autumnale	common sneezeweed	moist to wet
Helianthus divaricatus	rough sunflower, woodland sunflower	dry
Heliopsis helianthoides	ox-eye	dry to wet
Hypericum pyramidatum [=*H. ascyron*]	great St. John's-wort	moist to wet
Lespedeza capitata	round-headed lespedeza	dry
Liatris spicata	dense blazing-star	moist
Lilium canadense	Canada lily	moist to wet
Lilium superbum	Turk's-cap lily	moist to wet
Lobelia cardinalis	cardinal-flower	wet
Lobelia siphilitica	great blue lobelia	moist to wet
Mimulus ringens	Allegheny monkey-flower	wet
Oenothera biennis	common evening-primrose	dry to moist
Penstemon digitalis	tall white beard-tongue	dry to moist
Polygonatum biflorum	smooth Solomon's-seal	dry to moist

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

MEADOW PERENNIAL WILDFLOWERS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***tall*** *(6–8 feet)*		
Rudbeckia triloba	three-lobed coneflower	dry to moist
Senna hebecarpa	northern wild senna	dry to moist
Senna marilandica	southern wild senna	dry
Solidago canadensis	Canada goldenrod	dry to moist
Solidago gigantea	smooth goldenrod	moist to wet
Solidago rigida [=*Oligoneuron rigidum*]	stiff goldenrod	moist
Solidago rugosa	wrinkle-leaf goldenrod	dry to wet
Solidago speciosa	showy goldenrod	dry to moist
Symphyotrichum lanceolatum [=*Aster lanceolatus, A. paniculatus, A. simplex*]	panicled aster	dry to wet
Symphyotrichum novae-angliae [=*Aster novae-angliae*]	New England aster	dry to moist
Symphyotrichum novi-belgii [=*Aster longifolius*]	New York aster	moist to wet
Symphyotrichum pilosum [=*Aster ericoides var. pilosus, A. pilosus*]	heath aster	dry to moist
Verbena hastata	blue vervain, simpler's-joy	moist to wet
Verbesina alternifolia	wingstem	moist
Vernonia glauca	Appalachian ironweed, tawny ironweed	dry
Vernonia noveboracensis	New York ironweed	moist to wet
Veronicastrum virginicum	Culver's-root	moist
maximum height: ***intermediate*** *(3½–5 feet)*		
Asclepias purpurascens	purple milkweed	dry to moist
Eupatorium hyssopifolium	hyssop-leaved thoroughwort	dry
Gentiana andrewsii	bottle gentian, prairie closed gentian	moist to wet
Gentiana clausa	meadow closed gentian, bottle gentian	moist
Geum laciniatum	herb-bennet, rough avens	wet
Hypericum punctatum [=*H. maculatum*]	spotted St. John's-wort	moist

MEADOW PERENNIAL WILDFLOWERS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***intermediate*** *(3½–5 feet)*		
Ludwigia alternifolia	seedbox, false loosestrife	wet
Monarda fistulosa	horsemint, wild bergamot	dry to moist
Monarda punctata	spotted bee-balm	dry
Physostegia virginiana	false dragonhead	moist
Pycnanthemum virginianum	Virginia mountain-mint	moist to wet
Rudbeckia fulgida	eastern coneflower	moist
Rudbeckia hirta	black-eyed-susan	dry to moist
Scutellaria incana	downy skullcap	dry to moist
Solidago bicolor	silver-rod, white goldenrod	dry
Solidago juncea	early goldenrod	dry to moist
Solidago nemoralis	gray goldenrod	dry
Symphyotrichum laeve [=*Aster laevis var. laevis*]	smooth blue aster	dry
Vicia americana	purple vetch	moist
maximum height: ***short*** *(1½–3 feet)*		
Allium cernuum	nodding onion	dry
Asclepias tuberosa	butterfly-weed	dry
Asclepias verticillata	whorled milkweed	dry
Chrysopsis mariana	golden aster	dry
Conoclinium coelestinum [=*Eupatorium coelestinum*]	mistflower, wild ageratum	dry to moist
Dodecatheon meadia	shooting-star, pride-of-Ohio	dry to moist
Geranium maculatum	wood geranium	moist
Iris prismatica	slender blue flag	moist
Juncus tenuis	path rush	dry to moist
Lupinus perennis	blue lupine	dry to moist
Oenothera fruticosa	sundrops, narrow-leaved evening-primrose	dry to moist
Packera aurea [=*Senecio aureus*]	golden ragwort	moist
Penstemon hirsutus	northeastern beard-tongue	dry
Phlox maculata	wild sweet-william	moist to wet

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

MEADOW PERENNIAL WILDFLOWERS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***short*** *(1½–3 feet)*		
Phlox pilosa	downy phlox, prairie phlox	moist to wet
Pycnanthemum tenuifolium	narrow-leaved mountain-mint	moist
Sisyrinchium angustifolium	narrow-leaved blue-eyed-grass	moist to wet
Tradescantia ohiensis	Ohio spiderwort, blue-jacket	moist
Tradescantia virginiana	spiderwort, widow's-tears, Virginia spiderwort	dry to moist
Zizia aptera	golden-alexander	moist
Zizia aurea	golden-alexander, golden zizia	moist to wet

MEADOW PERENNIAL COOL-SEASON GRASSES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***intermediate*** *(3½–5 feet)*		
Calamagrostis canadensis	Canada bluejoint	wet
Deschampsia cespitosa	tufted hairgrass	moist to wet
Deschampsia flexuosa	wavy hairgrass, common hairgrass	dry
Dichanthelium clandestinum [=*Panicum clandestinum*]	deer-tongue, deer-tongue grass	moist
Elymus canadensis	Canada wild-rye	moist
Elymus riparius	riverbank wild-rye	moist to wet
Elymus virginicus	Virginia wild-rye	moist to wet
Leersia oryzoides	rice cutgrass	wet
Poa palustris	fowl bluegrass	wet
maximum height: ***short*** *(1½–3 feet)*		
Danthonia compressa	northern oatgrass	dry
Danthonia spicata	poverty grass, poverty oatgrass	dry
Hordeum jubatum [=*Critesion jubatum*]	foxtail-barley	dry

MEADOW PERENNIAL WARM-SEASON GRASSES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***very tall*** *(9–10 feet or more)*		
Andropogon gerardii	big bluestem, turkeyfoot	dry to moist
Tripsacum dactyloides	gammagrass	wet
maximum height: ***tall*** *(6–8 feet or more)*		
Andropogon glomeratus	bushy bluestem, bushy broomsedge	moist to wet
Andropogon virginicus	broomsedge, Virginia broomsedge	dry
Panicum virgatum	switchgrass	dry to moist
Sorghastrum nutans	Indian-grass	dry to moist
Spartina pectinata	prairie cordgrass, freshwater cordgrass	moist to wet
Tridens flavus	purpletop	dry to moist
maximum height: ***intermediate*** *(3½–5 feet)*		
Bouteloua curtipendula	side-oats grama, tall grama	dry
Muhlenbergia capillaris	hairgrass, short muhly	dry
Schizachyrium scoparium	little bluestem	dry to moist
Sporobolus cryptandrus	sand dropseed	dry
Sporobolus heterolepis	prairie dropseed	dry
maximum height: ***short*** *(1½–3 feet)*		
Andropogon gyrans	Elliott's beardgrass	dry to moist
Eragrostis spectabilis	purple lovegrass, tumblegrass	dry

MEADOW SEDGES AND RUSHES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***tall*** *(6–8 feet or more)*		
Scirpus cyperinus	wool-grass	wet
maximum height: ***intermediate*** *(3½–5 feet)*		
Carex lurida	lurid sedge, shallow sedge	wet
Carex scoparia	broom sedge	moist to wet
Carex stipata	stalk-grain sedge, owlfruit sedge	wet
Carex tribuloides	blunt broom sedge, bristlebract sedge	wet
maximum height: ***short*** *(1½–3 feet)*		
Carex intumescens	greater bladder sedge	wet
Carex vulpinoidea	fox sedge, brown fox sedge	wet
Cyperus esculentus	yellow nutsedge	moist to wet
Juncus tenuis	path rush	dry to moist

MEADOW FERNS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
maximum height: ***intermediate*** *(3½–5 feet)*		
Dennstaedtia punctilobula	hay-scented fern	dry to wet
Onoclea sensibilis	sensitive fern	wet
Pteridium aquilinum	northern bracken fern	dry

NATIVE TREES AND SHRUBS FOR LANDSCAPING AND WILDLIFE

Large Trees

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
Acer rubrum	red maple	Piedmont Coastal Plain	Height: 40'–60', Spread: same Habit is pyramidal in youth and rounded with age. Tolerant of most soils, but prefers slightly acid, moist conditions. Naturally occurs in wet area. Excellent fall color.	Buds, flowers, and leaves provide food for many birds and mammals. Chipmunks and squirrels eat seeds and some songbirds use twigs for nest building.
Acer saccharinum	silver maple	Piedmont Coastal Plain	Height: 50'–70', Spread: 40'–50' Has strong spreading branches which form a rounded crown. Tolerant of many soil types. One of the best trees for poor soils and wet conditions (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.	See red maple.
Acer saccharum	sugar maple	Piedmont Coastal Plain	Height: 60'–70', Spread: 40'–50' Upright oval to rounded habit. Prefers moist, well drained soils. Tolerates some shade.	See red maple.
Betula nigra	river birch	Piedmont Coastal Plain	Height: 40'–70', Spread: 40'–60' Pyramidal in youth and rounded with age. Often grown multistemmed. Best adapted to moist soils (often found on floodplains). Used in areas that are alternately wet and dry.	Catkins are used by redpolls and pine siskins. Foliage is used by browsers.
Betula lenta	sweet birch	Piedmont Coastal Plain	Height: 40'–55'+, Spread: 35'–45' Pyramidal in youth, forming an irregular, rounded, sometimes wide-spreading crown at maturity. Best in deep, rich, moist, slightly acid soils, however, often found on rocky, drier sites. Flowers are catkins, 2"–3" long. Yellow leaves in fall are best among birches.	See river birch.

Large Trees, *continued*

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.

Large Trees, *continued*

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.

Large Trees, *continued*

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
Pinus strobus	eastern white pine	Piedmont Coastal Plain	Height: 50'–80'+, Spread: 20'–40'+ Pyramidal in youth, crown at maturity has several horizontal and ascending branches. Fast grower. Grows best on fertile, well drained soils but is very adaptable.	Provides valuable cover and nesting sites for songbirds and mammals. Needles are used as nesting material. Seeds are eaten by quail, chickadees, grosbeaks, nuthatches, and woodpeckers.
Quercus alba	white oak	Piedmont Coastal Plain	Height: 100', Spread: 50'–80' Pyramidal in youth, becoming broad and rounded with wide spreading branches. Transplant as small tree. Prefers moist, well drained soils. Difficult to obtain from nurseries. Sometimes available as seedling.	Oaks, in general, are of major importance to wildlife. Acorns are at the top of the food preference list for wood ducks, pheasants, grackles, jays, nuthatches, thrushes, woodpeckers, rabbits, foxes, squirrels, and deer.
Quercus palustris	pin oak	Piedmont Coastal Plain	Height: 60'–70', Spread: 25'–40' Strongly pyramidal with ascending branches. One of the faster growing oaks. Full sun. Found naturally in wet soils but is adaptable to many soil types.	See white oak.
Quercus rubra	red oak	Piedmont Coastal Plain	Height: 60'–75'+, Spread: 40'–50' Habit is round-topped and symmetrical. Full sun. Prefers loamy, well drained soils. Fast growing.	See white oak.
Tilia americana	American linden	Piedmont Coastal Plain	Height: 60'–80', Spread: 35'–50' Pyramidal in youth, assuming a rounded shape with age. Full sun or part shade. Prefers deep, moist soils, but is tolerant of heavier soils.	Limited wildlife value.
Tsuga canadensis	eastern hemlock	Piedmont Coastal Plain	Height: 40'–70', Spread: 25'–35' Pyramidal in youth becoming more pendulous with age. Likes moist, well drained soils. Plant in sheltered area. Tolerates shade. Relatively fast growing. Excellent for screens, hedges.	Provides excellent cover for deer and songbirds. Nesting site for several warblers. Seeds are eaten by juncos, chickadees, and siskins.

Small Trees/Large Shrubs

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.

Small Trees/Large Shrubs, *continued*

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
Viburnum lentago	nannyberry	Piedmont Coastal Plain	Height: 15'–18', Spread: 6'–10' Shrub or small tree with open habit. Adapts to a wide range of soil conditions. Sun or partial shade.	Used by grouse, brown thrasher, cedar waxwing, squirrels, and deer.
Viburnum prunifolium	blackhaw virburnum	Piedmont Coastal Plain	Height: 12'–15', Spread: 8'–12' Round-headed tree or multi-stemmed shrub. Adaptable to many soil types. Sun or shade.	See nannyberry.

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.

Shrubs, *continued*

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

Shrubs, *continued*

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

SOURCES

Nurseries Specializing in Native Plants

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

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

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

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

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

Octoraro Native Plant Nursery
6126 Street Road
Kirkwood, PA 17536
717-529-3160
www.octoraro.com

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

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

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

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

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

Other Nurseries That Carry Native Plants

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

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

Musser Forests
1880 Route 119 North
Indiana, PA 15701
800-643-8319
www.musserforests.com
(Seedlings only)

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

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

Shemin Nurseries
P.O. Box 649
100 Green Tree Road
Oaks, PA 19456
610-666-0595
www.sheminnurseries.com
(Wholesale only)

Wildflower Sources

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

Ernst Conservation Seeds
9006 Mercer Pike
Meadville, PA 16335
800-873-3321
www.ernstseed.com

Prairie Nursery
P.O. Box 306
Westfield, WI 53964
800-476-9453
www.prairienursery.com

Sandy Wilson
Native Plants and Aquatic Nursery
834 Church Road
Harleysville, PA 19438
610-584-6302

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

Additional Sources for General Lists

Guide to Pennsylvania Nursery Stock
Pennsylvania Nurserymen's Association, Inc.
1924 North Second Street
Harrisburg, PA 17102

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

Information Sources

Manual for Woody Landscape Plants
Michael Dirr
Stipes Publishing Company, 1990

American Wildlife and Plants: A Guide to Wildlife Food Habits
Alexander C. Martin, et. al.
Dover Publications, 1951

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

Appendix E: Deer Management

Berks Nature Rules and Regulations
Deer Management Options
Case Study: Antietam Lake

Berks Nature Hunting Program (BNHP)

Berks Nature Hunting Program
2023-24 REGULATED DEER HUNTING PROGRAM
RULES AND REGULATIONS

Berks Nature Hunting Program (BNHP) conducts controlled deer hunts on properties owned and operated by Berks Nature to manage deer populations consistent with natural resource management goals. Hunters receiving permits for the deer management program are expected to conduct themselves in a safe, honest, and ethical manner. Any hunter who does not act accordingly will have his or her hunting permit revoked immediately. Listed below are the requirements that must be met to receive a permit, examples of what BNHP considers unacceptable behavior, and the regulations that must be followed while hunting.

Permit Requirements

1. All hunters must attend a preseason orientation meeting.
2. All hunters must present proof that they have completed the Pennsylvania Game Commission Hunter/Trapper Education Course. Additionally, it is suggested that all bow hunters complete a Bow Hunter Education Course through the PA Game Commission. The Bow Hunter Education Course is not required but is recommended.
3. Hunters must have an antlerless deer license for the wildlife management unit 5C.
4. All hunters must pass a proficiency test using the sporting arm they plan to hunt with. An **archer** must place three out of four arrows in the vitals of a 3-D target. The target will be placed at various distances up to 25 yards away. **Rifle** hunters must place 2 out 3 bullets in a 4-inch circle at 75 yards.

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

1. Shooting in marginal situations (running deer, when vital organs are obstructed, and at excessive distances).
2. Disrespect of Berks Nature employees, adjacent landowners and or other recreational users.
3. Consumption of alcoholic beverages or use of controlled substances.
4. Failing to appropriately follow up every shot.
5. Displaying game animals inappropriately that would give non-hunters a negative perception of the sport.

Hunting Regulations

1. Berks Nature will determine the days and hours of hunting permitted at a site.
2. Hunters must comply with all Pennsylvania Game Commission regulations.
3. Hunters must endeavor to harvest an antlerless deer. Any hunter that does not make a good faith effort to harvest an antlerless deer will have their permit revoked**. An antlerless deer must be harvested prior to harvesting a buck.**
4. Hunters must hunt at least **24** hours per hunting season or harvest a doe to be considered for hunting privileges for a following year.
5. Only portable tree stands may be used, and hunters must wear a safety harness/fall arrest system. Tree stands shall not harm trees. No screw-in steps are allowed or other tree damaging equipment may be used. All tree stands must be tagged with a tag provided by the hunt program manager.
6. Tree stands shall be removed from the Property by February 17, 2024.
7. All deer harvests and wounded deer must be reported to the hunt program manager within 12 hours.
8. Hunters must attempt to use non-lead ammunition. If you have issues finding non-lead ammunition or your rifle doesn't shoot well with it, please let the hunting program manager know.
9. Hunters must follow the hunting procedure listed below.

Hunting Procedure

All hunters must fill out the Hunting Log each time they hunt. This will be your record of hours spent hunting as well as any deer harvested on the Berks Nature property. Please fill this out in full each day you hunt. Please also let the hunt program manager know of any deer harvested or deer not recovered on the property within 12 hours.

Termination Procedure

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

1. The hunting program manager will verbally inform the hunter of the infraction.
2. The hunter will be provided the opportunity to respond to the accusation.
3. If, in the opinion of the hunting program manager, the hunter has clearly exhibited an Unacceptable Behavior or has violated one of the Hunting Regulations, he will verbally inform the hunter that his hunting permit is revoked immediately.
4. If hunting program manager determines that there are legitimate extenuating circumstances surrounding a violation, the hunter will be given a written warning and may be subject to a probationary period.
5. The hunter will be notified verbally or in writing of a warning or the loss of hunting privileges.

I, the undersigned, have read and understand the above rules, regulations, and termination procedure. I understand that failure to follow the rules and regulations will result in immediate loss of my hunting permit. I have attended an orientation session and I am aware of the property boundaries and the areas where hunting is prohibited. I assume all risk of entry onto the Premises. Berks Nature shall not be liable for any injury or damage to any person or property occurring on or about the Premises during the Term of the Permit.

Signature	Date
Printed Name	Hunting CID number
Email address	Antlerless license TAG number(s)

Vehicle Make, Model, Color and License Plate Number:

Berks Nature Hunting Program is committed to providing programs that are free from discrimination. Hunter selection is based entirely on qualification and competence and is not influenced or affected by race, age, color, ancestry, religion, sex, national origin, or any other legally protected status.

Deer Management Options

excerpted from

Stewardship Handbook
for Natural Lands in Southeastern Pennsylvania

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Natural Lands Trust

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and grassland tracts of at least hundreds of acres. One notable exception is the federally protected bog turtle *(Clemmys muhlenbergii)*, which inhabits relatively small wetlands throughout the region.

In Pennsylvania, wildlife can only be managed directly through activities approved by the state Game Commission and Fish and Boat Commission. These two agencies regulate hunting, trapping, and fishing within the state and support the protection of declining non-game species. The manager of natural lands can have a strong influence on which animal species use a site through stewardship of the plant and water resources on which wildlife depend. Over the last few decades wildlife management has transitioned from a goal of maximizing habitat diversity to encourage edge-loving game species (deer, rabbit, pheasant) to an approach that also includes creating large blocks of contiguous forest and grassland to protect populations that depend on forest interior and grassland habitat.

Rick Cowl

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Bill Moses

© iStockphoto.com/John Pitcher

"Interior habitat wildlife": scarlet tanager, river otter, Eastern meadowlark, bobcat

MAJOR STEWARDSHIP ISSUES

The natural lands in southeastern Pennsylvania have been directly and indirectly affected by human activities for many centuries. While humans have benefited from the products of agriculture and forestry (fuel, food, and building materials), many natural lands are now suffering from the residual effects of exploitation and mismanagement. Today, we look to natural lands more and more to provide local environmental and ecological benefits and to fulfill recreational and aesthetic needs. It is important to understand the full range of issues that should be addressed in any stewardship plan to meet and maintain these needs and benefits. Some issues (overabundant deer, invasive plants, hazards) are the result of past human activities. Some (stormwater erosion, adverse uses) result from more recent activities on or near natural lands. Others (recreational use, dead wood management) are more generally related to the restoration and management of natural lands. This section details the common stewardship issues and how they affect the stewardship of natural lands.

Deer Overabundance

Forest fragmentation, the extirpation of large predators, and cultural norms about hunting have resulted in the proliferation of white-tailed deer to unprecedented population densities. Researchers believe that native forests evolved with deer densities of 5–10 per square mile (1 square mile = 640 acres). ***Deer populations are no longer kept at ecologically sustainable levels*** as they were for more than 99% of their existence, first by large predators and more recently by Native Americans, for whom venison was a major source of food.

A diverse array of predators regulated deer populations for millions of years before humans arrived in our region, including the timber wolf, dire wolf, grizzly bear, giant short-faced bear, mountain lion, American cheetah, and jaguar. Human hunters arrived in what is now southeastern Pennsylvania at least 13,000 years ago, forcing out most of the other major predators, but American Indians, timber wolves, and mountain lions continued to regulate deer populations until Europeans arrived and expelled all three. For the first two centuries after William Penn's arrival, the human population grew exponentially and unlimited hunting began eroding the delicate balance between predators and deer that had prevailed for eons. By 1900, white-tailed deer were nearly extinct in Pennsylvania and other eastern states because of over-harvesting. By instituting game laws, state agencies successfully rebuilt the deer population. Unfortunately, these hunting rules, which largely persisted through the 20th century, focused on providing a "maximum sustained yield" of game for recreational hunters and the deer population consequently soared to unprecedented levels in just a few decades. There is general agreement among scientists, resource managers (foresters, wildlife biologists, farmers, hunters) and landowners (rural and suburban) that this strategy has led to the degradation of forests, agricultural lands, and suburban landscaping throughout the state. (A detailed summary of this issue can be found in the 2005 report by the Deer Management Forum, titled Managing White-tailed Deer in Forest Habitat From an Ecosystem Perspective, available at http://pa.audubon.org.) The simple reason for this is that abnormally high deer populations affect all vegetation layers of the forest, including shrubs, herbs, and

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Browsing by overabundant deer populations is the most significant factor in forest decline in Pennsylvania.

the seeds and seedlings that would have become the next generation of canopy trees, if not consumed by deer.

Statewide, the deer density now averages 25 deer per forested square mile, two to five times the desired density of 5–10 per square mile (2003 PA Game Commission census). In some Pennsylvania suburban areas, populations have risen above 100 per square mile. Deer densities at this level threaten the perpetuation of forest communities, which depend on the ongoing establishment of tree seedlings and saplings in sufficient numbers to occupy the gaps that are created by periodic natural or human disturbance. 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 (a sufficient number of

David Steckel

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 Steckel

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.

established seedlings and saplings available to replace existing trees and shrubs following mortality or disturbance of existing vegetation), with a density of 5–10 per square mile needed to sustain a high diversity of native species, including native herbaceous plants.

Deer are browsers, which means their diet consists mainly of newly grown twigs of woody plants, primarily trees and shrubs. When populations are high, deer can consume all of the established seedlings, as well as many tree seeds (particularly acorns) and herbaceous plants. Over 100 species of native wildflowers and other plant species have been extirpated from Pennsylvania; at least some of these losses have been partly a result of overbrowsing by deer, and many more species are known to be in trouble in the state from the same cause. Browsing by overabundant deer dramatically reduces the survival of native flora and has led to the collapse of plant species diversity in the forest understory and the near cessation of tree reproduction in vast areas of Pennsylvania forests. The resulting lack of cover, food, and structural diversity within forests *(see photos at left)* has undoubtedly reduced wildlife populations, particularly of small mammal, bird, and amphibian species. Native oaks, which are highly preferred food for deer, are not regenerating, which means that wildlife-rich oak forests will cease to exist as adult trees age and die. Furthermore, exotic (non-native) invasive plant species are generally avoided by deer and other plant-eating wildlife (which is one of the reasons they are invasive), so deer have contributed to their proliferation by stripping the forests of their native competitors.

Part of the problem in understanding the forest health problem is that it is *too* easy to "see the forest for the trees." Most forests in our region still look healthy, with a canopy of large trees that have

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.

grown since the last extensive clearing in the late 19th and early 20th centuries. The spread of invasive introduced shrub and understory tree species into natural areas over the last few decades has filled in the vegetation layers vacated by native species as the result of high deer densities. Most forests still look superficially healthy because they are green. Forests with an understory stripped of vegetation have a park-like structure, with tall canopy trees and a uniform low understory or no understory at all. Forests in some parts of our region have looked like this for so long that many people have the impression it is normal and natural.

The best chance for successful regeneration is within forest gaps where more sunlight is available for growth. However, the number of seedlings in a typical forest gap in southeastern Pennsylvania is usually many times less than in a gap in a healthy forest. Successful regeneration in a gap hinges on a few seedlings surviving a host of stresses (buck rubs, invasive vines, drought, insects, windthrow) over the many decades it takes to reach the canopy.

The elimination of tree regeneration not only removes the defining component of the future forest (canopy trees), it greatly amplifies the effects of other stressors by freeing up growing space to invasive plant species and physically creating the disturbed soil conditions to promote their spread. This, in turn, compromises the many benefits—environmental, ecological, and economic (timber production)—that forests provide.

In forests that have been subjected to overbrowsing for many years, the deer density will probably need to be lowered even further than the eventual optimal level for a period of time to allow the forest to regenerate. The section on estimating deer impact under **Wildlife Management** *(page 104)* provides guidelines developed by Penn State University and the US Forest Service for visually assessing deer impact on a forest community.

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.

Fragmentation and Edge Effects

Historically, land use in the region was dominated by agriculture and logging. Those uses, coupled with recent residential and commercial development, have effectively removed or disturbed most of the native vegetation in the region and, through subdivision and clearing, added countless miles of edge (the zone where forest meets a nonforested area) to the fragments of forest that remain. Edges allow light and drying winds to penetrate into

IN THIS SECTION

Stewardship Techniques and Procedures

This section provides an overview of the stewardship techniques and procedures that can help land managers in southeastern Pennsylvania address the problems highlighted in the **Major Stewardship Issues** section *(page 20)*. New information and methods pertaining to stewardship are emerging all the time. The land manager should keep current on natural lands management issues to become aware of new options as soon as possible. The land manager should also keep track of what techniques and procedures work best on his or her property and share this information with colleagues in the region (through Natural Lands Trust and other stewardship information networks) to improve prevailing best management practices.

WILDLIFE MANAGEMENT

The problems posed by an overabundant deer population are highlighted under **Major Stewardship Issues**. Deer overabundance causes the most significant adverse impacts affecting native Pennsylvania forests. The following is a discussion of the methods currently available and their applicability to reducing the impact of overabundant deer populations in southeastern Pennsylvania. It is followed by a much briefer discussion—an indication of their much lower impact—of Canada geese.

Deer Management Options

Wherever deer are present on natural lands in southeastern Pennsylvania, there is a strong likelihood that the population is higher than the ecosystem can sustain without substantial losses of native plant and animal species, forest structural diversity, and advance tree regeneration and the proliferation of exotic (non-native) invasive plant species, black-legged ticks, and the bacterium that causes Lyme disease. That is because deer populations are no longer regulated as they were for millions of years, first by native predators and more recently by Native Americans hunting to supply their families with food. Year-round, geographically pervasive predation is the only force that has been demonstrated to be capable of limiting deer population numbers in most of our region, but all of their major predators are gone and will not be returning. Foods preferred by deer are so abundant across southeastern Pennsylvania that competition for food does not limit deer numbers, at least not until they are so plentiful that browsing has caused catastrophic changes to native ecosystems. Recreational hunting as it

has been practiced since game laws were first instituted over a century ago is very different from predation or subsistence hunting. It does not regulate deer numbers at levels that allow native species diversity, forest structure, and advance tree regeneration to be sustained. However, the Pennsylvania Game Commission has been making changes to hunting regulations recently in recognition of the problems created by overabundant deer, expanding the hunters' "tool kit," extending hunting seasons, and allowing non-recreational culls in some circumstances. This has broadened landowners' options if they wish to reduce deer impacts on their natural lands. This section is designed to help a land manager determine which option or options are most appropriate for his or her property.

No management

No deer management is an option if natural factors (predators, disease, famine) and human activities (hunting, car accidents) within the area are maintaining the deer population at a level that does not adversely affect important natural or cultural resources. Another basis for no management that applies even where deer are overabundant and there is clear evidence of adverse ecosystem impacts is a landowner's belief that wild animals should not be harmed, perhaps coupled with the hope that nature or human ingenuity will eventually remedy the impacts without the need for lethal methods. In most situations in southeastern Pennsylvania, landowners with conservation priorities that include wildlife habitat, natural plant communities, or income from timber harvesting are likely to see those priorities compromised by the consequences of the no-management option.

Failure to manage the deer population will make healthy natural forest communities unsustainable in southeastern Pennsylvania.

David Stockel

Choosing not to manage deer can result in a park-like forest with only canopy trees and an herbaceous layer dominated by exotic invasive species.

An instructive example of the effects of the no-management approach is a 3,400-acre preserve north of Carlisle, Pennsylvania, managed by Natural Lands Trust. This property has suffered from extreme deer overabundance (densities over 100 per square mile) since the late 1960s when hunting was prohibited by the donor's will. The deer population has remained high—despite the total lack of understory vegetation—through the consumption of the annual mast crop (acorns, beech nuts, hickory nuts, etc. from the existing canopy trees), the few tree seedlings that are able to germinate, and agricultural crops on adjacent farm fields. As a result, the forest resembles a park with canopy trees and a carpet of

Japanese stiltgrass spread and sustained by deer disturbance of the soil. Studies of forest gaps—the usual site of dense regeneration—by biologists at Dickinson College show a complete absence of tree seedlings. Computer models confirm the obvious: in the best case scenario, one without a major wind event or forest pathogen, the forest will gradually degrade into an impoverished savanna community with extremely low native species diversity as the current canopy trees decline and die.

Based on the current understanding of deer ecology and results on properties with high-density deer populations, failure to manage the deer population will make healthy natural forest communities unsustainable in southeastern Pennsylvania. The loss of native species diversity and structural variation in the understory will reduce habitat for local and migratory wildlife. A forest without a diverse understory lacks cover for ground-nesting birds such as ovenbird, worm-eating warbler, and Louisiana waterthrush and protected feeding and nesting areas for other forest-interior birds, including barred owl, Acadian flycatcher, wood thrush, cerulean warbler, northern parula, American redstart, Kentucky warbler, and hooded warbler. A forest devoid of an understory also lacks shelter and moist conditions preferred by reptiles and amphibians, including salamanders, frogs, and turtles. The likely shift in plant dominance to exotic invasive species from natives, which are preferred browse for deer, will decrease food resources for insects (a key link in the food web sustaining larger animals), birds (the growth and survival of young birds, and often adults as well, depend on insects to supply fat and protein), and aquatic invertebrates in associated forest streams (they are largely unable to digest leaves of exotic plant species).

Without deer management, perpetuation of some semblance of natural forest communities would require the use of artificial regeneration (planted trees and tall shrubs) to regenerate the forest until the deer population collapses through disease or starvation. Trees and shrubs will need to be tall enough (>5 feet) when planted to escape browsing of terminal buds and be planted in numbers sufficient to maintain at least a 60% closed canopy under pressure from environmental stresses and pests and pathogens. The land manager will also need to accept the likely loss or severe degradation of the native herb layer.

Active management

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 are prohibited in the state 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 although they can be expensive if used over a large area.

Tree shelters are useful to protect seedlings in open areas (estate areas, forest

gaps, and edges) until they reach 6 feet in height and are above the maximum browsing height of deer. However, their cost and maintenance requirements might limit their use by some landowners (financial assistance for planting and tree shelters may be available from the Pennsylvania Bureau of Forestry or the USDA Natural Resource Conservation Service). A 5-foot tree shelter with support stake costs $5 to $6 depending on the quantity purchased. A per-acre cost at a 12-foot x 12-foot spacing will therefore run $1,500 – $1,800, plus tree seedlings and installation. Tree shelters also require periodic monitoring and maintenance as they are attractive to deer as rubs and are sometimes targets of vandals.

Fencing holds more promise as a deer management tool, but it involves significant up-front expense and frequent monitoring to ensure the integrity of the fence. Deer fencing around significant areas of land are 8–12 feet high and constructed of box wire, plastic mesh, or electrified wire (shorter fencing can be effective if the enclosed area is very small or narrow, such as a vegetable garden). The Pennsylvania Bureau of Forestry uses two 4-foot sections (8-foot total height) of box wire fencing kept tight to the ground to protect tree regeneration following timber harvests. Bowman's Hill Wildflower Preserve in Bucks County fenced 80 of its 100 acres with electrified wire in the early 1990s, effectively protecting its wildflower collection. Tyler Arboretum, near Media, Delaware County, in 2000 installed a 12-foot-tall, 2-mile-long deer fence around 105 acres of its collection at a cost of $350,000 (including more than $50,000 to provide vehicular access and a portion placed in the endowment for continuing maintenance). In addition to its high initial cost, fencing requires constant monitoring to quickly repair any breaks caused by falling limbs or vandals and restricts not only deer movement, but also the movement of several other animal species. Cost estimates for large-scale fencing projects are currently on the low end about $8–$10 per running foot of fence and, depending on site characteristics and materials used, can range up to $30 or more per running foot, including installation.

Gary Gimbert

Tree shelters are useful to protect seedlings in open areas (forest gaps and edges) from deer damage until they reach six feet in height and are above normal browsing height.

Costs and monitoring are complicated by internal roads, paths, or streams, requiring gates and stream crossing devices. One option that reduces the cost is to use temporary fencing, enclosing large (a quarter to half of the forested area) sections on a rotating basis to protect vital forest regeneration from deer browsing while maintaining accessibility to the rest of the forest for management and recreation. However, once advance tree regeneration is established and the fence is moved, the previously fenced areas are open to understory degradation again by deer browsing.

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Fencing can also be used as an instructional and monitoring tool. Small (10 meter square) deer exclosures can be built at a relatively low cost (approximately $300 per exclosure) to be monitored and compared to the existing forest. These study and demonstration areas provide a picture of the forest's potential when browsing impacts from deer are removed. They also provide a feasible, more understandable, and far more useful barometer of deer overabundance than estimating deer density. The state of the forest within the exclosure can guide deer management outside.

Repellents

Repellents create unpleasant sensory experiences that discourage deer from physically interacting with vegetation in the treated area. Repellents include periodic loud sounds, bright lights, or foul-tasting foliar sprays, 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.

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

The use of contraceptives to manage the deer population on natural lands in southeastern Pennsylvania is not only prohibited by law, except as part of an established research program, but it is also infeasible at this time due to the high cost.

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

At present, the cheapest and most common method for administering immunocontraceptives is through the use of dart guns—close-range arms that are accurate to about 40 yards. Most population biologists feel that in order to stop herd growth in deer, they have to prevent pregnancy in 90% of the female population. Immunocontraceptives developed so far have to be readministered periodically to sustain sterility in each individual doe.

Hormonal contraceptives work primarily by preventing ovulation in does. The most effective method for administering this type of contraceptive is through subcutaneous implants. Although one treatment can be effective for multiple years there are logistical and health concerns associated with the use of hormonal contraceptives in natural areas on free-ranging deer (entering

and leaving properties at will). The first is the need to immobilize each deer to apply the treatment, which is logistically difficult, very expensive, and stressful to the animal, often leading to self-injury or death. Potentially more problematic is the unknown consequences of introducing these hormones into the food supply.

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

The use of contraceptives to manage the deer population on natural lands in southeastern Pennsylvania is not only prohibited by law, except as part of an established research program, but it is also infeasible at this time due to the high cost (over $1,000 per doe annually for immunocontraceptives), the potential health risks of hormonal contraceptives, and the high mobility of the local deer herd. The fact that deer are free ranging throughout the region makes treating enough of the right animals almost impossible.

Trap and Transfer

Trapping or darting deer (requiring a permit from the Pennsylvania Game Commission) and moving them to another location is the most expensive, difficult, and ineffective deer control method. It is an option fraught with problems, the greatest of which is finding a location willing to accept more deer. This problem has become more difficult with the recent spread of chronic wasting disease (CWD) to nearby states (West Virginia and New York). Attracting well-fed deer into baited traps is the next challenge. Finally, survival rates of transported deer have been low. At present, the Pennsylvania Game Commission has a policy of issuing no permits for trapping and transferring deer.

Trapping or darting deer and moving them to another location is the most expensive, difficult, and ineffective deer control method.

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 by the Pennsylvania Game Commission. All lethal means of deer management focus on reducing the number of does by mainly targeting antlerless deer. Removing bucks has almost no effect on the year-to-year rate of population increase, decrease, or maintenance.

A controlled, recreational hunting program in most cases is the most practical deer management tool available in southeastern Pennsylvania at this time.

Hunting is the most frequently used deer population reduction and maintenance method commonly available to landowners and land managers.

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A controlled hunting program is probably the most effective deer management tool available to landowners in southeastern Pennsylvania at this time.

Drew Gilchrist

However, scientific evidence is still lacking that it is fully effective over a broad range of situations for reducing impacts of deer to levels adequate for the restoration and maintenance of ecosystem health. The likelihood of success rests to a large degree on the level of experience, skill, and dedication of the particular set of hunters who are the mainstay of the program.

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

Ideally, hunting can lower the deer population to a level where only a few deer need to be removed each year to maintain the population at a level that allows healthy regeneration of the forest. Achieving this maintenance level is often complicated by ongoing suburban development in the surrounding landscape, which temporarily concentrates more deer on the remaining natural lands. If this is the case, it will probably require an extended period of more intense hunting, targeting mainly does, until the conversion of unprotected natural areas in the landscape to residential or other uses is complete. Perpetuating a maintenance level is also complicated by the fact that with a lower population, it may take hunters as much time to search out and remove a few deer as it now takes to remove a few dozen deer. The land manager will need to engage proficient, dedicated hunters to maintain the population at acceptable levels. Until additional options become available, recreational hunting will be the most widely used long-term method of keeping the population in check and allowing for limited forest regeneration until a point where populations stabilize in the surrounding area, which could be decades.

There are several potential alternatives and modifications within the lethal removal option that can be employed to reduce deer populations. The first is the use of archery, particularly on small

properties or properties with numerous residential structures on its borders. This would expand the hunting area (the safety zone for archery is 50 yards; firearms require a 150 yard safety zone) and extend the hunting time during the year by several weeks. An added benefit of allowing expanded access by hunters is that permitted hunters will monitor for unwarranted hunting while they are in the field.

In some situations, it is more efficient to engage a local hunting club to implement a deer population control program. They can handle all program administration, including proficiency tests, the scheduling of hunting times, and data collection on the separate harvest rates of does and bucks. The group should provide proof of insurance and be in close contact with the property landowner or manager to avoid conflicts with other activities in hunting areas.

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

A final option does not involve recreational hunting at all. It is the use of sharpshooters to remove deer. Under this option qualified professional sharpshooters are hired to euthanize a high quantity of deer within a property. This requires a special permit from the Pennsylvania Game Commission. The process is very rigorous and requires the landowner to make a convincing case that hunting within current game laws is not a viable option for managing the deer population at desired levels. However, this is probably the safest (removal is usually done at night using infrared sighting scopes, over isolated baiting stations located where shots are directed into the ground) and quietest (sharpshooters use rifle silencers) removal method and is the most effective option for reducing the deer population in the shortest time. The cash outlay is relatively high but the time demands on the land manager can be considerably lower than that required to run a controlled hunting program. The venison is dressed and donated to charitable food banks or government-run institutions. Removal of other signs of the cull such as bloodied leaves may also be a part of the sharpshooters' services. Culls must be performed annually, at least until ecosystem restoration is achieved. Once the deer population is reduced and overbrowsing impacts are alleviated, a controlled hunting program—if it is permissible or feasible—may be adequate to maintain the desired deer population density.

Summary of Active Deer Management Options

METHOD	COMMENTS	MOST APPROPRIATE APPLICATIONS
Tree Shelters	High cost and maintenance requirements	Converting small open areas to forest. Protecting landscape plantings.
Deer Fencing	Significant up-front cost, frequent monitoring	Establishing tree regeneration in overbrowsed forest areas. Creating demonstration areas. Protecting collections (arboretums).
Repellents	Impractical in natural areas	Protecting landscape plantings in small areas.
Contraceptives	High cost, permit/license	Maintaining populations in areas enclosed by fencing or isolated by significant natural boundaries (e.g., water, mountains).
Trap and Transfer	Expensive, difficult, transfer location, permit/license	Removing deer that are in an area that puts humans or themselves in immediate danger.
Lethal Removal	Currently most effective, safety concerns	Reducing and maintaining populations in areas large enough to provide appropriate safety zones.

Estimating Deer Impact

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

Deer Impact Index 1
Very low: No deer browsing. Occurs only within a well-maintained deer exclosure.

Monitoring vegetation indicators is a practical way to assess the effect of deer on forested areas.

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

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

Deer Impact Index 4
High: Preferred species are sparse or absent and all plants are nearly the same height as a result of browsing. Vegetation in the shrub layer is sparse except for the least-preferred species (e.g., spicebush, American beech, exotic invasive shrubs).

Deer Impact Index 5
Very high: A pronounced browse line is evident with virtually no vegetation below the browse line except for two rhizomatous fern species, hay-scented fern and New York fern or exotic invasive herbaceous species such as Japanese stiltgrass and garlic mustard.

The deer impact index is a qualitative measure; its utility for detecting change over intervals as short as one or two years is weak and its usefulness depends heavily on the level of experience and knowledge of the evaluator on food-plant preferences of deer, expected maximum sizes of various plant species under a variety of habitat conditions, and how to distinguish signs of deer browsing from plant damage by other animals and causes other than herbivory. Please note that these impact levels apply to later successional stages, particularly maturing, mature, and old-growth forests. Young forests (up to approximately 30 years old) typically have a dense canopy that prevents sunlight from reaching the

forest floor. In this stage—called the pole or stem exclusion stage—the understory is largely free of shrubs and herbs due to heavy shade. As the forest matures and the canopy thins from the death of weaker trees, there is sufficient light to support a shrub layer on which deer can browse.

Quantitative sampling is more time-consuming but its interpretation involves less judgment and specialized expertise. A quantitative approach could include periodic surveys along a transect or cataloging vegetation change within fixed plots. The latter could be used in conjunction with the construction of deer exclosures. Methods need to be scientifically rigorous if the results are to be sufficiently credible to serve as the basis for labor-intensive and potentially costly deer management procedures. For example, the protocol should include:

- random selection of areas to be sampled;
- sampled areas large enough and sufficiently dispersed to include the variety of plant resources found within the property;
- sufficient replication and interspersion of treatments across the entire sampling area, for example, deer fencing, repellents, hunting; and
- sufficient number of samples to increase the likelihood of early detection of relatively subtle differences and to minimize the chances of confusing the effects of deer browsing with the effects of other factors that influence plant species composition.

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

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

The US Forest Service has developed assessment procedures for determining the current level of deer impact on forest regeneration as well as the level of competition from invasive species and other plants (e.g., ferns, mountain-laurel) that might interfere with the growth of established seedlings after a timber harvest. A copy of this assessment procedure is outlined in the Forest Service General Technical Report NRS-11 available from the US Forest Service, Northern Research Station, 359 Main Road, Delaware, OH 43015 or http://nrs.fs.fed.us/pubs/2471.

Estimating Deer Abundance

It is often said that a density of 15–20 deer per forested square mile is a maximum level allowing minimal advance tree and shrub regeneration, and a density of 5–10 per square mile is needed to sustain a high diversity of native species, including native herbaceous plants. These numbers come from a small set of studies in large forest tracts of a single forest type in northwestern Pennsylvania, in which deer density was known because the research areas were fenced, emptied of deer, and then restocked with exactly the numbers of

deer needed to achieve specific densities. This was excellent research, but we also know that deer density interacts with a host of other factors in determining the level of browsing impact on various forest ecosystem functions. Those other variables include forest type, understory species composition, landscape context, soil type, soil moisture regime, forest-floor light level, length of growing season, alternative food sources, historical land use, patterns of seasonal movement by deer, and legacy effects of prolonged high deer numbers (e.g., depleted seed bank, scarcity of live seed sources within dispersal distance, and disproportionate abundance of non-preferred understory plant species). These interactions are complex, unpredictable, and severely constrain the potential usefulness of deer density alone as a predictor of ecosystem impacts.

Where resources are limited, which is certainly the case for most managers of natural lands in southeastern Pennsylvania, it may be cost-ineffective to divert time and money from vital tasks, including deer management, to estimating deer density. Keeping careful track of the number of does killed each year by hunters or sharpshooters, in combination with rigorous monitoring of ecosystem indicators (see previous section) is sufficient in most cases for tracking progress in achieving and maintaining a deer density that allows forest ecosystems to be sustainable.

However, if the resources are available, it is desirable to monitor deer abundance to make certain that management actions intended to reduce or maintain deer populations actually do so. Making a full count of any animal species in the wild is nearly impossible, but several methods have been developed to estimate the abundance of white-tailed deer.

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

Direct methods include aerial surveys, which have the advantage of covering large areas quickly and easily, although hiring pilots and renting aircraft are expensive. The main problem with using aerial surveys for white-tailed deer in this region is visual obstruction by vegetation. Although the region contains a predominantly deciduous forest and aerial surveys are performed only in winter, a large percentage of deer can be obscured by evergreen trees and shrubs, topographic features, and even the trunks and branches of deciduous trees and shrubs. Researchers have shown that thermal imagery—flying at night using infrared-sensitive instruments—is far more effective than daytime aerial survey methods. It is ideally done on very cold winter nights, when the thermal contrast is greatest. Sources of error include counting two or more deer lying or standing together as one and missing deer that are partially obscured by evergreen foliage, tree trunks, or topography. A recent review evaluating the application of thermal imagery technology in a variety of deciduous forest environments reported inconsistent results, with 11 to 69% of the deer missed in the audited surveys and an average detection rate of 56% of the total deer present in the study areas.

Another direct approach is the mark-recapture method, which involves marking individual deer and comparing the proportion of marked deer recaptured or killed in a subsequent roundup or hunt. This method is highly labor-intensive and extremely expensive because a large number of deer need to be marked—at

least 45% of the deer if the population is small (less than 200). In addition, the method is based on the assumptions that marks are never lost and deer do not emigrate from the study area. The mark-recapture method has been shown to overestimate deer populations because of unknown mortality of marked deer and emigration from study areas. Accurate monitoring of mortality and emigration requires the use of radio-collars in place of marks. Another problem with this method is that every deer is assumed to have the same probability of being recaptured or taken by hunters, which is likely to be violated owing to differences between older and younger deer in wariness, ability to evade pursuers, and hunter preference. The only place the mark-recapture method has been used is in a small minority of scientific research projects that are well funded; it is beyond the budgets of most land managers and researchers.

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

Counting fecal pellet groups is the most widely applied means of indirectly estimating deer density. A typical method is to visit a large sample of uniform-sized plots across the study area and eradicate

If the resources are available, it is desirable to monitor deer abundance to make certain that management actions intended to reduce or maintain deer populations actually do so.

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

Although widely used, pellet group counts are subject to many sources of error, which may be minimized by careful design and execution of the specific protocol. They include observer skill and fatigue in detecting pellet groups, choice of plot shape, habitat (vegetation) influences on detection of pellet groups, and decay rate of pellets. The most sophisticated surveys apply the technique of "distance sampling" to account for differential detection among habitats, factor in the decay rates of pellet groups, and use a statistically based sampling design. However, even

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

NATURAL LANDS TRUST REGULATED HUNTING PROGRAM
Rules and Regulations

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

Permit Requirements

1. All hunters must attend a preseason orientation course to be conducted by the preserve manager.
2. All hunters must present proof that they have completed the Pennsylvania Game Commission hunter-trapper education course. Bowhunters must present proof that they have completed a bowhunter education course.
3. Hunters must have an antlerless deer license for the deer management unit of the preserve.
4. All hunters must pass a proficiency test using the sporting arm they plan to hunt with. For **firearms**, a hunter must place 4 out of 5 slugs in a 9-inch paper plate at 45 yards. No buckshot allowed. Shooting from a treestand 10 feet above the ground, an **archer** must place 5 out of 6 arrows in the vitals of a 3-D target. The target will be placed at 5, 10, and 15 yards from the base of the tree.

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

1. Shooting in marginal situations such as at running deer, when vital organs are obstructed, and at excessive distances.
2. Disrespect of Trust employees, adjacent landowners, and other preserve users.
3. Consumption of alcoholic beverages or use of controlled substances.
4. Failing to appropriately follow up every shot.
5. Displaying game animals unnecessarily.

continued...

the most careful surveys are based on a number of questionable assumptions, including a constant defecation rate and no variation in decay rates among habitat types. Research on defecation rates indicates that they vary among seasons (presumably because of dietary changes) and among age and sex classes and that pellet decomposition rates differ according to habitat type. Despite their limitations, however, pellet group counts may be the most practical means of monitoring changes over time in deer densities in natural areas.

Natural Lands Trust's Deer Management Program

At Natural Lands Trust, our goal is to preserve and enhance the plant communities within our preserve system to maximize wildlife benefits. With that goal in mind and based on an understanding of the requirements of the state wildlife code, we have instituted a deer management program that focuses on reducing deer populations to a level that will allow advance tree regeneration and survival of native herbaceous species. While we employ small exclosures to protect certain plants and for demonstration purposes, over most of our lands we implement controlled hunts to reduce the numbers of deer.

The rules that hunters must adhere to reflect an overriding concern for safety, not only for the participants of the management program, but for other preserve users such as walkers and bird-watchers *(see sidebars)*. A mandatory proficiency test ensures that hunters are familiar and competent with their sporting arm and a flagged map locates hunter positions for the preserve manager and other hunters. Participants wear bright NLT armbands that allow preserve managers as well as others to tell from a distance if a hunter has permission to hunt. The rules place due emphasis on removing does from the population, because it is almost exclusively the doe removal rate that influences population size. Preferentially harvesting does is capable

NATURAL LANDS TRUST REGULATED HUNTING PROGRAM
Rules and Regulations

...continued

Hunting Regulations

1. The Trust will determine the days and hours of hunting permitted at a site.
2. Hunters must comply with all Pennsylvania Game Commission regulations (including returning report cards).
3. Hunters must endeavor to harvest an antlerless deer. Any hunter that does not make a good faith effort to harvest an antlerless deer will have their permit revoked. Archers must take an antlerless deer before being eligible to harvest a buck.
4. Hunters must hunt at least 20 hours.
5. Only two shells can be loaded at any one time (one shell in the chamber, one in the magazine).
6. Only portable tree stands may be used and hunters must wear a safety belt. No screw-in steps are allowed. All tree stands must be removed by January 26th, or they will be forfeited.
7. Crossbows and .410 shotguns are not allowed.
8. Hunters must follow the hunting procedure listed below.

Hunting Procedure

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

Termination Procedure

If the preserve manager witnesses a case of unacceptable behavior or a violation of one of the hunting regulations by a permitted hunter, or is informed of such an incident by a reliable source, he will abide by the following procedure to address each incident:

1. The preserve manager will verbally inform the hunter of the infraction.
2. The hunter will be provided the opportunity to respond to the accusation.
3. If, in the opinion of the preserve manager, the hunter has clearly exhibited an unacceptable behavior or has violated one of the hunting regulations, he will verbally inform the hunter that his hunting permit is revoked immediately.
4. If there are legitimate extenuating circumstances surrounding a violation of hunting regulation 6 or 8, the hunter will be given a warning. A second violation of these regulations will result in immediate loss of hunting privileges. Violations of any other hunting regulation or unacceptable behavior rule will not receive a warning and will result in immediate termination of hunting privileges.
5. The hunter will be notified in writing of a warning or the loss of hunting privileges.

Jack Steffernd

Dan Barringer

As part of its deer management program, Natural Lands Trust regulates the hunters it permits on its preserves. Requiring a certain level of proficiency and mapping hunter locations help protect the safety of all preserve users.

of bringing populations to tolerable levels far more quickly than would a random removal strategy; preferentially harvesting bucks has almost no effect on birth rates and therefore will not control the population size.

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

Goose Management Options

The Canada goose did not breed anywhere in Pennsylvania before the 1930s, when the Pennsylvania Game Commission began releasing captive pairs, with their flight feathers clipped, into the wild. Since then, the species has gone from an awe-inspiring native of the high Arctic that heralded spring and fall each year with the breathtaking spectacle of its migrating flocks to a semi-domestic species regarded in many areas as an unwanted pest. 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. The following management recommendations apply to the year-round resident population of Canada geese; the much smaller migratory population seldom if ever causes any problems.

On properties with attractive goose habitat, landowners will need to consider active management to prevent degradation of on-site and off-site water quality by coliform bacteria and nutrient input from

bctv < https://www.bctv.org>

Posted on August 29, 2023 by Heather Adams

Antietam Lake Park Deer Management Program to begin Third Year on September 16

by The County of Berks

Berks County is preparing for the start of the 2023-2024 Antietam Lake Park Deer Management Program. The archery-only hunting season will begin on September 16, 2023, and run through January 27, 2024. Hunting will be prohibited on Sundays with the exception of November 12, 19, and 26, when it will be permitted. Hunting will be permitted 30 minutes before sunrise until 30 minutes following sunset.

The Antietam Lake Park Deer Management Program is a joint venture between the Berks County Parks and Recreation Department and USDA Wildlife Services, who also manage hunting programs for the City of Reading and Berks Nature. No hunting will be allowed in Antietam Lake Park without authorization from USDA Wildlife Services and a valid permit. Archery hunters must follow all Pennsylvania Game Commission rules.

Hunters selected to participate in the program will complete the application process, pass a proficiency test, and attend an orientation which included safety and hunting ethics. Valid hunters will carry a hunting permit card for identification purposes.

This program is meant to reduce deer populations until the negative impact to our parks is alleviated, and then to maintain deer populations as needed to have a balanced ecosystem. This will reduce park land damage and forests property damage, minimize the threat of disease, reduce deer-related accidents, and re-balance the local ecosystem.

For more information or to get a Waiting List Application, please contact The USDA Wildlife Services office at 610-916-1415.

Appendix F: Stormwater Management

Stormwater Management in Pennsylvania

Fact Sheet

Commonwealth of Pennsylvania • Department of Environmental Protection

STORMWATER MANAGEMENT IN PENNSYLVANIA

WHAT IS STORMWATER MANAGEMENT?

Stormwater management involves the control of water that runs off the surface of the land from rain or melting ice or snow. The volume, or amount of runoff and its rate of runoff, substantially increase as land development occurs. Construction of impervious surfaces, such as roofs and parking lots, and the installation of storm sewer pipes which efficiently collect and discharge runoff, prevent the infiltration of rainfall into the soil. Management of stormwater is necessary to compensate for the possible impacts of development such as frequent flooding, erosion and sedimentation problems, concentration of flow on adjacent properties, damages to roads, bridges and other infrastructure as well as non-point source pollution washed off from impervious surfaces.

HISTORY OF DRAINAGE CONTROLS IN PENNSYLVANIA

Court decisions over the years have placed various common law duties and responsibilities on landowners involved with obstructing water courses and collecting and discharging of runoff onto adjacent lands.

Pennsylvania cities, boroughs, townships and counties have been authorized by state statute (Pennsylvania Municipalities Planning Code, Act 247 as amended) to prepare comprehensive plans for community development, zoning ordinances and subdivision and land development ordinances and regulations that may include provisions for drainage and stormwater management. However, governments are not required to adopt these plans containing development controls. Further, there is no obligation for local governments having stormwater management regulations to consider the effects of runoff beyond their boundaries. Often, municipalities within a watershed may require different levels of control that result in increased flooding problems.

PENNSYLVANIA'S STORMWATER MANAGEMENT PROGRAM

The Pennsylvania legislature enacted the Storm Water Management Act (No.167) in 1978 to authorize a program of comprehensive watershed stormwater management which retains local implementation and enforcement of stormwater ordinances similar to local responsibility of administration of subdivision and land development regulations. Under the Act, the Department of Environmental Protection (DEP) provides grant money to counties to develop stormwater management plans for designated watersheds. This planning effort results in the incorporation of sound engineering standards and criteria into local codes and ordinances to manage runoff from new development in a coordinated, watershed-wide approach.

HOW THE STORMWATER PROGRAM WORKS

Counties develop stormwater plans for each of their watersheds within their boundaries. DEP develops grant agreements with counties to pay for 75 percent of the cost to prepare the plans. Upon completion of a plan by a county and approval by DEP, municipalities located in the watershed adopt ordinances consistent with the plan. Developers are then required to follow the local drainage regulations that incorporate the standards of the watershed plan when preparing their land development plan. Although not all watersheds have been studied, developers in non-studied areas are still required to follow any local drainage regulations adopted under the Municipalities Planning Code.

GUIDE TO THOSE AFFECTED BY RUNOFF

Individuals and property owners affected by runoff due to development need to know who is responsible for management of stormwater runoff in their particular situation. The following guide can assist in making that determination.

Municipalities: Historically, municipalities have been responsible for enacting ordinances to regulate stormwater as they review subdivision and land development plans (Pennsylvania Municipalities Planning Code).

Developers: Developers are required to follow local drainage regulations. In watersheds having a completed Act 167 plan, developers, by following local ordinances, would be following the standards and criteria of the approved watershed plan.

Department of Environmental Protection: DEP is responsible for management of the stormwater planning program but has no regulatory authority for individual activities. Section 10 and 12 of the act provide DEP with authority to compel county planning and municipal implementation in studied watersheds. DEP also provides technical guidance and training to counties, municipalities and individuals.

County Conservation Districts: The Districts investigate runoff complaints resulting from earthmoving activities. Stormwater may be controlled during construction activities through temporary erosion and sedimentation control devices such as sedimentation basins. Upon stabilization of work sites, temporary erosion and sedimentation structures are often converted to permanent stormwater facilities under the jurisdiction of municipalities.

SUGGESTIONS IN RESOLVING STORMWATER PROBLEMS

- Document problems by taking photographs and videos and making sketches of site conditions.
- Try to determine the source of stormwater runoff. Is there new development upstream/uphill from your location? Are there nearby road improvements, such as widening or drainage pipes installed?
- Is the runoff originating from an active construction site where earthmoving activities are occurring or is there sediment or mud leaving the site? If so, the County Conservation District may assist with any erosion and sedimentation control problems.
- In the case of runoff originating from recent development, contact the municipality where the development is located.
- Seek legal counsel if the problem has not been resolved after seeking assistance from all involved parties or agencies.

LOANS AVAILABLE FOR UNDERTAKING STORMWATER PROJECTS

Governmental agencies are eligible to obtain low interest loans from the Pennsylvania Infrastructure Investment Authority (PENNVEST) to resolve drainage problems.

Loans are available for the construction, improvement or rehabilitation of stormwater systems and installation of best management practices to address point or nonpoint source pollution associated with stormwater. Examples of stormwater projects eligible for funding include:

- New or updated storm sewer systems to eliminate stormwater flooding or to separate stormwater from sanitary sewer systems;
- Detention basins to control stormwater runoff; and/or
- Stormwater facilities to implement best management practices to reduce nonpoint source pollution.

The loan program is administered by PENNVEST staff with technical services from DEP. DEP engineers provide technical guidance to loan applicants. The scope of their guidance includes:

- Conducting planning consultation meetings with loan applicants and their engineers;
- Reviewing project plans and specifications;
- Rating the projects under established criteria;
- Recommending projects for funding;
- Participating in and representing PENNVEST at preconstruction conferences;
- Conducting interim and final construction inspections; and
- Assisting PENNVEST in conducting educational programs.

AVAILABLE INFORMATION FROM DEP

- The Storm Water Management Act (No. 167) of 1978.
- Storm Water Management Guidelines and Model Ordinances.
- Chapter 111. Storm Water Management - Grants and Reimbursement.
- PENNVEST regulations and application form

To obtain publications, contact the

Pa. Department of Environmental Protection
Bureau of Watershed Management
Division of Water Use Planning
Rachel Carson State Office Building
P.O. Box 8555, Harrisburg, PA 17105-8555
717-772-4048
FAX 717-787-9549

This fact sheet and related environmental information are available electronically via Internet. For more information, visit us through the PA PowerPort at http://www.state.pa.us or visit DEP directly at http://www.dep.state.pa.us (directLINK "Stormwater").

www.GreenWorks.tv - A web space dedicated to helping you learn how to protect and improve the environment. The site features the largest collection of environmental videos available on the Internet and is produced by the nonprofit Environmental Fund for Pennsylvania, with financial support from the Pennsylvania Department of Environmental Protection, 877-PA-GREEN.

Appendix G: Riparian / Watersheds

Streamside Buffers

STREAMSIDE BUFFERS

Trees help create healthier land and cleaner water, naturally!

So, what is a streamside buffer?

A streamside buffer is a deliberate planting of trees and shrubs along any size of waterway to protect it against erosion and pollution. Trees within these buffers act like sponges to slow rainwater runoff, keeping your land intact and protecting your property value.

Cleaner water and healthier land both benefit all Pennsylvanians. Planting a streamside buffer shows your neighbors that you are a good steward of your land and how much you value your community.

What types of trees and shrubs work best?

Effective streamside buffers feature trees and shrubs native to our region. Native plants thrive in our climate, are easier to care for and provide excellent food and habitat for local species of wildlife in water and on land, including trout and pollinators. Many different species, like those listed on the right, can thrive in streamside buffers.

There are many other trees and shrubs that may work for your property and make a great streamside buffer. Your buffer specialist will work with you to plan the perfect streamside buffer that best meets your needs and your land.

FLOWERING TREES/ SHRUBS:

Dogwoods
Redbud
Pussy willow
Serviceberry
Blackhaw viburnum

TREES/SHRUBS THAT PRODUCE EDIBLE NUTS/FRUIT:

Persimmon
Pawpaw
Highbush blueberry
Elderberry
American hazelnut

GENERAL TREES/ SHRUBS:

Sycamore
Swamp White Oak
Black willow
Ninebark
Arrowwood viburnum

How much space is needed to install a streamside buffer?

To create an effective streamside forest buffer that filters pollution and improves your property, approximately 150–200 trees should be planted on each acre. Trees should be spaced 10 to 15 feet apart and planted in rows to help make caring for the trees easy.

Streamside buffers should be at least 35 feet wide or planted in 2–3 rows going back from the edge of the streambank. The wider the streamside buffer, the better it works to stop erosion, reduce pollution, clean the water, and create privacy on your property. However, any trees along a stream are beneficial!

Each new streamside buffer and the spacing, width and tree species selected will be tailored specifically to your property and your preferences as the landowner.

What type of maintenance is needed to maintain a buffer?

After trees are planted, they need help to thrive and grow. For the first several years, weeds around the trees should be removed or controlled. After trees are planted, they are protected with plastic shelters, which help keep them safe from hungry wildlife. Tree shelters should be straightened after winter, and after storm or flooding events. Your buffer specialist can help you complete a tree care and maintenance plan to ensure your planting continues to be a success.

I'm interested in buffering my stream. What next steps do I take?

We want to help you plant your buffer! We can recommend an approach that is customized for you and your property—and we can help find funding opportunities and support to install your streamside buffer.

Contact our stream buffer experts at dcnr.pa.gov/BufferMyStream, ra-nrstreambuffers@pa.gov, or 717-705-2820 to arrange a visit.

Buffering your stream shows your neighbors and the community that you are a good steward of your land. It has a positive impact on Pennsylvania's natural resources and the Chesapeake Bay watershed—and leaves a legacy for years to come.

THE BENEFITS OF STREAMSIDE BUFFERS

Reduced erosion: Tree roots hold streambanks in place.

Improved habitats: Streamside buffers create better natural conditions for wildlife in the water and on land, including trout and pollinators.

Enriched landscape: Buffers add shade, privacy and help with property value.

Cleaner water: Trees and shrubs filter pollution.

YOUR LAND. YOUR LEGACY. YOUR NATURAL RESOURCES.

Protect them all by planting a streamside buffer.

Learn more at dcnr.pa.gov/BufferMyStream

pennsylvania
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

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Photo credits: Will Parson/Chesapeake Bay Program

Coldwater Conservation Plan

for the

Wyomissing Creek Watershed

Prepared by Berks County Conservation District for the Wyomissing Creek Watershed Coalition

2013

This project was funded by a planning grant from the Coldwater Heritage Partnership

BERKS COUNTY CONSERVATION DISTRICT

Table of Contents

Acknowledgements

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The Berks County Conservation District prepared this plan in order to provide a road map for the conservation of the Wyomissing Watershed's coldwater characteristics. The Municipalities of West Reading, Wyomissing, Shillington, Spring, Mohnton, Cumru, Brecknock and the City of Reading are to be commended for their willingness to plan for the conservation and enhancement of the Wyomissing Creek and surrounding lands. The Berks County Conservation District wishes to recognize these municipalities for their partnership, planning efforts, and active participation.

The Berks County Conservation District also wishes to acknowledge the Berks County Conservancy, as the nonprofit completed a 2004 Watershed Conservation Management Plan. Much of the historical data in this report can be attributed to that report.

Lastly, Great Valley Consultants has been a gracious and willing partner in the planning process. The Berks County Conservation District acknowledges the technical assistance, guidance, field work, and partnership that this company provided that aided in the completion of this plan.

Thank you.

Introduction & Objectives of the Coldwater Conservation Plan

The main objective of this Coldwater Conservation Plan is to assist the Municipalities of the Wyomissing Watershed in conserving the cold water characteristics and resources of the Wyomissing Watershed by providing a road map that will outline how to reduce the impacts of nonpoint source water pollution.

In 2012, the Berks County Conservation District applied for and received a grant from the PA Coldwater Heritage Partnership to create an overview of suggestions that would assist the Municipalities of the Wyomissing Watershed in reducing nonpoint source pollution inputs into the Wyomissing Creek and its tributaries. Formed in 1946, the Berks County Conservation District (BCCD) is dedicated to the encouragement of and education in the wise stewardship of soil and water, so that present and future generations in Berks County may have healthy land on which to live and work, and clean water for drinking and recreating. The BCCD has a long, successful history of partnering with local and state organizations to implement Best Management Practices (BMP) that reduce the amount of nonpoint source water pollution from entering Berks County streams.

In 2010, the Municipalities of Reading, West Reading, Wyomissing, Shillington, Spring, Mohnton, and Cumru began meeting regularly to discuss various concerns regarding the Wyomissing Watershed. The concerns addressed such issues, including but not limited to, how to comply with the proposed changes in the PA Department of Environmental Protection's (PA DEP) Municipal Separate Storm Sewer System (MS4) program and how to comply with a 2004 Sediment TMDL. In 2013, Brecknock Township joined the seven other municipalities that make up the Wyomissing Watershed in the existing cooperative partnership.

The Municipalities that are located within the Wyomissing Watershed have been working together in a cooperative effort to investigate the current conditions of the Watershed as well as plan for ways in which the Watershed would be able to meet TMDL and/or MS4 requirements. The municipalities collectively realize that surface water pollution from nonpoint sources cannot be resolved nor addressed by one entity alone, but rather needs to be addressed by working together in a joint intergovernmental and municipal partnership. This initiative represents a growing, beneficial trend in natural resources management as various municipalities in Berks County often partake in joint comprehensive planning processes that work to better plan growth, conserve natural resources, and comply with MS4 requirements. The project partners meet monthly to assess the Watershed's needs and plan for present and future actions.

The BCCD has supplied aid to the Watershed and its Municipalities by applying for assistance from PA DEP's Division of Water Quality Standards and the Coldwater Heritage Partnership. The goals of these two grants was to first assess the current conditions in the Wyomissing Watershed and second to begin planning opportunities for BMP implementation. While the Coldwater Heritage Partnership Grant was awarded, the Surface Water Assessment proposal was not awarded due to federal and state budget cuts. Thus, the interested Wyomissing Watershed Municipalities (hereafter referred to as the Wyomissing Creek Watershed Coalition or WCWC), requested that the Berks County Conservation District supply a proposal and budget that would outline the tasks and costs related to carrying out a surface water assessment. The WCWC approved of the proposal that the BCCD provided to complete the surface water assessment. In the fall of 2012, an assessment of nine stream sites in the Wyomissing Watershed was conducted by EcoAnalysts. In this assessment, a stream site's chemical parameters,

biological life, and habitat present was assessed in accordance with the PA DEP's Instream Comprehensive Evaluations Protocol.

Although the Surface Water Assessment and the Coldwater Heritage Grant are two separate projects that were funded by separate entities, the surface water assessment, along with field work, helped to shape the recommendations in this Coldwater Conservation Plan. Both the Coldwater Conservation Plan and the Surface Water Assessment documents are to serve as guiding documents for the BCCD, WCWC, and the public in addressing stormwater concerns and nonpoint source water pollution.

Background

Watershed Description

The Wyomissing Creek Watershed is located in Berks County, Pennsylvania; it originates in Brecknock Township, just north of Knauers and flows in a northeasterly direction for approximately 8.4 miles before its confluence with the Schuylkill River in the Reading area. The 15.7 square mile watershed contains a total of 20.8 miles of streams. According to United States Geological Survey-StreamStats and the 2004 TMDL Report, approximately 38% of the land is covered by forest and approximately 37% is urban landuse. Also, approximately 4.4 miles of streams in the Wyomissing Creek Watershed flow through agricultural land use. Municipalities in the watershed include Brecknock, Cumru, Mohnton, Reading, Shillington, Spring, West Reading, and Wyomissing.

In Pennsylvania, streams or stream reaches are classified under water quality standards regulated by the Pennsylvania Department of Environmental Protection. There are five protected use designations assigned to streams that support the maintenance and propagation of fish species and suitable habitat for flora and fauna. The two highest designations, High Quality (HQ) and Exceptional Value (EV) mandate special water quality protection, as they embody outstanding ecological resources that are required to be maintained at existing quality. The majority of the Wyomissing Creek is listed as a High Quality – Cold Water Fishery under its Pennsylvania Chapter 93 Designated Use. There is a 2.5 mile stretch of the Wyomissing Creek Watershed located from the State Route-222 Bridge to the Museum Road Bridge in Reading, PA that is listed as Class-A Wild Trout Waters by the Pennsylvania Fish and Boat Commission. Protected uses of the Wyomissing Creek Watershed include aquatic life, water supply, and recreation. However, the Wyomissing Creek watershed was surveyed under the PADEP's Statewide Surface Water Assessment Program, which resulted in 6.1 miles being determined as impaired with sediment and not meeting its Designated Use. In 2004, a Total Maximum Daily Load (TMDL) was developed for Wyomissing Creek, which set a sediment load allocation. The TMDL has since been approved by the United States Environmental Protection Agency. Also in 2004, the Berks Conservancy, along with the PA Department of Conservation and Natural Resources (DCNR) and the William Penn Foundation completed a comprehensive Wyomissing Creek Watershed Conservation Plan.

The stream corridor includes the stream and adjacent land along the stream. Stream characteristics and water quality are greatly dependent upon the natural features of this land, as well as the modifications that have occurred over time. Most of the land closest to the Wyomissing Creek and its tributaries is subject to periodic flooding during rainstorms. It is in these floodplain areas where many residents have built homes. This land is usually flat and contains alluvial soils that may be wet a portion of the year. It often supports wetland vegetation that can serve as excellent areas for wildlife habitat. Floodplain areas vary with topography and the size of the stream, increasing with stream order and drainage area. The floodplain serves as a natural buffer area along the creek. This greatly aids in the impact of runoff and nutrient loading. The Wyomissing Creek's floodplain lies in both low-density residential area and wooded areas. The residential areas have shorter grass and lawns and normally do not feature natural wetland vegetation.

Land uses in a watershed directly affect the quality and quantity of both surface and groundwater. Uses such as agriculture, timber harvesting, and urban and suburban development can impact water quantity by changing runoff amounts, timing and infiltration rates. These uses can also change water quality by contributing sediment and nutrients to runoff and groundwater. Below is a table summarizing the major land uses in the watershed. (This table is not an exhaustive table of the land uses that exist in the Wyomissing Watershed. Rather, this table is meant to show the relative nearness of values in both the percentage forested land and urban land uses.)

Table of Wyomissing Creek Watershed Land Use

Parameter	Value
Area in square miles	15.713 sq mile
Total stream length in miles	20.1 miles
Percent of area covered by forest	38.5563%
Percent of area covered by lakes, ponds, reservoirs and wetlands	0.3094%
Percent of area covered by urban uses	37.4293%

Data provided from United States Geological Survey-StreamStats

Many of the Wyomissing Creek's tributaries flow through forested habitats, which enhance the water quality of the stream system as a whole. Much of the land along the mainstem of Wyomissing Creek is developed as residential housing. Residential housing can create serious water-related problems associated with earth moving activities and increased impervious surfaces. These changes increase runoff, which carry sediment, nutrients and chemicals to streams, degrading the water quality. In areas where natural buffering cannot handle these impacts or a buffer is lacking, non-point source pollution is the result.

Previous Studies

The Berks County Conservancy created a Watershed Conservation Management Plan for the Wyomissing Watershed in 2004, funded by the Department of Conservation and Natural Resources (DCNR) and the William Penn Foundation. The goal of the 2004 plan was to provide local governments, nonprofits, and Watershed residents with recommendations to restore and conserve the resources of the Wyomissing Watershed.

The Berks County Conservancy Plan addressed overall Watershed health such as native and invasive plants, critical areas for conservation (Agricultural, Historical, Ecological etc.). This Coldwater Heritage Plan seeks to build upon what the Berks County Conservancy created in 2004 by specifically addressing nonpoint source surface water pollution and municipal stormwater concerns. The following is a list of recommendations that were listed in the 2004 Berks County Conservancy Watershed Conservation Management Plan (items that are italicized with a check mark have been completed):

- Erosion Remediation: Erosion along the banks of the Wyomissing Creek is a prevalent problem. Grading the stream bank on an angle and placing appropriate stabilization along the edges of

the stream bank in problem areas can be helpful in preventing erosion. The stream would also benefit from seeding the banks to establish a riparian buffer.

- Livestock in the Creek: When livestock access to streams is not controlled, a sizable portion of sediment pollution comes from the unprotected stream banks caused by livestock grazing and trampling. Fencing stream banks and limiting livestock access with stream crossings promotes the establishment of a healthy vegetative cover. Vegetation binds soil particles together creating a stable bank that reduces erosion. Stream bank vegetation helps trap sediment and absorbs some nutrients that may run off of adjacent cultivated fields and feedlots.
- Dam Removals: There are a number of dams within the watershed that serve no purpose anymore. These dams disrupt the natural flow of the water in the creek and have no positive impacts on the ecosystem. Removal of these dams is a possible project.
- Channelization: In combination with the dam removal, another way to restore streams to a more natural state would be de-channelization. By de-channelizing the stream the flow will return to natural condition. Doing this would also enhance the aesthetics of the area. De-channelization of the stream within the park and near the Wyomissing Public Pool would not only create a more pleasing look aesthetically but it would also increase the health of the stream.
- <u>Other less specific projects which can be done</u>
  - ✓ *Encourage municipal ordinances to require retention of riparian buffers in developments along the stream banks.*
  - ✓ *Develop a prioritized list of Wyomissing Creek Watershed municipalities to contact and provide education and information to encourage the development or amendment of ordinances to protect the resources of the watershed*.
  - ✓ *Partner with organizations and agencies to hold public educational meetings for the residents and municipal officials in the Wyomissing Watershed.*
  - Upgrade headwater streams within the Wyomissing Creek watershed to HQ or EV status.
  - Hold public workshops on the management of invasive species as part of the "Natural Habitat Workshop Series."
  - ✓ *Partner with DEP and the County Planning Commission on educating the municipalities about stormwater management issues.*
  - ✓ *Encourage townships to develop projects to increase and /or improve recreational facilities in the Wyomissing Creek Watershed.*
  - Work to develop a conservation easement program for stream buffers, either through donation of easements or the purchase of easements.

Unique and Outstanding Values in the Watershed

The Wyomissing Creek is listed as a High Quality – Cold Water Fishery stream under its Pennsylvania Chapter 93 Designated Use. There is a 2.5 mile stretch of the Wyomissing Creek Watershed located between the State Route-222 Bridge to the Museum Road Bridge in Reading, PA that is listed as Class-A Wild Trout Waters by the Pennsylvania Fish and Boat Commission. While Pennsylvania has over 83,000 miles of streams, only 25% are considered high-quality coldwater fisheries. Of that, less than 2% are designated as highly productive waters that contain naturally reproducing wild trout. The Wyomissing Creek is one of those waterbodies that are considered to be in the elite 2% of the streams in PA that can support reproducing trout.

Also, there is a County-wide effort in Berks County to collaboratively address MS4 requirements. The Wyomissing Watershed Municipalities are members of this County-wide effort. In 2013, the group, along with Berks County Planning Commission, the BCCD, and the Berks Conservancy, formalized into a Berks County MS4 Steering Committee. This committee is a cooperative cost sharing initiative to share ideas and maximize educational outreach to the public, municipal employees, and students on stormwater pollution.

Ice skating pond at Wyomissing Park in early spring

Finally, the Wyomissing Watershed is fortunate to have a vast amount of parkland located within its boundaries. Particularly the park land that exists along the creek in the municipalities of West Reading and Wyomissing provide opportunities for the public to have access to the stream while providing a low intensive land use and vegetated stream bank. Not only do parks provide areas for recreation, (some areas have access to the stream for fishing), parks can also be a place to educate Watershed Residents. Parks are an ideal place for demonstration projects that both prevent pollution and then educate the public on the importance of preventing nonpoint source pollution within the park. A list of the park land that was listed in the 2004 Berks Conservancy Watershed Conservation Management Plan is below:

Public and Private Parks within Wyomissing Watershed	
<u>Mohnton Borough</u>	**<u>Wyomissing Borough</u>**
Community Park	Berkshire Heights Playground
Moblic Courts	Happy Hollow Playground
Mohnton Family Swimming Assoc.	Wyomissing Park
<u>West Lawn Borough</u>	*Berks County Tennis Club*
West Lawn Playground	*Mid Atlantic Fitness Center*
Kerry Irwin Field	*Berks Gymnastics Academy*
Kidsports Fun and Fitness	Community Playground
<u>West Reading Borough</u>	Fountain Park
Bicentennial House	Wyomissing Hills Park
Municipal Playground	*Wyomissing Hills Swimming Assoc.*
The Body Shoppe	
<u>Cumru Township</u>	
Montrose Manor Park	*Italicized = Privately Run*
JR's Skateaway	
Mohnton Fish and Game	

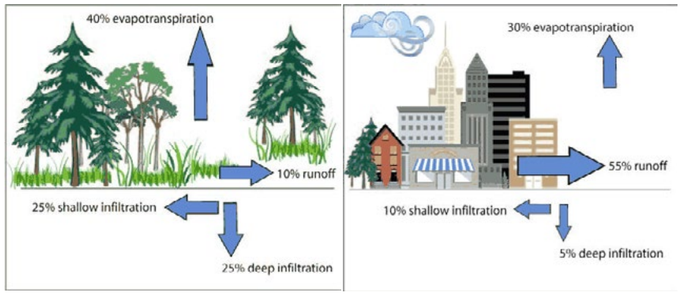
(Taken 2004 Berks County Conservancy Watershed Conservation Management Plan)

In addition to the parks listed above, the below parks have been established:

- **City of Reading**
  - Reading Public Museum
  - Yarnell Park
- **Wyomissing Borough**
  - Museum Park
  - Lauers Run Park
- **Spring Township**
  - Klines Creek Park
- **Mohnton Borough**
  - Mohnton Memorial Park
- **Cumru Township**
  - Montrose Manor Playground
  - Pennwyn Playground

Impairments and Total Maximum Daily Load

Land development can dramatically alter the hydrologic cycle of a site and, ultimately, an entire watershed. Prior to development, native vegetation can either directly intercept precipitation or draw on the water that has infiltrated into the ground and return it to the atmosphere through evapotranspiration.



Water Cycle in undeveloped areas versus urbanized areas.
Illustrations taken from Clean Water Education Partnership

Development can remove this beneficial vegetation and replace it with lawn or impervious cover, reducing the site's evapotranspiration and infiltration rates. Clearing and grading a site can remove depressions that store rainfall. Construction activities may also compact the soil and diminish its infiltration ability, resulting in increased volumes and rates of stormwater runoff from the site. Impervious areas that are connected to each other through gutters, channels, and storm sewers can transport runoff more quickly than natural areas. This shortening of the transport or travel time can cause flow in downstream waterways to peak faster and higher than natural conditions. These increases can create new and aggravate existing downstream flooding and erosion problems and increase the quantity of sediment in the channel. Filtration of runoff and removal of pollutants by surface and channel vegetation is often eliminated by storm sewers that discharge runoff directly into a stream. Increases in impervious area can also decrease opportunities for shallow and deep infiltration which, in turn, reduces stream base flow and groundwater recharge. Reduced base flows and increased peak flows produce greater fluctuations between normal and storm flow rates, which can increase channel erosion. Reduced base flows can also negatively impact the hydrology of adjacent wetlands and the health of biological communities that depend on baseflows.

In addition to increases in runoff peaks, volumes, and loss of groundwater recharge, land development often results in the accumulation of pollutants on the land surface that runoff can then transport to streams. New impervious surfaces and cleared areas can accumulate a variety of pollutants such as fertilizers, animal wastes, and vehicle fluid. Pollutants can include metals, suspended solids, hydrocarbons, pathogens, and nutrients. In addition to increased pollutant loading, various land use changes can adversely affect water quality and stream biota in more subtle ways. For example, stormwater falling on impervious surfaces or stored in detention or retention basins can become heated and raise the temperature of the downstream waterway, adversely affecting cold water fish species such as trout. Development can remove trees along stream banks that normally provide shading, stabilization, and leaf litter that falls into streams and becomes food for the aquatic community.

Specifically, the Wyomissing Creek was sampled under PADEP's Statewide Surface Water Assessment Program, which resulted in segments of the Wyomissing Creek being determined to be impaired with sediment and not meeting its Designated Use. In 2004, a TMDL was developed for Wyomissing Creek, which set a sediment load allocation. The TMDL has since been approved by the United States Environmental Protection Agency. The goal of any TMDL is to calculate the maximum amount of a pollutant that a water body can receive and still meet its water quality standards. This means that to achieve its designated use as a High Quality-Cold Water Fishery, the Wyomissing Watershed must reduce the amount of pollution that it receives. Below is a breakdown of the Sediment TMDL for the Wyomissing Creek Watershed:

Component	Sediment (lbs./yr.)
TMDL (Total Maximum Daily Load)	6,329,495.48
MOS (Margin of Safety)	632,949.55
WLA (Wasteload Allocation)	3,747,238.13
LA (Load Allocation)	1,949,307.80

(Taken from the 2004 Wyomissing Creek Sediment Total Maximum Daily Load)

2012 Wyomissing Creek Surface Water Assessment

In November of 2012, an assessment of the Wyomissing Creek's Mainstem and tributaries was authorized by the WCWC and performed by EcoAnalysts, Inc. The BCCD provided in the field assistance during the two day assessment process. The Surface Water Assessment evaluated the stream's physical habitat, water chemistry, and biological life (macroinvertebrates) according to PA DEP's Instream Comprehensive Evaluations Protocol. The results of this assessment was processed by utilizing the Index of Biotic Integrity (IBI), which PA DEP uses to determine if a stream is attaining its Designated Use or is impaired. A summary of the findings of the Stream Assessment are below (*charts and tables were directly taken from the 2012 Surface Water Assessment document*):

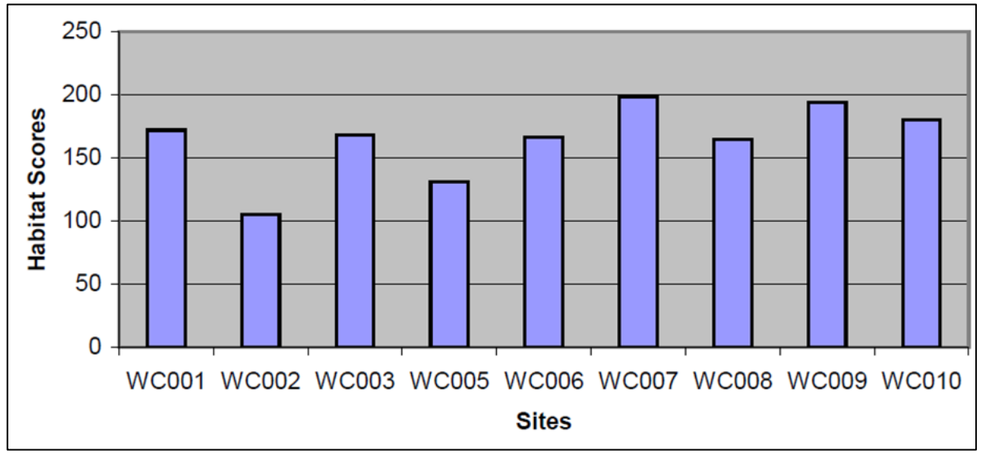
Table of Wyomissing Watershed Stream Assessment Sites

Site	Latitude/Longitude	Description
WC001	40.32698N/-75.94689W	Mainstem Wyomissing Cr., above JMA, next to playground
WC002	40.32207N/-75.96923W	Off Old Mill Road Bridge
WC003	40.31627N/-75.96807W	Off Old Wyomissing & Lauers Ln. below bridge
WC004 ***(site was dry-not sampled)***	*40.30385N/-75.97854W*	*UNT 01839*
WC005	40.29510N/-75.97954W	Off Wyomissing Ave. & Mohnton Blvd.
WC006	40.29502N/-75.97932W	Mainstem upstream UNT 01840 off Wyomissing Ave.
WC007	40.28261N/-75.99653W	Off gravel lane-Rudloff Ln.
WC008	40.27548N/-75.99754W	Off Wyomissing Road
WC009	40.26788N/-76.00564W	Off Yorkshire Road
WC010	40.26925N/-76.00060W	Off Wyomissing Road

Summary of Water Quality Results Per Site

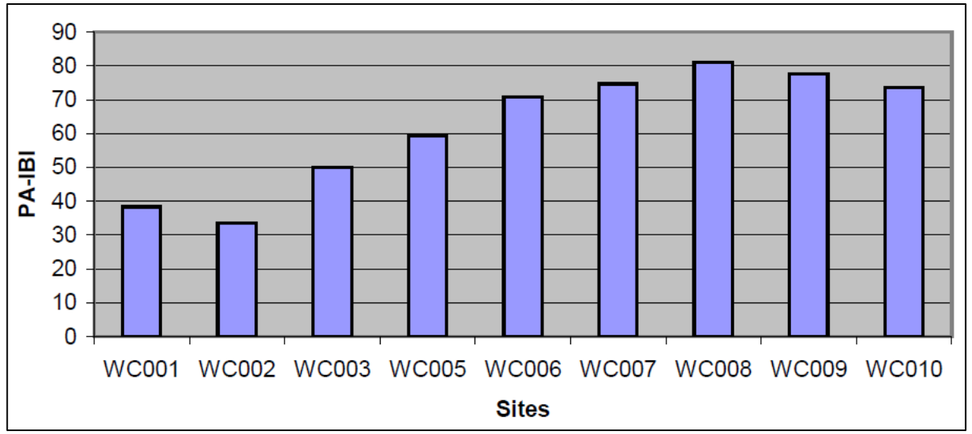
Sites	Temperature (ºC)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/l)	% Oxygen Saturation	pH (standard units)	Alkalinity (mg/l)	Total Diss. Solids (g/l)
WC001	10.57	568	12.48	112.2	7.99	200	0.369
WC002	12.98	879	12.98	110.8	8.01	280	0.571
WC003	10.85	391	11.79	106.7	7.64	140	0.254
WC005	11.81	466	11.50	106.1	7.75	140	0.304
WC006	11.87	260	11.11	102.8	6.95	80	0.169
WC007	9.75	324	11.02	97.1	7.36	100	0.211
WC008	10.31	169	10.75	95.9	7.31	60	0.110
WC009	10.63	189	10.62	96.0	7.22	60	0.123
WC010	9.80	136	10.56	93.2	7.07	60	0.088

Summary of Physical Habitat Scores Per Site



The Habitat scores were ranked in this study as follows: optimal: 240-192; suboptimal: 180-132; marginal: 120-72; and poor: ≤ 60. Gaps between these scoring ranges were ranked based on best professional judgment.

Table of Index of Biotic Integrity (IBI) Per Site



In summary, the Stream Assessment that was conducted in 2012 indicates that impairment status of the Wyomissing Watershed has remained unchanged. In other words, the segments that were attaining their Designated Use as determined before the study maintained their attaining status. Furthermore, the segments of the stream that were not attaining their Designated Use and in need of a TMDL also remained the same.

Specifically, the chemical water quality data showed no specific item of concern that would affect the biological community. The Habitat Analysis revealed 2 sites that were considered optimal, 6 suboptimal, and 1 marginal (WC002).

The overall results showed that sites WC001, WC002, WC003, and WC005 did not meet the criteria to be deemed attaining. The remaining sites, WC006, WC007, WC008, WC009, and WC010 were considered attaining. Because of the relatively high habitat scores that all of the sites (except for WC002) received, the stream assessment report does indicate that a likely cause of impairment in the watershed is the effects of scour and deposition due to stormwater. The assessment report states that although the bottom substrate appears stable between storm events, the macroinvertebrates are not present due to instability during storm events because of stormwater scour.

The findings of the 2012 Stream Assessment of the Wyomissing Watershed have helped shape this Coldwater Heritage Plan. This plan now addresses a merged approach to addressing the water quality concerns in the Wyomissing Watershed that take into consideration both sediment issues and effects of increased stormwater runoff. It should be noted that site WC002, which received the lowest habitat score, was the one site that did show that sediment may be a contributing factor to its marginal status.

Recommendations and Next Steps

Based upon the Surface Water Assessment performed by EcoAnalysts and the field investigations done by the BCCD, three general recommendations are put forth in this plan that will aid in the conservation and enhancement of the Wyomissing Watershed's Coldwater Characteristics. Appendix A includes a map of the Wyomissing Watershed that highlights particular land uses that may be amenable to implementing the three types of recommendations provided by this plan. These types of lands include schools; parks, County and Municipal owned land (referred to as "Public Land"); and the Reading Hospital. The three general recommendations are listed below and are expanded upon in the following sections.

Recommendation #1 *Inventory and Pursue Stormwater Retrofit/Disconnection Opportunities*

Recommendation #2 *Actively Educate Watershed Stakeholders*

Recommendation #3 *Inventory Stream Corridor Restoration Opportunities*

#1 Inventory and Pursue Stormwater Retrofit/Disconnection Opportunities

While the headwaters of the Wyomissing Watershed are mainly rural areas, the mouth of the stream and up to Mohnton Borough is mainly urbanized residential and commercial areas. Most of the urbanization in this portion of the Watershed took place before modern stormwater regulation/practices were implemented. As is common in most of these older communities, there is an opportunity to introduce stormwater retrofits. Stormwater retrofits often involve updating, changing, or enhancing current, onsite stormwater management practices and converting them into practices that address a pollutant or issue of concern. Retrofits include but are not limited to: wetland plantings and removal of low flow channels in stormwater basins to decrease the amount of water entering the stream during storms; installation of rain gardens or other bioinfiltration practices; and decreasing the amount of impervious surfaces. These types of practices should be installed where it is feasible and practicable as the specific site permits. Often times utilizing stormwater retrofits in a "treatment train," where stormwater flows through several types of practices is an effective way of addressing stormwater runoff related concerns.

This plan identifies areas where various stormwater retrofits could be feasible while providing education to Watershed residents through demonstration projects and preventing stormwater associated pollution from entering the Wyomissing Creek. However, a more in-depth investigation in each municipality may be warranted to better investigate a watershed-wide stormwater retrofit plan, which would examine the areas where presently uncontrolled runoff could be treated and infiltrated back into the ground, or taken up by plants.

Table of Best Management Practices and Possible Locations

Best Management Practice	Potential Location in Watershed	Photo Example of Practice
Rain Gardens Rain gardens are shallow depressed gardens designed to capture and soak up stormwater flows	• West Wyomissing Elementary • Berks Catholic High School • Wyomissing Junior Senior High School • Lincoln Park Elementary • Governor Mifflin Middle School • Reading Public Museum • Museum Park • Lauers Run Park • Yarnell Park • Montrose Manor Playground • Mohnton Memorial Park • Gouglersville Fire Company	
Permeable Pavers Replacing hard, impermeable surfaces with materials such as permeable pavers allows rainwater to soak into the ground. This reduces the amount of runoff that leaves the property.	• West Wyomissing Elementary • Berks Catholic High School • Wyomissing Junior Senior High School • Lincoln Park Elementary • Governor Mifflin Middle School • Lauers Run Park • Yarnell Park	
Rain Barrels/Cisterns Rain barrels and cisterns collect and store rainwater from roofs. Often this water is directed to garden or landscaped areas.	• West Wyomissing Elementary • Berks Catholic High School • Wyomissing Junior Senior High School • Lincoln Park Elementary • Governor Mifflin Middle School • Reading Museum	
Green Roof Green roofs are covered with a waterproof membrane and then planted with a special vegetation system to absorb rainfall.	• Wyomissing Junior Senior High School • Berks Catholic High School • Reading Museum	
Dry Wells A dry well is a small, excavated pit filled with stone or gravel that temporarily stores stormwater from roofs until it soaks into the soil.	• GAI-Tronics • Gouglersville Fire Company • West Wyomissing Elementary • Berks Catholic High School • Wyomissing Junior Senior High School • Lincoln Park Elementary • Governor Mifflin Middle School	

Best Management Practice	Potential Places in Watershed	Photo Example of Practice
Wetlands or Permanent Pools Shallow excavations can be carved into the bottom of dry ponds to create wet micro-pools or wetlands.	• The Highlands Residential Community • Basin at Kendal & Frederick St. (Whiskey Ditch) • Basin at Thomas Drive @ Rt 222 (Montrose)	
Modifying the Outflow Stormwater basins have outflows that are sized to restrict storm flows and allow only a certain volume of water to flow through at a certain rate. Retrofits of the outflow often allow ponded runoff to be stored for longer periods to better mimic the predevelopment flows downstream.	• The Highlands Residential Community • Basin at Kendal & Frederick St. (Whiskey Ditch) • Basin at Thomas Drive @ Rt 222 (Montrose) • Park Terrace Basin (Mohnton) • Northridge Development Basin (Mohnton)	
Increasing time of travel Older stormwater ponds often routed water quickly through stormwater facilities with concrete channels and direct flow paths to outflow structures. Retrofit projects, often removes such low flow channels and carves out a winding path through the stormwater facility. This allows more time to remove pollutants from the stormwater.	• GAI-Tronics • The Highlands Residential Community • Basin at Kendal & Frederick St. (Whiskey Ditch) • Basin at Thomas Drive @ Rt 222 (Montrose) • Montrose Blvd & Lancaster Pike • Park Terrace Basin (Mohnton) • Northridge Development Basin (Mohnton)	

*#2 Actively Educate Watershed Stakeholders Landowner/Public Education***

Streamside Landowners and Public Education

Private landowners control nearly all the land within the Wyomissing Creek watershed. Private landowners fall into a number of categories: residential, commercial, agricultural, and industrial. It is the practices that landowners carry out on their land that has the greatest influence on water quality in the Wyomissing Creek and its tributaries. For that reason, it is essential that effective outreach and education target this group, ensuring that they have the appropriate information to properly manage their land, and put in place conservation and best management practices that will protect water resources. While creating this Coldwater Conservation Plan, a public meeting was held to inform residents about the process to create the Plan and to garner their suggestions as to how to improve the Wyomissing Watershed. Appendix C outlines the public input that was received while creating this plan. Various opportunities exist to educate streamside landowners and the general public:

Recommendation	Means to Achieve Recommendation
Inventory and outreach to streamside landowners	Outreach to all streamside landowners informing them of the appropriate ways to care for streamside property and giving them opportunities to seek technical advice should they need it.
Educate Watershed landowners about a wide variety of best management practices that affect residential and commercial properties	Watershed municipalities should carry out informational workshops for their residents to promote a sense that everyone has a stake in the health of the watershed, and that individuals can make a difference. (Topics include, but are not limited to: care of septic systems, proper use of lawn and garden chemicals, managing stormwater, understanding various BMPs- such as rain gardens and swales that may be on their property, how to dispose of household hazardous waste, washing vehicles on lawn areas and not on driveways, and the benefits of native vegetation, and pet waste).
Ensure that all residents are aware of and have opportunities to connect with the Wyomissing Creek Watershed Coalition	Incorporate Wyomissing Creek Watershed Coalition materials into the municipal newsletters, water bills, trash bills, and municipal websites. Investigate the potential need for a website for the group. Also, stream signage or "entering the watershed" signage may be a way to connect residents with the Coalition.
Inventory and outreach to "other groups"	There are numerous groups within the watershed carrying out a range of missions related to the community. These groups include social clubs, church groups, girl and boy scout troops, and historical societies. With outreach, these entities have the chance to assist with natural resource protection projects while meeting their own objectives.

*** The Berks County MS4 Steering Committee may be able to aid in the coordination and execution of the educational recommendations given in this report.*

Government Elected and Appointed Officials

This group includes township supervisors, council members, planning commission, and zoning board members. These decision-makers must be well-informed in order to put in place sound regulations, and then implement those regulations to appropriately protect our natural resources. Future education and outreach efforts to reach this group can include:

Recommendation	Means to Achieve Recommendation
Outreach to Township Supervisors	Presentations at Supervisor and Council meetings to present the results of this report, and to determine where additional educational resources might be needed.
Establish Watershed-wide Environmental Advisory Council (EAC) Network	Working on the recommendations from this document could provide a jumping-off point for municipal environmental advisory councils. This could also establish a watershed-wide elected official network that would bring together Township Supervisors and Borough Council members to discuss issues concerning zoning, regulation, and development. Regulatory consistency across municipal boundaries could be a goal of this network (if not already being addressed)
Outreach to Municipal Boards and Commissions	Meet with Municipal Zoning Boards and Planning Commissions to discuss natural resources conservation and environmental protection

Municipal Public Works, Roads, and Utility Staff

Municipal staff has responsibility for a number of activities that can have a profound effect on water and natural resources. Among these activities are: mowing of municipal owned properties and roadsides, spraying of herbicides and pesticides, maintaining and upgrading of infrastructure and any installed BMPs. Ensuring that Municipal employees are trained to maintain newly installed BMPs will help ensure the success of the practice.

Recommendation	Means to Achieve Recommendation
Offer trainings to Municipal Staff	General educational outreach program should be developed for municipal staff to keep them informed about the best management practices that affect the activities they carry out.

#3 Inventory Stream Corridor Restoration Opportunities

Stream corridor enhancement and stream bank restoration are important practices that maintain stream functionality and improve stream health. There are many opportunities in the Wyomissing Watershed to implement these "on the stream bank" practices. It is important to note that when considering these practices, one should begin in the headwaters of the Watershed and work down to the Mainstem. This ensures that the stream is able to adapt to the ever changing circumstances of the land that drains to it. Also, educational opportunities should be considered when determining where to start these practices. Parks, schools, and other public lands lend themselves well to a streambank restoration project that restores a healthy stream bank and educates residents about it.

Potential site for riparian buffer project at Lauers Lane

Type of Best Management Practice	Potential Places in Watershed	Photo of Practice
Riparian Buffer Restoration By planting trees along stream banks, we can help prevent stream bank erosion, prevent nonpoint source pollution and cool stream temperatures.	• Lauers Lane Stream Segment • Old Fritztown Road Development-Walking Path • Gottschall Property • West Reading Playground • Reading Public Museum • Museum Park Riparian • Wyomissing Park • Pennwyn Playground • Mohnton Memorial Park • Klines Creek Park Area	
Streambank Restoration Streambank restoration not only seeks to stabilize the bank, but to reconnect the stream to its floodplain where possible	• Montrose Blvd & Lancaster Pike • West Reading Playground • Pennwyn Playground • Klines Creek Park Area	
Agricultural Best Management Practices These BMPs include, Manure Management Plans, Ag Conservation Plans, Livestock/Stream bank Fencing,Livestock Crossing, & Manure storages	• The BCCD has performed Agricultural Outreach visits to various Agricultural Landowners in the Wyomissing Watershed. These areas may benefit from BMP assistance. See Map in Appendix B .	

Summary/Conclusion

The Wyomissing Watershed is a historical watershed that has urbanized over the past century. While it shares urban characteristics with its neighbors of Reading, West Reading, Mohnton, and Shillington, the Wyomissing Watershed has a rural headwater area in Brecknock and Cumru Townships. The rural characteristics, such as forested areas, serve the stream well. Despite its less densely urbanized headwaters, portions of the Wyomissing Creek are impaired. Furthermore, the Municipalities of the Wyomissing Watershed include urbanized areas that are regulated MS4 areas. The Municipalities of the Wyomissing Watershed have been collaboratively working together to address various regulations and concerns and have formed the Wyomissing Creek Watershed Coalition. This plan was composed to aid the WCWC in addressing MS4 and TMDL requirements and improve the health of the Wyomissing Watershed.

While this Coldwater Conservation Plan provides a list of possible restoration and/or best management practice installation recommendations, it should be noted that the list is not an exhaustive list. The project ideas put forth in the plan are to aid and guide municipal officials in determining and examining project location. Furthermore, the Wyomissing Watershed is a watershed in which land uses are changing daily; thus, it is the goal of the BCCD to have the recommendations and suggestions put forth in this plan be fluid and flexible to better aid the Watershed Stakeholders that are addressing watershed health. There are various other practices that the WCWC could pursue that would address MS4 regulations and improve stream quality; however, after investigating this particular Watershed, the recommendations outlined below are the more effective ways to prevent surface water pollution and to restore the stream corridor to a healthy state.

Recommendation #1 Inventory and Pursue Stormwater Retrofit/Disconnection Opportunities

Recommendation #2 Actively Educate Watershed Stakeholders

Recommendation #3 Inventory Stream Corridor Restoration Opportunities

Other practices not focused on in this particular plan, but could aid in general stormwater pollution prevention include increasing the amount of tree plantings across the watershed (not just along stream banks) and street vacuuming to prevent sediment, cinders and litter from entering the stream.

It is the recommendation of the BCCD, that the WCWC begin a dialogue with PA DEP in how the various municipalities have been working together to holistically address stormwater regulations, TMDLs, and stream impairments. The BCCD also recommends that the Schuylkill Action Network (SAN) be included in the WCWC dialog as the group has various state and federal government partners that may be of technical assistance to this group and the Watershed. The efforts that the WCWC are undertaking are a true watershed based planning approach to solving stream quality issues in the Wyomissing Watershed.

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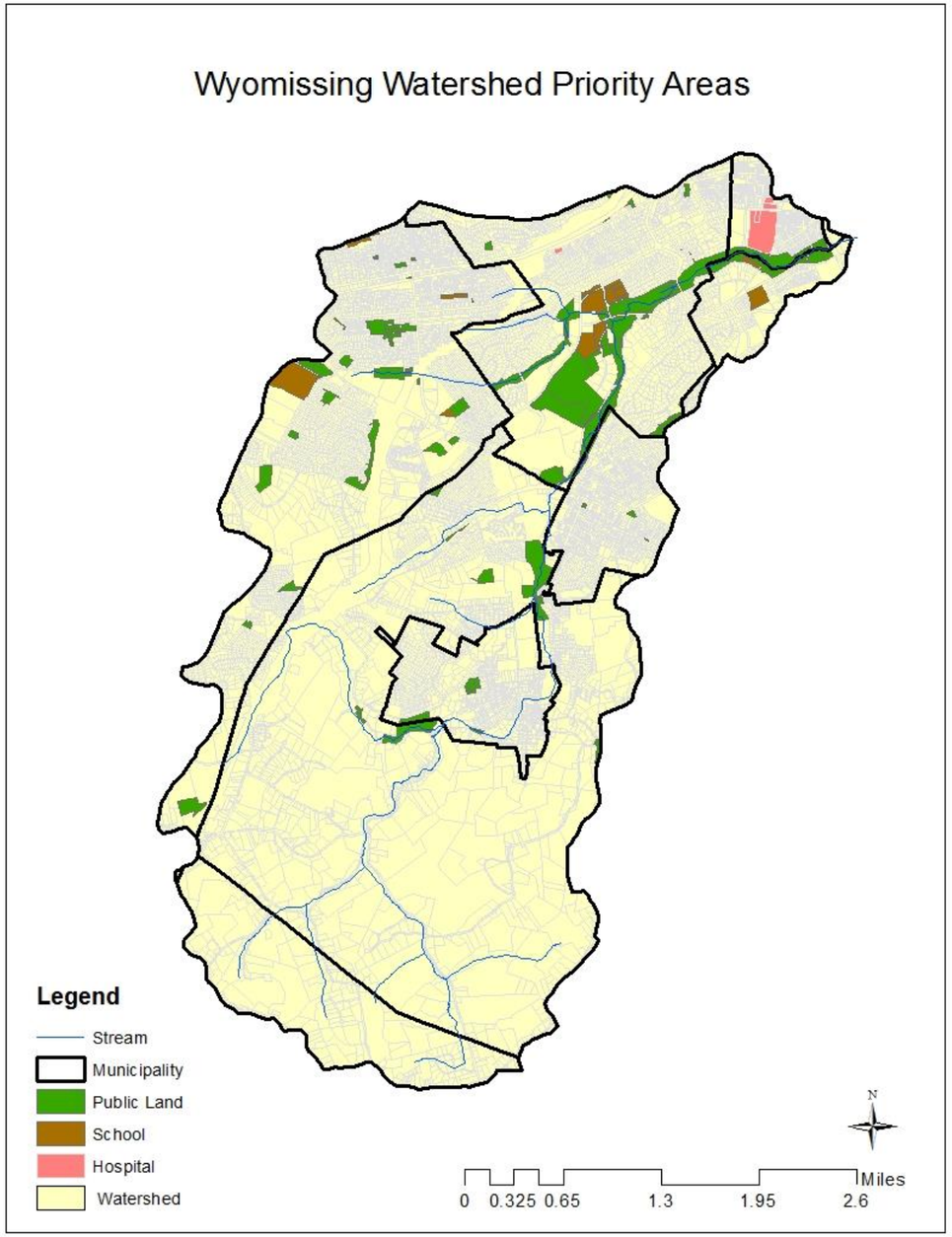
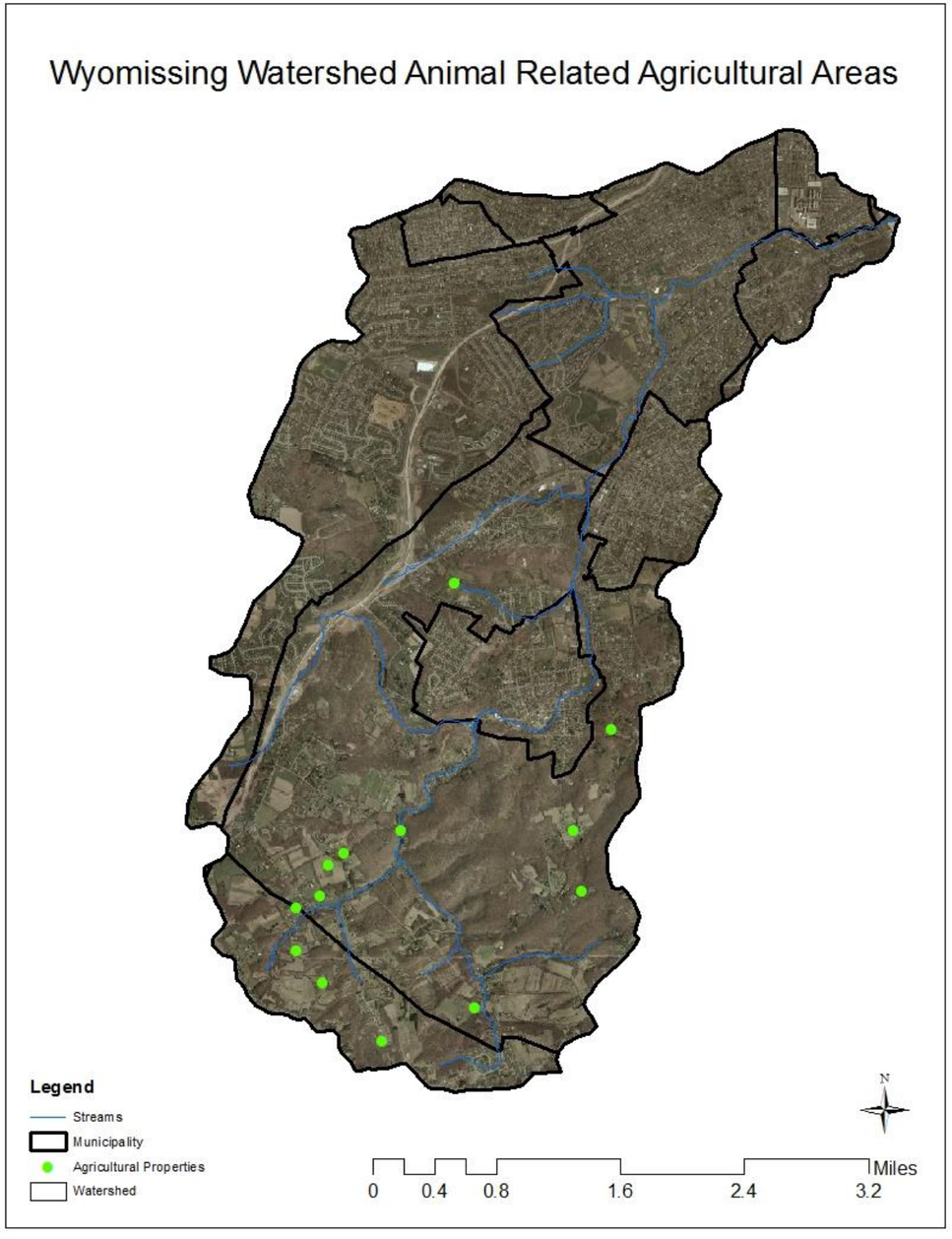
Appendix A – Map of Potential Priority Areas for Projects



Appendix B – Map of Animal Related Agricultural Areas



Appendix C – Summary of Public Input

The public input listed below was collected via public input sheets and/or phone correspondence while the Coldwater Conservation Plan was being created. When possible (if contact information was provided), the BCCD followed up with the person who submitted the comment/question. Public Input was imperative in this process as it helped shape the recommendations that are put forth in this Plan.

- Investigate to see if the Reading Public Museum would be interested in projects. Work with the Museum on educational projects.
- Organize stream clean-ups that concentrate on picking up litter along streams.
- Concerned that the extremely large number of starling flocks may create pollution in the stream and concerned for public health.
- Poll the people who use Wyomissing Park for fishing and recreation to see if they would be interested in assisting in stream clean-ups. Utilize those with common interests to help projects.
- Is there a website about this effort to get more information?
- Are Schools and Municipalities involved in this process?
- Please visit my property, I would like to see what I can do for this effort.

BERKS COUNTY CONSERVATION DISTRICT
Conserving Natural Resources for Our Future
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Appendix H: Trail Design & Maintenance

Trail Design and Maintenance

excerpted from

Stewardship Handbook
for Natural Lands in Southeastern Pennsylvania

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Natural Lands Trust

October 2008

accompanied by effective bioengineering practices. The simplest form of bank regrading entails pulling a bank back from the water line to a 3:1 slope. Erosion-control fabric is installed along with new seeds, plantings, and stakes. However, when trees exist on the slope or the working area is limited, the technique must be modified. Every stream is different and one method does not fit all conditions. All streambank modifications should consider upstream land use changes and the long term success of the project as well as downstream effects of new flow patterns.

- ***Geomorphology*** – Fluvial geomorphology is a multidisciplinary field of study that analyzes local topography, soils, and climate to select specific stream geometry. The recommended geometry based on such a study includes specifications on entrenchment and sinuosity of the stream in order to mimic natural stream patterns.

  In extreme cases, modifying stream geometry may lead to actual earthwork within the stream to help restore equilibrium. This could include a variety of methods including J-hooks, check dams, and log diversions. The purpose of these techniques is to redirect water and encourage areas of sedimentation to protect eroding banks.

TRAIL DESIGN AND MAINTENANCE

General Guidelines

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

Recreation Enhancement

- Trails should be varied so as to enhance the user's enjoyment and visual experience.
- Trails should provide scenic views and incorporate points of interest such as historic structures or sites, wetlands, ponds, or rock outcrops. Main trails should bypass these resources where possible, with only secondary trails providing access to them.

- Trails should be buffered from the sight, sound, and hazards associated with man-made features, including roadways, buildings, and urban or suburban land uses.
- The trail designer should make creative use of vegetation to enhance the hiking experience.
- The trail designer should route trails through varied types of plant cover, avoiding alignments through continuous stands of similar vegetation.
- Trails should not have long straight sections that are unbroken by vegetation or topography. Short trail sections with many broad turns are desirable.
- Sudden changes in direction or too much meandering should be avoided, except where switchbacks are needed to negotiate a long steep slope.
- Planting showy native plants and butterfly or hummingbird-attracting plants in a naturalistic style in key areas along trails can greatly improve user enjoyment.
- Locating resting areas (benches or access to large, flat-topped boulders) near features such as streams and ponds will allow users opportunities to pause and enjoy the sights and sounds of the resources on the property.

Environmental Protection

- Every attempt should be made to position trails outside of environmentally sensitive areas, but, with careful planning, a trail may incorporate special features of the landscape into its design with minimal environmental impact.
- When locating a trail, primary emphasis should be placed upon characteristics of soils and topography that control trail stability.
- Trails should follow the contour of the landscape.
- Trails should not go straight up steep grades.
- Areas having slopes in excess of 20% should be avoided, unless those areas are to be paved or otherwise stabilized (e.g., steps).
- Soils that are deep, well drained, resistant to erosion, and do not have high seasonal water tables are most suitable for trail development.
- Where trails follow steep grades, sidehilling—cutting a notch and sometimes filling to form a narrow bench—should be used to reduce erosion and improve surface drainage.
- Switchbacks should be used when going up steep gradients where sidehilling cannot gain elevation fast enough.
- Switchback segments should not be visible from one another.
- Wide turns should be used in switchbacks to limit shortcutting, particularly where the trail is in an open hardwood forest where users can see ahead. Visual anchors should be used to encourage users to follow the trail.
- Trail layout should minimize impact on sensitive resources, such as wetlands. If highlighting these areas, special precautions should be taken to reduce the impact of hikers through the use of bridges and elevated walkways.
- Side trails leading to fragile resource areas should generally be longer and more difficult to discourage the majority of main trail users from using them.

Public Use and Safety

- Where there are road crossings, the hiker's exposure should be minimized by crossing in the shortest practical manner, usually at right angles, with adequate sight distances.
- Trails should not parallel road rights-of-way.
- Trails should avoid areas of streams and ponds with steep banks, deep water, or other potential hazards to children.
- Where trails are in the vicinity of urban or suburban land uses, they should have a buffer as wide as possible and sight lines as long as possible to keep potential conflicts with adjacent landowners to a minimum.

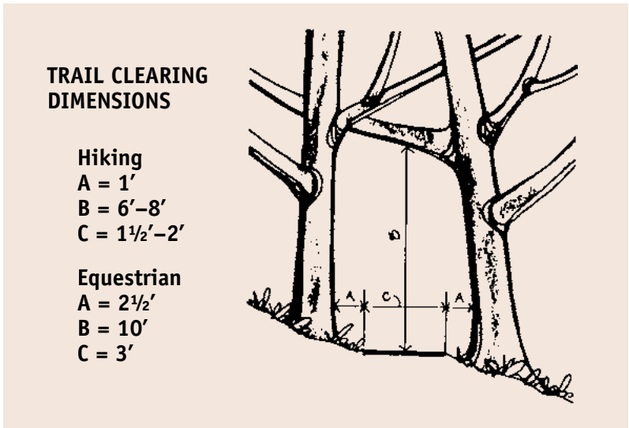
Trail Construction

Constructing good, easily maintained trails and their associated structures is somewhat complicated. The basic concepts are described below, but please refer to **Additional Information Sources**, *page 217*, for detailed reference manuals on the subject.

Trail Clearing

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

After the precise location of the trail is determined, the treadway should be cleared. For hiking trails, an 18–24-inch wide treadway should be cleared with all projecting limbs cut back an additional 1 foot. For equestrian trails, a 3-foot-wide treadway should be cleared with all projecting limbs cut back an additional 2½ feet for a total horizontal width of 8 feet. The trail should be cleared to a vertical height of 6–8 feet for a hiking trail and 10 feet for an equestrian trail.

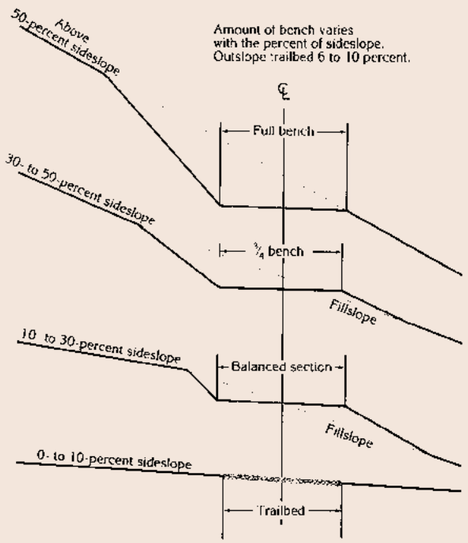


PA DER, Bureau of State Parks, Division of Outdoor Recreation, The Pennsylvania Trails Program, 1980.

In clearing trails all shrubs, vines, low-hanging branches, blowdowns, small trees, and fallen logs should be removed. Logs and rocks can be used along the trail edges and as anchors and points of interest. Shrubs and small trees should be cut flush with the ground surface. Care should be taken not to disturb the ground surface or to pull plants out by the roots as this will lead to erosion of the treadway. Large trees fallen across the trail should be left in place by making two cuts and removing a 4-foot-wide section from the trunk across the trail. If motorbikes or mountain bikes are a potential problem, the logs can be notched to provide a flat surface for hikers, yet prohibit the passage of wheeled vehicles.

When clearing is completed, cuttings should in general be scattered in areas adjacent to the trail and left to decompose. It may be necessary to collect

TYPICAL TRAIL CROSS SECTIONS



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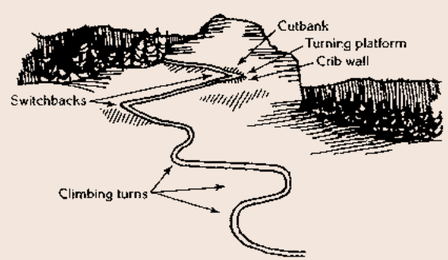
SWITCHBACKS AND CLIMBING TURNS



US Forest Service, Technology and Development Program

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

the cuttings and remove them from the immediate trail area where the trail runs through more formally landscaped areas such as along public roads and through suburban developments.

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

Treadway Stabilization

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

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

Trails on Slopes

Where a trail cuts across a slope greater than 10% (1 foot rise for every 10 feet of run), a slightly outsloped or sidehill

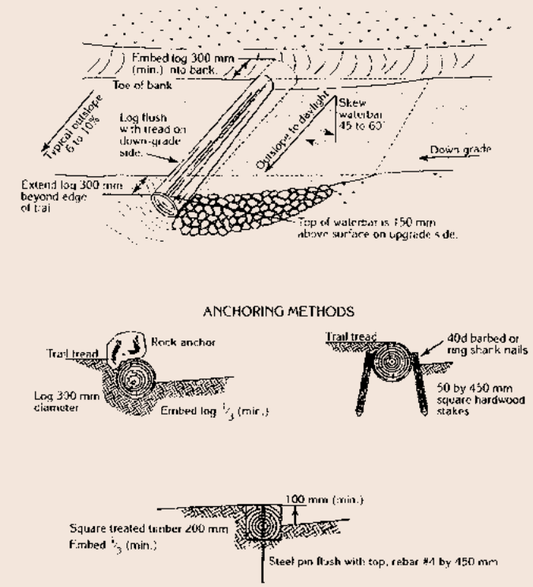
treadway should be excavated to prevent trail widening and erosion *(top far left)*. Depending on the slope, the amount of excavation and the use of the excavated material varies. On steeper slopes, excavated soil is not used at all in the fillslope. This soft material is likely to erode away quickly, creating dangerous soft spots on the downhill edge of the trail. As the slope decreases, it becomes more feasible to use fill material as part of the treadway.

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

Surface Water Control

Diverting surface water off the trail is one of the first priorities in designing and maintaining trails. Running water erodes the treadway and support structures and can even lead to loss of the trail itself. The first choice to address surface water is to enhance the natural drainage by outsloping the treadway and creating grade dips such as Coweeta dips, bleeders, or drainage dips. The aim is to take advantage of the natural

LOG OR TREATED TIMBER WATERBAR AND ANCHORS



US Forest Service, Technology and Development Program

topography wherever possible, making sure the water won't return to the treadway. A Coweeta dip uses a reversal in grade on sidehill trails to shed water continuously all along the trail segment. A bleeder is a shallow graded depression across the treadway. A drainage dip, appropriate only on grades less than 8%, is a channel reinforced with earthen mounds running diagonally across the treadway.

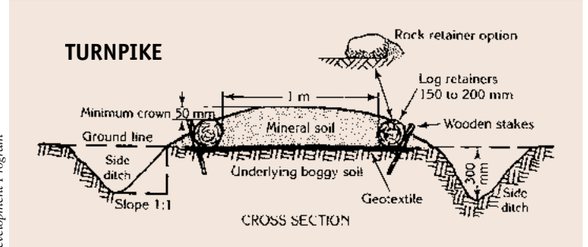
Waterbars are the second most common drainage structure after outsloping. They are diagonal rock or log barriers that divert water off the treadway *(above)*. Even though waterbars have been standard practice in the past, they should be avoided where it is feasible to use some form of a grade dip. By design, water hits the

waterbar and is turned. The water slows down and sediment drops in the drain. The number one cause of waterbar failure is sediment filling the drain until the water tops the bar and continues down the trail, rendering the waterbar useless. A good grade dip can be built more quickly, works better, requires less maintenance, and is less obtrusive on the landscape.

Waterbars are useful on trails where there isn't much soil to work with, in areas that experience torrential downpours, and where a tripping hazard is acceptable. They may also be necessary when repairing older trails where no provision was made during design or construction for proper drainage.

Correctly installed, a waterbar must be constructed of rock or a rot-resistant type of wood. Logs should be a minimum diameter of 6–8 inches at the small end—greater if water flow is heavy—and all bark must be removed. It should be placed at a 30°–45° angle and extend at least 1 foot past the outside edge of the treadway on both sides. If the natural topography would allow water to return to the trail, it is essential that the situation be remedied by extending an outlet trench beyond the end of the rocks or log. Where water flow is heavy or the bar directs water down a steep slope, runoff may erode the soil adjacent to the treadway. Where this is a problem, rocks should be placed in the channel to slow the water and make it drop its sediment.

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



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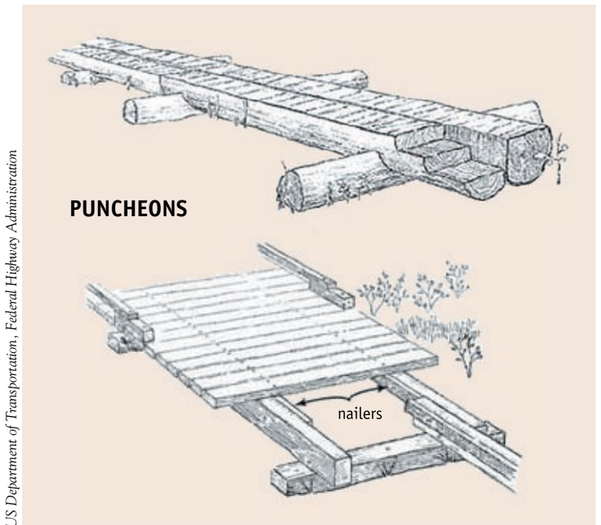


US Department of Transportation, Federal Highway Administration

Trails in Wet Areas

Trails should be designed to avoid wet areas. Equestrian trails in particular should avoid small streams and wetlands if at all possible to prevent water degradation from erosion and excrement. Where this is impossible or an existing trail has developed a drainage problem, several options exist. Because nearly every technique for fixing trails in wet areas is expensive and needs to be repeated periodically, relocating the problem section of trail should be considered first.

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

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

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

Crossing Drainage Swales, Streams, and Wetlands

For minor crossings of small streams and drainage swales, there is no need for construction of elaborate bridges. Natural stream crossings using stepping stones are ideal where the stream flow is generally low and there are not significant fluctuations, except following major storm events. The stepping stones should be large and flat-topped. They should be placed approximately 2 feet apart across the stream. Ideally, the bottom on which the stones are laid should be stone in order to prevent movement.

As an alternative to stepping stones, a simple bridge could be constructed of a single or double stringer with two base logs similar to the puncheon described above. The base logs should be placed on each bank above the flood level on a flat stone or ledge, secured with pins if possible. The stringer(s) should be secured to the base log on each end using 10-inch or 12-inch spikes or large bolts. Both the base logs and the stringers should be of rot-resistant wood, such as black locust, eastern red-cedar, or white oak, from which all the bark has been removed. To facilitate construction, crossing sites for bridges should be selected where the banks are the same height and midway between turns. A handrail is needed for safety only if the top of the stringer is more than 3 feet above the stream. The stringer surface should be randomly scored to provide safer footing when wet.

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

Boardwalks are elevated post and decking structures that provide access to marsh and wetland ecosystems with minimal negative impacts. Boardwalks are usually constructed of wood and the foundation is usually a pier or wood post. If touching the ground or submerged in water, the posts most often are chemically treated with an oil- or water-based

wood preservative such as creosote, pentachlorophenol, chromated copper arsenate, or zinc chloride. These wood preservatives are toxic to the natural environment and can be harmful to human health. They do, however, add longevity and structural safety. Two alternatives are posts made from recycled plastics that do not release harmful chemicals into the ground or water and galvanized steel helical piers and anchors. The recycled plastic post is either mechanically driven to the depth of firm soil or bedrock or secured in a concrete footing set in an excavated hole. The helical piers and anchors screw into the ground quickly, much the same as a wood screw goes into a piece of wood. Railings are an optional consideration for boardwalks that meander through wetland habitat. When the height of the decking above the ground exceeds 30 inches, rails are recommended.

Permits may be required for a boardwalk. The US Army Corps of Engineers (for the Delaware River watershed: Philadelphia District, 215-656-6729; for the Susquehanna River watershed: Baltimore District, 410-962-3670) requires a permit for any discharge of fill within wetlands.

Abandoning Trails

When it becomes necessary to abandon a trail, it should be done effectively and with sensitivity. Restoring abandoned trails to a natural state requires as much attention and planning as constructing new trails. The goal is to reduce the continuing impact abandoned trails have on the landscape. Simple restoration may consist of blocking new shortcuts and allowing the vegetation to recover. "Planting" old tree stumps and placing rocks naturalistically within the old treadway helps give the trail immediate closure. Complex restoration projects include obliterating the trail, recontouring, and revegetating the treadway with appropriate plant species (*see* **Native Plant Materials**, *pages 172–200*). Careful monitoring and follow-up are necessary to ensure that eventually almost all evidence of the trail is gone.

Each abandoned trail should be closed. If the trail is not blocked to prevent further use, the trail may persist indefinitely. Closure is particularly important if stabilization and revegetation are being attempted. The abandoned treadway should be blocked to all traffic, recontoured, and disguised to prevent users from being tempted to take it. This work should be accomplished for all segments visible from trails that remain open.

If the section of trail to be abandoned is short, it is simplest to just pile brush along its entire length. If it is long, brush should be placed far enough along from its intersections with trails in current use to obscure the path. Extending the brush a few feet on either side of the entrance will help deter users from going around the blockage. If there are any areas of active erosion, these should be stabilized to restore the natural contour and drainage patterns. Revegetation can be accomplished passively or actively. Passive revegetation allows surrounding vegetation to colonize the abandoned trail. This works when erosion has been stopped, adequate precipitation occurs, and adjacent vegetation consists of desirable (native) species that spread and grow rapidly. Active revegetation ranges from transplanting onsite vegetation to planting seeds or propagated plants of appropriate native species (*see* **Native Plant Materials**, *pages 172–200*). Successful revegetation almost never is complete within a single season.

STEWARDSHIP HANDBOOK FOR NATURAL LANDS IN SOUTHEASTERN PENNSYLVANIA

Trailheads and Parking Facilities

Determine where trailhead and parking should be located, taking into consideration safe vehicular access, site conditions suitable for construction of a parking area, proximity of neighbors, and ease of policing. Try to avoid locating parking facilities and trailheads in areas where the trail would deteriorate under heavy use. Before you finalize the site location, you should contact Pennsylvania One Call (1-800-242-1776) to determine if there are any underground utility lines near the site.

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

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

Trail Signage

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

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

Other appropriate types of signage for trails indicate the distance to other locations, points of interest, or improvements (e.g., office, shelters) and inform users where they are leaving the property.

Trail signage should be constructed of materials that are in harmony with the natural environment and are sufficiently rot-resistant. Options include wood (black locust, white oak for posts; cedar for the sign), recycled plastic, metal, fiberglass embedded, laminated, or for very short-term temporary signs, paper. Wood signs should be ¾–1½ inch in thickness with wording inscribed using a router or sandblaster. The sign can either be left unpainted or painted with one or two contrasting colors.

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

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

Trail Marking

Trail markers include cut or painted blazes on trees; wood, plastic, or metal marker tags; and marker posts. These markers are used to help travelers identify the trail corridor when the treadway is indistinct, the ground is covered with snow, or when the path is confused by multiple trails or obscured by weather such as dense fog. They should be used only when the trail is not obvious, there is a sudden change in direction, and at trail junctions.

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

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

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

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

HAZARD TREE MONITORING PROGRAM

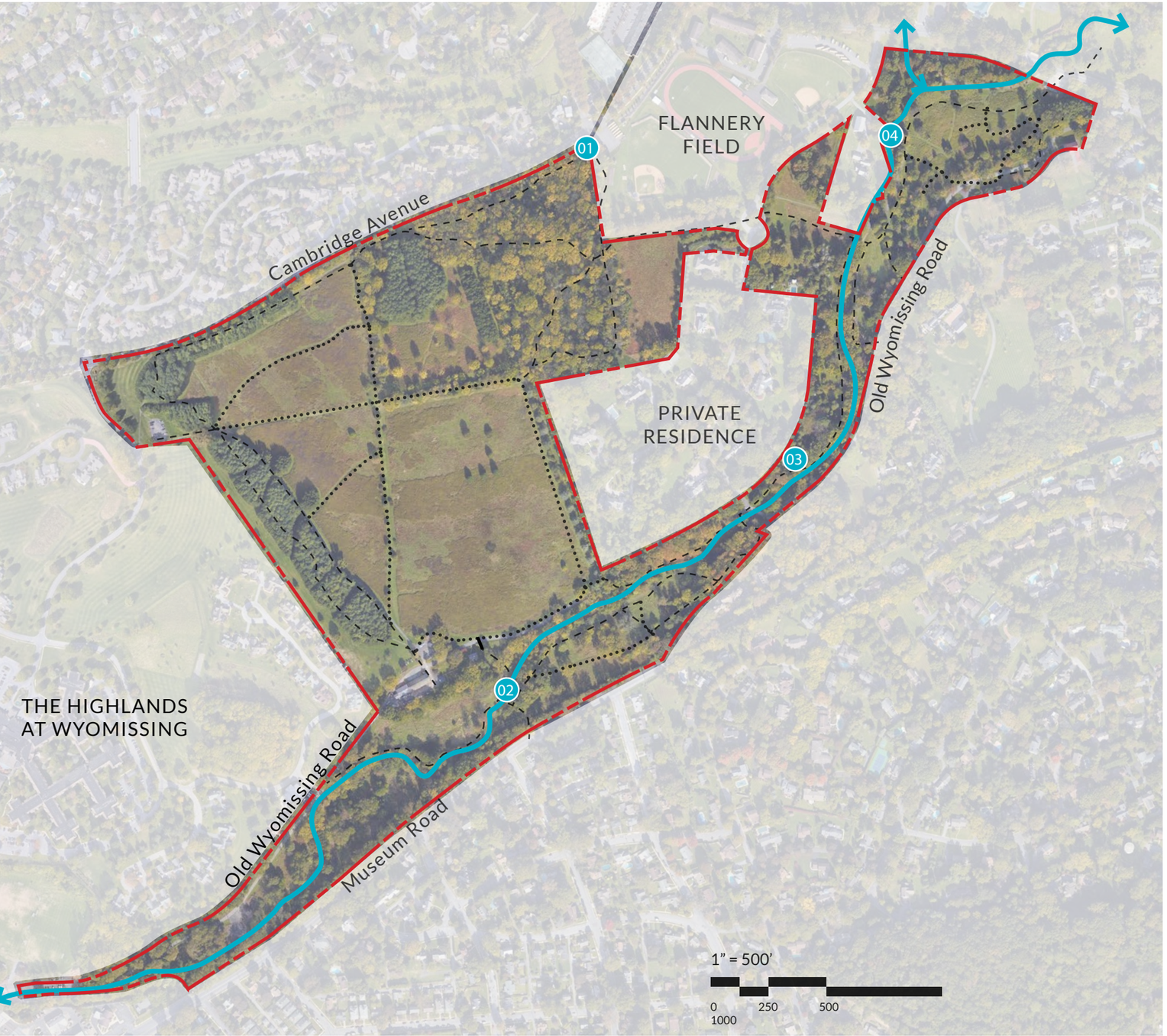
All landowners are required to make a reasonable effort to prevent trees within their property from causing injury or property damage (real or pretended ignorance does not diminish your responsibility or liability). This is best accomplished through a regular program of monitoring areas of high use such as public roads, adjacent properties with structures, and sites used for recreational (play areas, benches, boardwalk, bird blind, sleeping platforms, cabins) or educational (pavilion, bleachers, rustic amphitheater) activities. These areas should be monitored at least once each year and after major storm events. Ideally, the landowner should hire a certified arborist (list available from the International Society of Arboriculture, *see* **Resources**, *page 211 for contact information)* to perform the inspection. Private landowners who cannot afford an arborist or who wish to augment this annual inspection with their own

Holly Harper

A hazard tree situation

Appendix I: Site Inventory & Assessment Maps

Cultural Aspects
Invasive Species
Stormwater & Streambank Erosion
Trail Counter Locations
Trail Issues
Tree Plantings



Photopoint 01 - 40.31912, -75.9736.
Zone 3A: Historical land use evidence .
Facing SE.

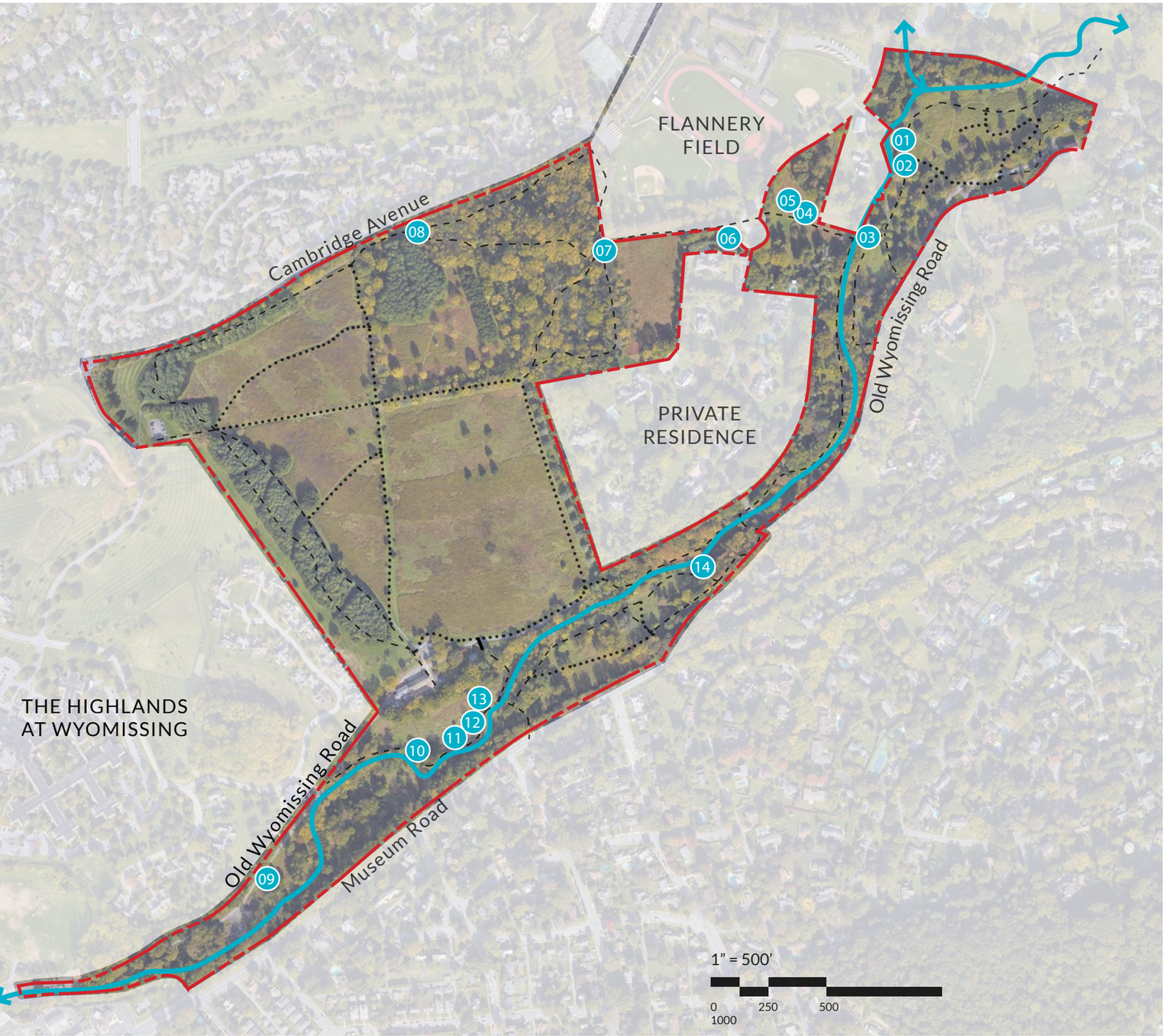
Photopoint 01 - 40.31912, -75.9736.
Zone 3A: Historical land use evidence .
Facing SSE.

Photopoint 02 - 40.31283, -75.97148.
Zone 2A: Spring house at private residence.
Facing SSW.

Photopoint 03 - 40.31644, -75.96835.
Zone 2B: Cherry Ln. spring house.
Facing N.

Photopoint 04 - 40.32069, -75.96768.
Zone 2C: Mill Race.
Facing NNE.

Cultural Aspects



Point 01 Zone 2C - Porcelain Berry - 40.32107, -75.96853.
Porcelain berry (red tinged leaf tissue) dominated field, south from Old Mill Rd parking lot (pictured in background).
Facing NNE.

Point 01 Zone 2C - Porcelain Berry - 40.32107, -75.96853.
Porcelain berry dominated field, south from Old Mill I parking lot.
Facing SSW.

Point 02 Zone 2C - Honeysuckle - 40.32041, -75.96856.
Honeysuckle monoculture on stream bank. Riparian buffer is < 10-ft.
Facing WSW.

Point 02 Zone 2C - Honeysuckle - 40.32041, -75.96856.
Honeysuckle monoculture on stream bank. Riparia buffer is < 10-ft.
Facing N.

Point 03 Zone 2C - Honeysuckle - 40.31967, -75.96892.
Honeysuckle on 5-foot buffer with stream.
Facing SSE.

Point 04 Zone 1- Chinese Silvergrass - 40.3196 -75.96982.
Chinese silver grass adjacent to stormwater meado
Facing S.

Invasive Species Map

Point 05 Zone 1 - Stiltgrass & Thistle - 40.31969, -75.96999.
Stiltgrass and Canada thistle.
Facing N.

Point 06 Zone 1 - Stiltgrass - 40.31916, -75.9708
Stiltgrass meadow adjacent to trail near track fiel
Possible site for additional trees to shade out stiltgra
Facing WSW.

Point 07 Zone 3A - Tree of Heaven - 40.31836, -75.97272.
Tree of heaven amid dead ash tree, at crest of hill near Ball field.
Facing W.

Point 08 Zone 3A - Tree of Heaven - 40.31795 -75.97486.
Zone 3A. Tree of heaven, honeysuckle, stiltgrass throughout.
Facing SE.

Point 09 Zone 2A - Phragmites - 40.30924, -75.97322.
Phragmites.
Facing SSE.

Point 10 Zone 2A - Poison Hemlock & Reed Can Grass - 40.31153, -75.9719.
Poison hemlock (right), reed canary grass (left).
Facing NNE.

Point 11 Zone 2A - Purple Loosestrife - 40.31177, -75.97123.
Purple loosestrife.
Facing W.

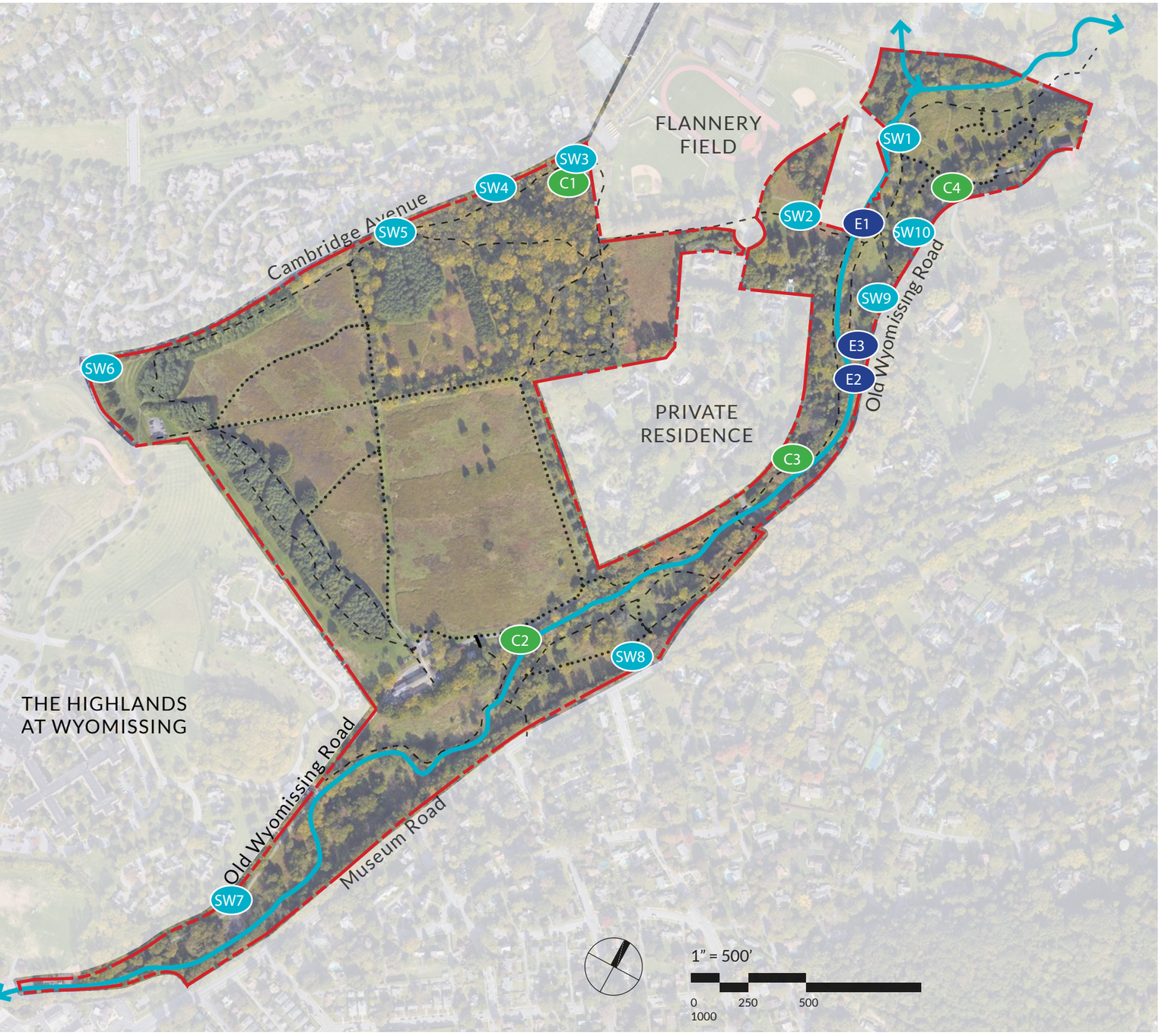
Point 12 Zone 2A - Mugwort - 40.31202, -75.971
Mugwort.
Facing S.

Point 13 Zone 2A - Phragmites - 40.31214, -75.97116.
Phragmites.
Facing N.

Point 13 Zone 2A - Phragmites - 40.31214, -75.97116.
Phragmites.
Facing N.

oint 14 Zone 2B - Poison Hemlock & Japanese Knotweed - 40.315, -75.96896.
Japanese knotweed.
Facing N.

Point 14 Zone 2B - Poison Hemlock & Japanese Knotweed - 40.315, -75.96896.
Poison hemlock (left) Japanese knotweed (right).
Facing NE.



Photopoint C1 - 40.31912, -75.9736.
Zone 3A: Historical land use evidence .
Facing SE.

Photopoint C1 - 40.31912, -75.9736.
Zone 3A: Historical land use evidence .
Facing SSE.

Photopoint C2 - 40.31283, -75.97148.
Zone 2A: Spring house at private residence.
Facing SSW.

Photopoint C3 - 40.31644, -75.96835.
Zone 2B: Cherry Ln. spring house.
Facing N.

Photopoint C4 - 40.32069, -75.96768.
Zone 2C: Culture aspect, old farm wall.
Facing NNE.

Photopoint E1 - 40.31977, -75.96877.
Zone 2C: Stream bank erosion.
Facing WSW.

Stormwater, Erosion, Streambank & Cultural Aspects

Photopoint E2 - 40.31749, -75.96753.
Zone 2B: Upstream of stone wall on Old Wyomissing Rd. Streambank requires rehab and potential for another vein across stream. Potential for permitting.
Facing WSW.

Photopoint E3 - 40.31787, -75.96763.
Zone 2B: Continue to stabilize wall with rocks to its end point. Honeysuckle destabilizing wall. Possibility for permit.
Facing N.

Photopoint SW1 - 40.32073, -75.96843.
Zone 2C: Stormwater swale currently runs from Catalpa tree to Willow, then right into trail. Recommendation to move swale to run into meadow for infiltration.
Facing N.

Photopoint SW10 - 40.31964, -75.96804.
Zone 2C: Trail is acting as a berm for stormwater, needs culvert to escape this zone. It is contributing to the erosion at the bridge in photo E1.
.
Facing N.

Photopoint SW4 - 40.31847, -75.97459.
Zone 3A: Cambridge Ave stormwater issues, not all water going into inlet.
Facing WSW.

Photopoint SW5 - 40.31735, -75.97577.
Zone 3A: Stormwater detention area potential (trees), currently runs down trail.
Facing W.

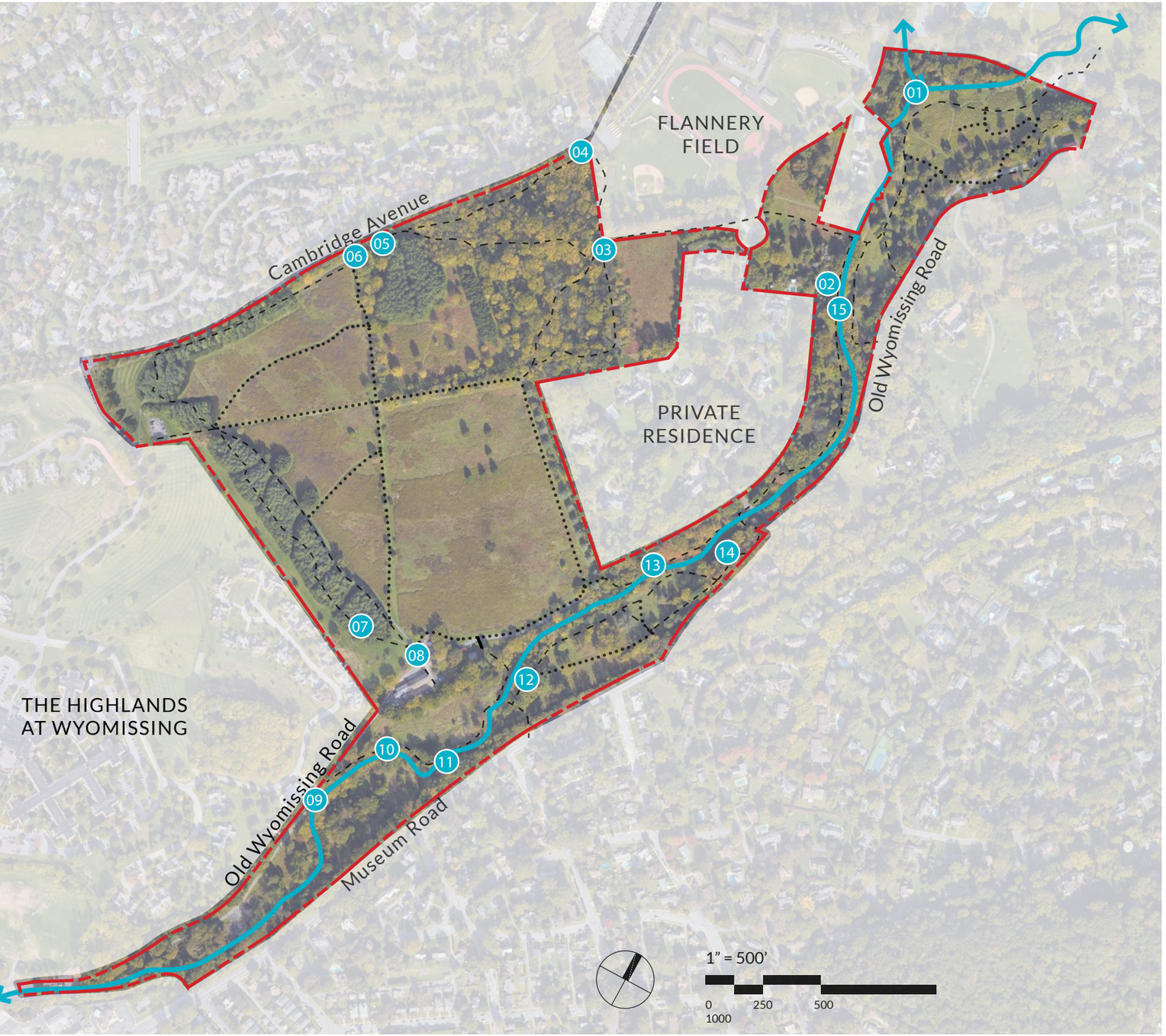
Photopoint SW6 - 40.31416, -75.97945.
Zone 3A: Stormwater detention area; pending future parking lot expansion, additional berms and trees to mitigate stormwater will be necessary.
Facing SSE.

Photopoint SW7 - 40.30857, -75.9736.
Zone 2A: Dump zone close to creek, could be moved further uphill to prevent drainage into Wyomissing Creek.
Facing NNE.

Photopoint SW7 - 40.30857, -75.9736.
Zone 2A: Dump zone close to creek, could be moved further uphill to prevent drainage into Wyomissing Creek. Investigate for alternatives to current composting area.
Facing ENE.

Photopoint SW8 - 40.31358, -75.96935.
Zone 2B: N. Waverly St. stormwater issue, pipe needs to be cleaned out.
Facing SE.

Photopoint SW9 - 40.31852, -75.96811.
Zone 2B: Former bridge location. Streambank and stormwater pinch point due to constriction from abutments.
Facing W.



Trail Issues Map

Photopoint T1 - 40.32186, -75.96866.
Zone 2C: Trail location is too close to stream, bigger buffer recommended .
Facing ENE.

Photopoint T10 - 40.31113, -75.97261.
Zone 2A: Gravel trail could be discontinued and g path be made the only option. Gravel trail is too c to stream. .
Facing NNE.

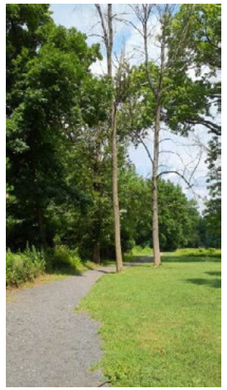
Photopoint T11 - 40.31124, -75.97172.
Zone 2A: Trail is in floodplain, recommended to forego this trail and reroute to the grass one in T10 photo.
Facing SE.

Photopoint T12 - 40.31243, -75.97082.
Zone 2B: Redundant trail along creek, could elimi
Facing N.

Photopoint T13 - 40.3147, -75.96945.
Zone 2B: Trail needs wider buffer between it and stream, reroute.
Facing NE.

Photopoint T14 - 40.31503, -75.96864.
Zone 2B: Trail could benefit from a water bar.
Facing N.

Photopoint T15 - 40.31852, -75.96811.
Zone 2C: Could move trail further away from stream for larger buffer.
Facing N.



Photopoint T15 - 40.31852, -75.96811.
Zone 2C: Hazard trees to be removed from trail ed
Facing SSE.

Photopoint T2 - 40.31911, -75.96872.
Zone 2C: Trail location is too close to stream, bigger buffer recommended.
Facing N.

Photopoint T3 - 40.31843, -75.97258.
Zone 1:Trail erosion near climber bench.
Facing SW.

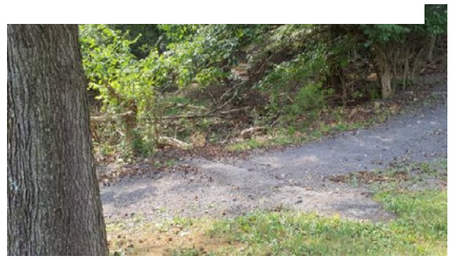
Photopoint T3 - 40.31843, -75.97258.
Zone 1:Trail erosion near climber bench.
Facing NE.

Photopoint T4 - 40.31931, -75.9736.
Zone 3A: Crosswalk recommendation location, Wes baseball field, on Cambridge Ave.
Facing NNE.

Photopoint T5 - 40.31725, -75.97582.
Zone 3A: Erosion and redundant trails.
Facing SSE.

Photopoint T5 - 40.31725, -75.97582.
Zone 3A: Redundant trail.
Facing SW.

Photopoint T5 - 40.31725, -75.97582.
Zone 3A: Redundant Trail.
Facing NNE.

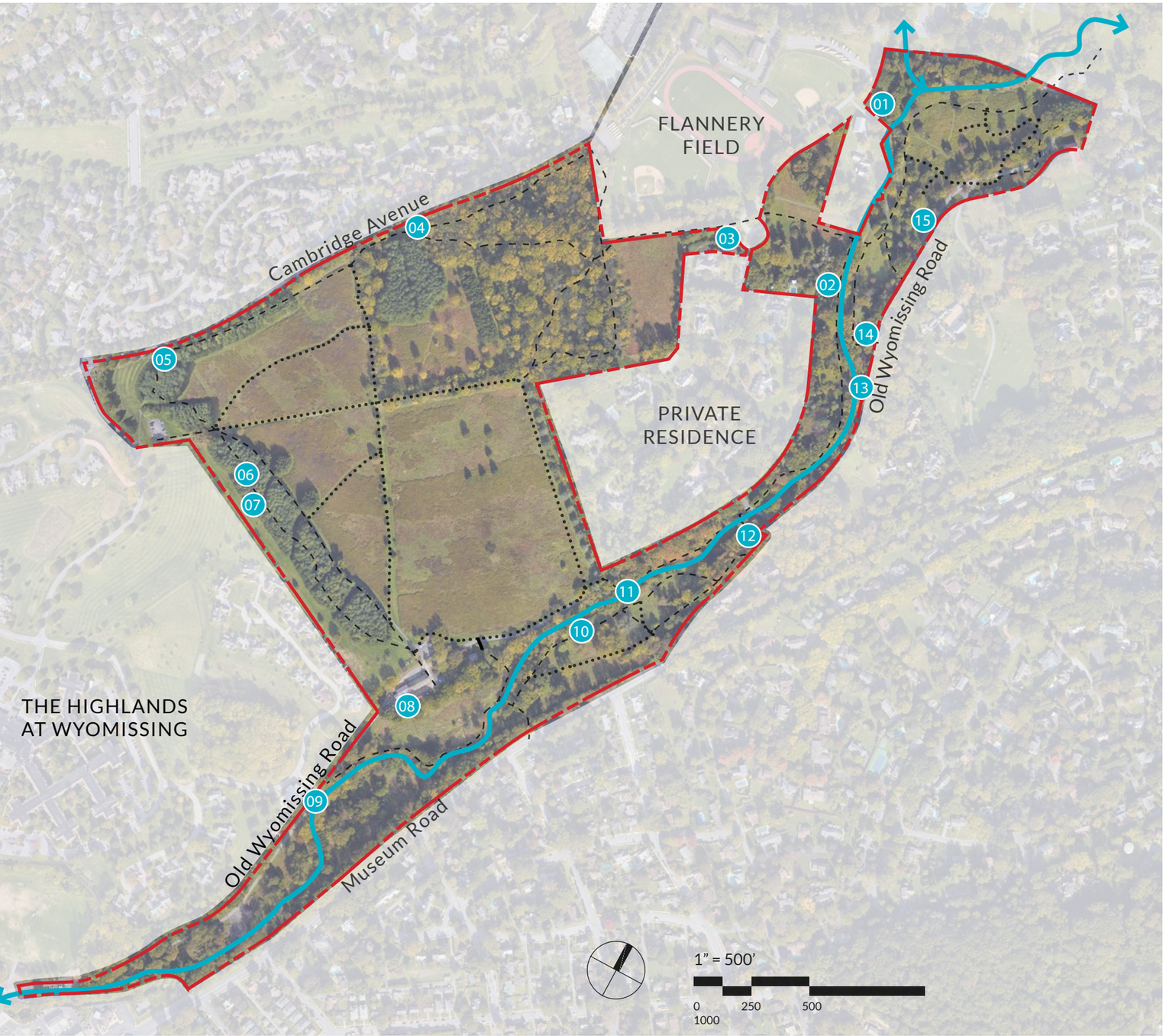


Photopoint T6 - 40.31702, -75.9764.
Zone 3A: Water bar needs reinforcement/maintenance
Facing SSE.

Photopoint T7 - 40.31259, -75.9743.
Zone 3B: Example of hazard branches to keep trimmed along trail in Zone 3B.
Facing N.

Photopoint T8 - 40.3126, -75.97312.
Zone 1: Trail is too wide for practical use. Meadow should be allowed to constrict trail.
Facing N.

Photopoint T9 - 40.31039, -75.9732.
Zone 2A: Could be a through way for maintenance vehicles if compromise with Highlands could be made.
Facing W.



Point 01 Zone 2C - 40.32122, -75.969.
Zone 2C. Planting location for trees along Wyomissing Creek, south-west of Old Mill Rd. parking lot.
Facing SSW.

Point 01 Zone 2C - 40.32122, -75.969.
Zone 2C. Planting location for trees along Wyomissing Creek, south-west of Old Mill Rd. parking lot.
Facing N.

Point 02 Zone 2C - 40.31903, -75.96875.
Zone 2C. Cherry Ln. Representative photo of lawn space along length of Cherry Ln. Additional tree cover recommended.
Facing S.

Point 03 Zone 1 - 40.31916, -75.97084.
Zone 1. Stiltgrass meadow adjacent to trail, near track field on High Rd. Possible site for additional trees to shade out stiltgrass.
Facing WSW.

Point 04 Zone 3A - 40.3174, -75.97563.
Zone 3A. Manicured lawn adjacent to Cambridge Ave. receives excess stormwater due to grade at location. Recommended tree planting location and grass meadow establishment.
Facing WSW.

Point 05 Zone 3B - 40.31449, -75.97885.
Zone 3B. Manicured lawn at Cambridge and Parkview. Stormwater collection basin, recommended conversion to meadow or trees.
Facing SSW.

Tree Planting Map

Point 05 Zone 3B - 40.31449, -75.97885.
Zone 3B. Manicured lawn at Cambridge and Parkview. Stormwater collection basin, recommended conversion to meadow or trees.
Facing SSE.

Point 06 Zone 3B - 40.31366, -75.97658.
Zone 3B. Tree planting area or close off redundant trail access from Highlands.
Facing NE.

Point 07 Zone 3B - 40.31327, -75.97623.
Zone 3B. Additional trees to be planted along evergreen line.
Facing SE.

Point 08 Zone 3B - 40.31226, -75.97287.
Zone 3B. South-east corner of golden meadow, at Park Barn. Additional tree planting recommended at site to supplement existing tree cover and shield developments.
Facing WSW.

Point 09 Zone 2A - 40.30975, -75.97332.
Zone 2A. Floodplain and stormwater drainage on Old Wyomissing Rd. Additional tree planting to shade stiltgrass, stabilize soils adjacent to stream.
Facing S.

Point 10 Zone 2B - 40.31391, -75.97013.
Zone 2B. Additional tree plantings to stabilize eastern stream bank of Wyomissing creek.
Facing SW.

Point 11 Zone 2B - 40.31484, -75.96926.
Zone 2B. Trail is too near to eastern stream bank of Wyomissing Creek. Relocation of trail to create buffer followed by tree planting at site.
Facing ENE.

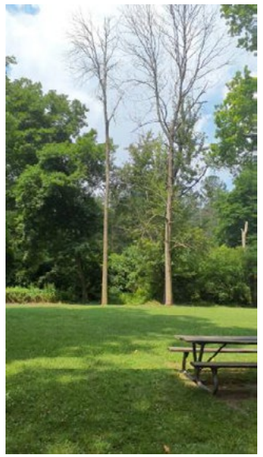
Point 11 Zone 2B - 40.31484, -75.96926.
Zone 2B. Trail is too near to eastern stream bank of Wyomissing Creek. Relocation of trail to create buffer followed by tree planting at site.
Facing W.

Point 12 Zone 2B - 40.31573, -75.96834.
Zone 2B. Additional trees recommended at far end of lawn on Old Wyomissing Rd.

Point 12 Zone 2B - 40.31573, -75.96834.
Zone 2B. Additional trees recommended at lawn on Old Wyomissing Rd.

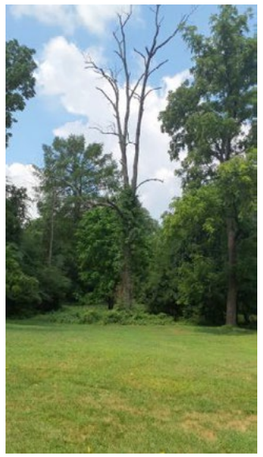
Point 12 Zone 2B - 40.31573, -75.96834.
Zone 2B. Unused lawn on Old Wyomissing Rd., recommended tree plantings.
Facing WSW.

Point 13 Zone 2B - 40.3175, -75.96754.
Zone 2B. Tree plantings recommended to stabilize stream bank on Old Wyomissing Rd.
Facing SSW.



Point 14 Zone 2B - 40.3184, -75.96793.
Zone 2B. Picnic area in floodplain next to Wyomissing Creek. Dead trees, to be cut and replaced.
Facing WNW.

Point 14 Zone 2B - 40.3184, -75.96793.
Zone 2B. Picnic area in floodplain next to Wyomissing Creek. Space for additional wetland trees.
Facing N.



Point 15 Zone 2C - 40.32006, -75.96781.
Zone 2C. Dead ash tree adjacent to Old Wyomissing Rd. South of Old Mill Rd. parking lot.
Facing ENE.

Point 15 Zone 2C - 40.32006, -75.96781.
Zone 2C. Sickly tree of heaven (right). Open lawn for additional tree plantings adjacent to Old Wyomissing Rd. South of Old Mill Rd. parking lot.
Facing N.