Potential Funders for High Priority Projects at the Neversink Mountain Preserve

POTENTIAL FUNDER	PROGRAM
PA Department of Conservation and Natural Resources (DCNR) *Contact:* Dennis DeMara 610-377-5780 ddemara@pa.gov	*Schuylkill Highlands Conservation Landscape Initiative Mini-Grant Program*
	Community Conservation Partnership Program
	PA Recreational Trails Program
PA Department of Environmental Protection (DEP) *Contact:* Reading District Office 1005 Crossroads Boulevard Reading, PA 19605 610-916-0100	*Environmental Education Grants Program*
	Growing Greener Watershed Grants
	Nonpoint Source Implementation Program (Section 319)
Natural Resources Conservation Service (NRCS) *Contact:* Berks County Ag Center 1238 County Welfare Road Leesport, PA 19533 610-372-4655 ext. 3	*Wildlife Habitat Incentives Program (WHIP)*
	Environmental Quality Incentives Program (EQIP)
	Conservation Stewardship Program (CSP)
PA Department of Community and Economic Development (DCED) *Contact:* Hon. David R. Kessler 2 School Drive Oley, PA 19547 610-987-0980 Sen. John C. Rafferty, Jr. 3770 Ridge Pike Collegeville, PA 19426 610-831-8830	*Community Development Grants*
National Park Service and PA DCNR *Contact:* Schuylkill River Heritage Area 140 College Drive Pottstown, PA 19464 484-945-0200	*Schuylkill River National and State Heritage Area Grant Program*
Berks County Community Foundation *County:* Richard Mappin P.O. Box 212 501 Washington Street, Suite801 Reading, PA 19603 610-685-2223	*The Conservation Equity Funds*
Pottstown Health and Wellness Foundation *Contact:* 152 East High Street, Suite 500 Pottstown, PA 19464 610-323-2006	
Wyomissing Foundation *Contact:* 960 Old Mill Road Wyomissing, PA 19610 610-376-7494	
Local Corporations	*Corporate Charitable Giving Programs*
	Employee Volunteer Programs

Invasive Vegetation Management

excerpted from

Stewardship Handbook
for Natural Lands in Southeastern Pennsylvania

David B. Steckel
Holly M. Harper

Editor and Contributor
Roger Latham, Ph.D.

Editors
Susan Charkes, Ann F. Rhoads, Ph.D.

Contributors
Dan Barringer, Tim Burris, Drew Gilchrist,
Darin Groff, David Harper, Andy Pitz,
Jim Thorne, Nathan Walker

Natural Lands Trust

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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

invasive species =
one that rapidly spreads and outcompetes multiple native species

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**

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.

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.

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.

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.

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

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.

INVASIVE VEGETATION MANAGEMENT

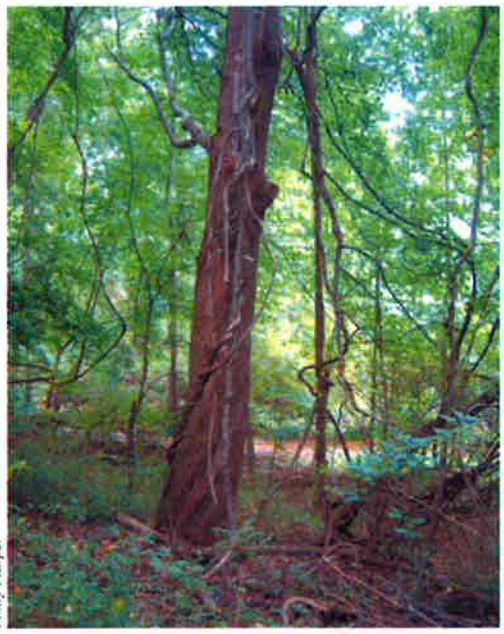
Management Strategy

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...

...continued

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

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.

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.

Dan Barringer

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 .

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

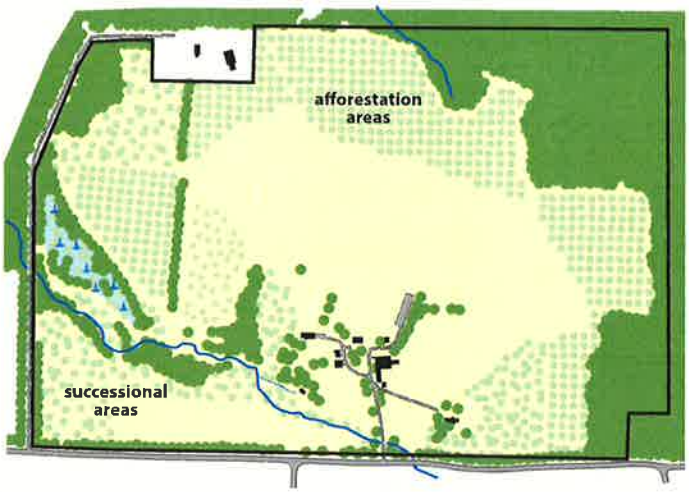
native grass species. Meadow areas heavily affected by invasives may warrant herbicide application (refer to **Herbicides**, below, for further details), followed by planting of natives.

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.



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

Dan Burninger

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 Berringer

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.

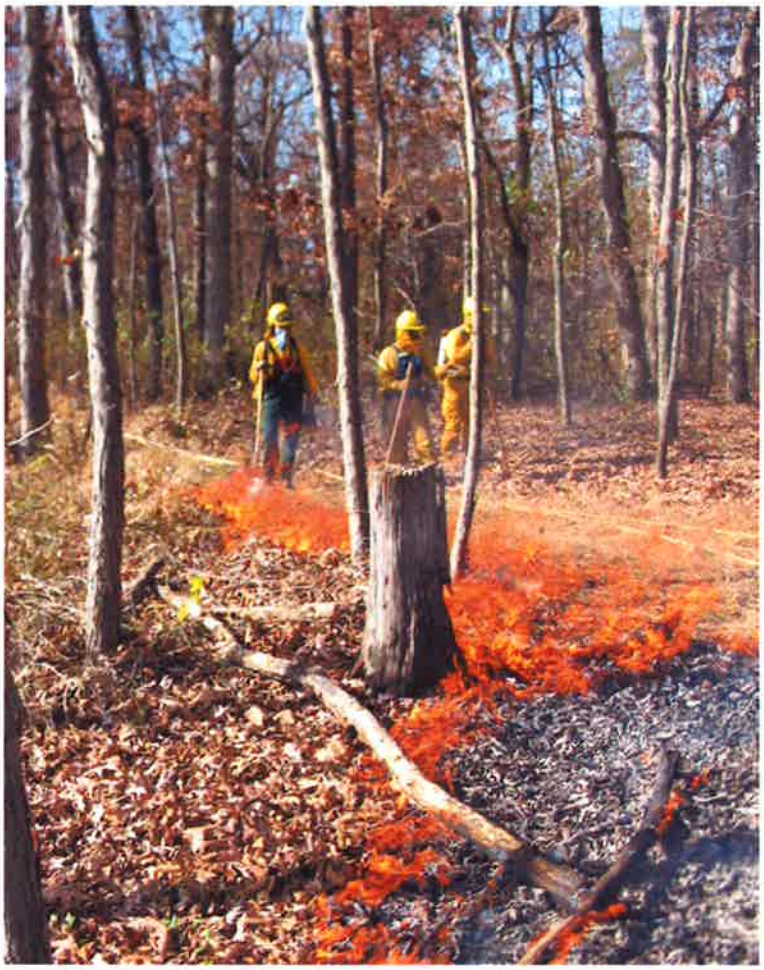
Recommended Techniques and Procedures

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 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.



Dann 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.

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.