BEST MANAGEMENT PRACTICES

art by
Skye Caldwell

FOR PRIORITY INVASIVE SPECIES IN THE LOWER HUDSON VALLEY

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BEST MANAGEMENT PRACTICES FOR PRIORITY INVASIVE PLANTS IN THE LOWER HUDSON VALLEY

A Revised and Expanded Edition of the Original 2016 Report

Prepared for

Lower Hudson Partnership for Regional Invasive Species Management

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Table of Contents

INTRODUCTION

by Erik Kiviat

We would love to have a magic wand we could wave to make pestiferous nonnative plants go away, or at least be greatly reduced in abundance. Alas, there is no such wand, and we must be careful that the solutions are not worse than the problems. Even carefully planned vegetation management projects can poison desirable plants and wildlife, degrade habitat structure for animals of conservation concern, result in soil erosion and greenhouse gas emissions, and cause spread of weed propagules downstream, downslope, or downwind. "Invasion science" is an evolving endeavor to understand and steer the ecology of organisms considered overabundant and somehow adverse to wild native organisms, and human economics, health, or culture. And the "invasive" species themselves are a moving target, colonizing, reproducing, spreading, hybridizing, and evolving.

There is a "knowing-doing gap" in invasive species management, where research results and translation into best practices often does not inform on-the-ground actions of land managers.[1] It has been shown in the UK that most nature managers imitate the practices of their predecessor or neighbor managers rather than exercising "evidence-based conservation"[2]; only 2.4% of managers surveyed used the primary scientific literature to guide management decisions. We hope these fact sheets will help address this gap in the Lower Hudson PRISM region of the Lower Hudson Valley and New York City. By interpreting the scientific literature and experiences of professionals in the field, we have compiled accessible and accurate information for landowners, land managers, gardeners, farmers, foresters, policymakers, and anyone else with a connection to the land and an interest in conserving biodiversity by managing invasive plants.

For these fact sheets, we chose a subset of invasive plants that are both significant problems in our region, and that had enough peer-reviewed literature or first-hand experience of practitioners in the region to produce evidence-supported, non-chemical management recommendations. For some species where only a few management methods have been tested, we recommend testing a method that worked with a similar species. Our revisions of the original 2016 fact sheets cover the same 15 species plus 5 additional species of interest to LH PRISM member organizations. A new feature of this revised document is changes in a few common names to eschew geographic or ethnic bias (see [3]).

Why, whether, and when to control invasive species

When do nonnative, invasive plants threaten native species? In some cases, they directly threaten native plants through competition for space, light, water, or nutrients, or threaten native plants and animals indirectly by changing soil chemistry, soil microbiota, nutrient cycling, vegetation structure, or plant community composition of a native habitat (of course, native species also have these ecological effects, perhaps less rapidly or dramatically). In other cases, the invaded area is a highly disturbed one such as a roadside ditch or wetland fill, and the invasive species may occupy a useful niche by growing where many native plants do not thrive and provide shelter or resources to native animals. Certain invasive plants, e.g., the nonnative subspecies of common reed provide valuable ecosystem services—including sediment building and stabilization in tidal marshes, carbon sequestration, and water quality maintenance—while either degrading or enhancing habitat for certain native species of conservation concern.[4] A highly altered environment may not be able to support native species of conservation concern unless significant changes are made, for example, to soil structure, soil microbial or fungal communities, water or nutrient availability, or canopy closure. The closer a habitat or community resembles a native, undisturbed example, the better chance of a successful outcome for invasive species removal. However, desired outcomes are often challenging to obtain, and restoration to former, apparently more healthful conditions is commonly elusive.

Complicating this picture is the fact that many of our forests, wetlands, and other natural communities that are protected from obvious disturbances such as logging or cut-and-fill are nevertheless suffering from many less obvious impacts. These include overabundant white-tailed deer, proliferation of nonnative earthworms, insect and fungus pests that do widespread damage to forest trees, inputs of a variety of pollutants (including atmospheric deposition of nitrogen from west of New York State), a shifting climate, and changing human activities. The lack or disruption of natural disturbance regimes such as fire or flooding is also a source of stress on certain natural communities. Finally, it is becoming clear that past disturbance—such as plowing or other agricultural activity tens, hundreds, or even thousands of years ago—has continuing effects on soil properties, nutrient cycling, and plant community composition.[5] The presence or abundance of nonnative plants is often predicted by one or more of these factors, and (just as with the more obviously disturbed land) removal of the plants may be unlikely to change the conditions that facilitated their growth.[6] Often, diversity or abundance of nonnative plants indicates environmental degradation but does not necessarily predict lower levels of habitat function for native fauna and flora.

Nevertheless, there is strong evidence that many invasive plants, just by their presence or abundance, dramatically shift soil nutrient composition, microbiota, nutrient cycling rates, and other processes, making their immediate environment friendlier to themselves and often to other invasive plants.[7] In some cases, their removal reverses these effects. Moreover, some of the disturbance factors contributing to the success of invasives (and the decline of natural communities) can be addressed to some extent: deer abundance can be controlled on some sites; nutrient and chemical inputs from lawn and garden fertilizers, home septic systems, pest control, construction sites, crop fields, and livestock can be reduced; landowners can determine where and how often mowing, tree harvesting, and other disturbances will happen. Planting carefully selected native woody or herbaceous plants in invaded areas can also help by establishing competitors for the invasive plants, aiding forest regeneration, and possibly restoring soil properties and plant and animal communities.

The effects of nonnative, invasive plants vary not only by species, but also by situation. Ecological relationships—including the negative or positive impacts of a plant—may vary from one place to another within the region, even across distances of a few yards (e.g., from sun to shade, or across a wetland boundary). Under some conditions, a given species will form a spreading patch so dense it becomes almost a vascular plant monoculture, with obvious negative effects for the displaced native flora and fauna. In some cases, a population of a rare plant or animal is known to be threatened by the encroachment of an invasive plant, although in some cases, the opposite can also be true. The vast majority of cases are less clear-cut, with invasive plants at low to moderate densities, or in discrete patches, and providing value to certain organisms in the form of cover or food, but perhaps reducing habitat quality for other organisms. In some cases, there is no obvious effect or even a positive effect (for example, protection of a rare plant from herbivory provided by the co-occurrence of invasives).[8] Decisions about whether or not to manage a pest population can only be based on imperfect knowledge—which at least is summarized in the following fact sheets—and available resources.

In conducting literature searches for this report, there was much evidence that certain nonnative weeds, such as common reed, mugwort, and knotweed, have many existing or potential uses involving a variable degree of processing. For example, biofuels, construction materials, medicines, foods, livestock forage, phytoremediation, and biological pesticides. There is controversy concerning the often-mentioned idea of managing a weed by harvesting it as a resource. Although many such uses may be impractical on a small scale, landowners and managers should keep in mind, for example, the potential use of weeds for livestock forage. Of course, weeds that may be accumulating contaminants in industrial or roadside habitats should not be used for forage or food.

Why focus on non-chemical control?

In invasive species management, as in agricultural weed management, chemical control is the dominant method. It is almost always more labor-efficient (hence cost-efficient) than manual or mechanical control, and often more successful, at least in the short term. Despite this obvious benefit, the environmental costs of herbicide use—discussed below—are considerable. For this reason, we have focused on non-chemical management practices, which are ultimately more sustainable for human health, environmental health, and biodiversity protection. Furthermore, landowners can use non-chemical techniques without the services of a state-licensed pest control operator. (It should be remembered, however, that even non-chemical techniques may require a permit if implemented in a wetland, stream channel, on a nature reserve, or near New York City water supply reservoirs and the streams that feed them.)

There are many active ingredients in commonly used herbicides, and in commercial formulations these are mixed with other chemicals (such as surfactants) to increase their efficacy, resulting in numerous and often proprietary mixtures. Research into environmental safety of these products is commonly insufficient and predominantly industry-funded. Nevertheless, enough independent, peer-reviewed research has been published that some of the potential negative effects of herbicide use are becoming apparent. Glyphosate-based herbicides are the most commonly used type in the US and globally,[7] and they also have been the subject of most research into nontarget effects (effects on organisms other than the target weed).[9] Although glyphosate is widely reported to break down quickly in the environment, in soil tests dissipation time varied from 1 to 197 days (mean = 32 days). The breakdown product aminomethylphosphonic acid (AMPA), approximately equivalent in toxicity to glyphosate in several animals tested, dissipated in 76-240 days (mean = 76 days). In non-flowing water, it took 7-14 days for glyphosate to reach 50% of the applied concentration.[10] Glyphosate and/or AMPA were found in 57% of more than 3,700 soil and water samples taken across the US and both are also found in crops, processed foods, and livestock feed.[10,11] We do not yet know all the effects of pervasive low-level exposure to these chemicals on humans and other organisms, but many have been demonstrated. Glyphosate exposure at environmentally relevant concentrations can cause liver, kidney, and respiratory damage in laboratory rodents.[12] As an endocrine-disrupting chemical, it has been shown to alter hormonal systems (including sexual development) and gene expression patterns in various vertebrates, and alter embryonic development, causing malformations in amphibians, chickens, and pigs. It is probably carcinogenic to humans, according to the World Health Organization. Its antibiotic effects can harm the intestinal flora of vertebrates, and promote the development of new strains of antibiotic-resistant bacteria. Even “inert” ingredients in herbicide

formulations are proving to be toxic (the surfactant mix including POEA in Roundup® is much more toxic to amphibians, fish, and aquatic invertebrates than pure glyphosate).[13] One of the most concerning laboratory findings is that glyphosate inhibits bacteria necessary for the formation of the exoskeleton in a beetle; the authors speculated that the global use of this chemical may be contributing generally to insect population declines.[14] Herbicides can easily reach nontarget habitats and organisms due to drip from treated plant parts, aerial drift, runoff, spills, and errors in application. Techniques of application such as "clip and drip" and injection reduce but do not eliminate the risk of nontarget effects. For example, control of tree-of-heaven by injection of imazapyr resulted in significant mortality of other woody species within a 3-m radius.[15]

Belief in the efficacy of herbicides may lead individuals to be less likely to perform follow-up treatment or monitoring, although in most cases successful eradication of a patch takes several years with herbicides, just as with mechanical methods. Overuse of herbicides demonstrably leads to the evolution of herbicide-resistant weeds. Also, herbicides are predicted to decline in efficacy with increasing atmospheric carbon dioxide and/or temperature.[16]

Setting management goals and making a management plan

Control of invasive plants using manual, mechanical, and cultural control methods is labor-intensive and depends on a long-term commitment to manage the invader, restore native vegetation, and monitor thereafter to prevent recurrence. Because of the effort involved, setting appropriate goals is extremely important. A good first step is to determine the habitats most worthy of management—from a biodiversity perspective—on your property, including any large, high quality, rare, or uncommon habitats. These can include natural communities such as forests and wetlands, but also some types of agricultural land, abandoned fields, or other human-modified habitats with high value for some species of conservation concern. For instance, a rocky ledge or a small patch of mature forest may support rare plants; a large hayfield can provide nesting habitat for grassland-adapted birds such as the bobolink; a wetland or pond surrounded by unmanaged habitat can be important for amphibians. The *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* by E. Kiviat and G. Stevens [17] and the *Biodiversity Assessment Handbook for New York City* by E. Kiviat and E.A. Johnson [18] define common and rare habitats in our region and explain their potential conservation values. Many other useful resources are listed on the New York State Department of Environmental Conservation (NYS DEC) Hudson River Estuary Program's *Conservation and Land Use Program for the Hudson River Estuary Watershed* web page.[19] It also helps to think about land use and aesthetic goals, which may be informed by what you have learned about the habitats on your land and the species they may support.

Next, assess which invasive plants are present, their locations, and the approximate extent and density of each occurrence. This may require a year of acquainting yourself with the land in all the seasons, since different species are easier to spot at different times. Field guides, knowledgeable friends and neighbors, extension agents, wildflower clubs, and, of course, LH PRISM members and Hudsonia may be good resources at this stage. Accurate identification is important because valuable native species can be confused with invasive nonnative species (e.g., the native subspecies of common reed [*Phragmites australis* ssp. *americanus*]).

Reading the fact sheet for each species should help you determine which habitats it may threaten, whether it is a problem now, and whether it may become one if left unchecked. For instance, some invasive shrubs provide good bird habitat in an old field, but have negative effects at high densities in a forest understory. Some species fail to produce seeds or eventually die under a dense canopy, but seed production at the sunny forest edge perpetuates the population. If a diverse mixture of native plants coexists within the invasion, perhaps active management is not needed. In forests, pay particular attention to native woody plant regeneration. Often, actions such as limiting access of white-tailed deer, replanting native woody plants, or limiting soil and canopy disturbance will do more to enhance habitat for native species and discourage invasives than direct removal of the offending plants.

Once the problem areas and species are identified, set realistic goals. These should take into account the time, labor, and budget at your disposal, with the expectation that management will need to happen for several or many years. They should also reflect the chances of success of restoring a native habitat. In many cases, total removal of an invasive is not reasonable with any method. Some reasonable goals include complete removal of a weed that is just becoming established (*early detection – rapid response* or EDRR), keeping a large patch from spreading (containment), preventing production of seeds or vegetative propagules, or reducing density. Identify the best timing for management actions, and set up a schedule across years. Timing can be crucial. For example, cutting or girdling in different seasons can affect mortality or the number of root sprouts. If timed right, most species can be annually cut or pulled to almost eliminate reproduction by seed. These fact sheets should also help you avoid worsening the problem. For example, cutting some perennial species once a year, or even three times a year, will only make them grow more vigorously. Most importantly, include restoration (if necessary) and monitoring as part of the plan. Much work removing invasive plants has been wasted because a lack of follow-up actions resulted in the recovery of the targeted species or the colonization by other weeds. Moreover, if management treatments and their outcomes are not documented, other managers will not benefit from your experience.

In planning the management of nonnative weeds, and for nature management in general, let the following three principles guide your decision-making:

1. Study the local situation with its biota and non-living environment.
2. Clarify the goals of management.
3. Make use of current scientific research findings.

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UPDATED SPECIES ACCOUNTS

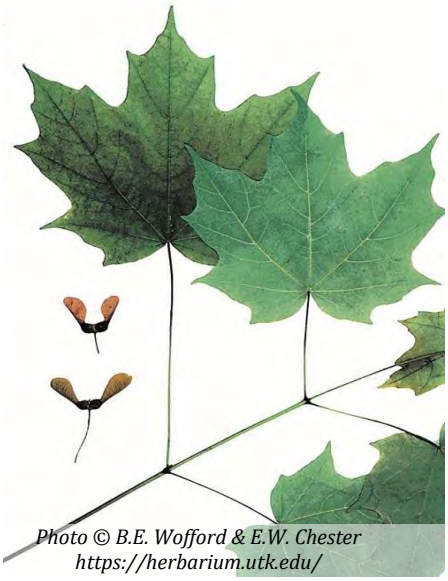
The following section covers species included in the original 2016 report.

Their content has been updated and expanded for the 2025 edition.

HARLEQUIN MAPLE

Acer platanoides

Photo © University of Tennessee Herbarium Knoxville https://herbarium.utk.edu/



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Biological Category
Plants

NY Legal Status
Regulated

Species Type
Tree

Habitat
Terrestrial

DESCRIPTION

Harlequin maple (*Acer platanoides*), often called Norway maple, is a member of the Sapindaceae (soapberry) family.[1] It is a medium to large shade tree (40-60 ft, occasionally upwards of 90 ft) with a life span of up to 150 years.[2–4] It closely resembles the native sugar maple (*Acer saccharum*) but can be distinguished from the latter either through its sap color during the growing season (white) or its leaf buds in winter (purplish or green, with rounded tips and 2-3 pairs of bud scales).[2,5] Cultivars of harlequin maple (particularly 'Crimson King') are still sold, planted, and maintained in the US today, [6] and research on this species' spread highlights its continued expansion and the role of human activity in its persistence.[7,8]

IDENTIFICATION FEATURES

Leaves: Simple, opposite, deciduous, with 5-7 lobes, and rounded sinuses between lobes. Milky white sap when leaf or petiole (leaf stem) are broken (may not be detectable when the tree is dormant).[1,2,9]

Seed: Encapsulated in papery membrane with a wing (samara).[1] Pairs of samaras with wings spreading 180°, as opposed to sugar maple, where wings make an inverted "U" shape.[1]

Bark: At all life stages, the bark of harlequin maple is brown to gray. Young tree bark has orange tinted vertical cracks. Mature tree bark develops narrow intersecting ridges. Old trees have ridges which are flatter and wider.[10]

SIMILAR SPECIES

Sugar maple has similar leaves but often fewer (3-5) lobes.[1] In summer, these trees can be distinguished by breaking a fresh leaf or leaf stem: harlequin maple has white sap while sugar maple sap is clear.[9] In winter, harlequin maple end buds are purplish or green, have rounded tips and 2-3 pairs of bud scales while sugar maple buds are reddish-brown, conical and pointed, and have more scales.[2,5] Sugar maple bark is similarly colored but does not form distinct ridges and furrows.[10]

Silver maple (left) and harlequin maple (right)

Harlequin maple (*Acer platanoides*)

INTRODUCTION HISTORY

Harlequin maple is native to Europe and western Asia, where it thrives in a range of temperate forests. In its native habitat, it is commonly planted as a street tree and used for specialty wood products such as veneers. The species was introduced to the U.S. in 1756 when seedlings were shipped from England to John Bartram of Philadelphia, who then began to offer them locally.[11] Its use was mainly limited to wealthy Americans who valued its aesthetic appeal, until 1833, when it was formally approved for planting along streets and avenues.[12] It rose to prominence as one of the most commonly planted urban trees following the decline of American elm (*Ulmus americana*) in the 1930s.[12,13]

ECOLOGY AND HABITAT

Harlequin maple is a highly adaptable species that thrives in a multitude of habitats, particularly urban and disturbed environments.[7] Its ability to tolerate shade gives it a competitive advantage over native species, allowing it to alter forest structure by suppressing the growth of sub-canopy saplings and seedlings.[14] This species has also demonstrated a high degree of plasticity in resource allocation, shifting biomass to its roots when light availability increases, which enhances its competitiveness for belowground resources.[14] This adaptability contributes to its success in both urban and forested environments, where it is commonly found forming dense stands that reduce biodiversity.[14]

Although it is well-suited to many site conditions, studies suggest that harlequin maple does not regenerate as effectively in certain conifer-dominated stands, potentially due to soil acidity constraints.[15] Given its widespread establishment and ecological impacts, harlequin maple is considered a significant invasive species in North American forests and urban landscapes.[7]

REPRODUCTION AND PHENOLOGY

Harlequin maple blooms in early spring and relies on insects for pollination. Its wind-dispersed seeds mature in late summer and can travel more than 100 yards from the parent plant.[16,17] Germination rates are high compared to native tree species, even in deep shade. Seedlings grow slowly under low light and can persist at a small size for years, creating a "seedling bank."[18] Growth of the seedling bank rapidly accelerates once gaps from treefall or other disturbances increase light availability, allowing harlequin maple to reach the canopy in about half the time it would take native co-occurring trees.[19] Although shade-tolerant, this species can take a long time to reach maturity under closed canopies (as much as 30-40 years).[16]

IMPACTS OF THIS SPECIES

Once established, harlequin maple is a strong competitor in the forest understory, and can displace native shade-tolerant species such as sugar maple.[18] However, because harlequin maple can be slow to reach maturity in deep shade (30-40 years), it has spread relatively slowly so far.[18]

This species negatively affects the growth of native tree saplings (especially conifers) at each of its life stages.[20] Richness of understory plants is greatly reduced under harlequin maple trees compared to native trees, as harlequin maple seedlings and saplings densely fill the forest floor and mature trees of this species create tightly closed canopies which then affect the vertical structure and light levels in forests.[14]

Harlequin maple also increases nutrient availability and the rate of nutrient cycling in soils (especially on richer soils), which may increase its competitive advantage but also increase growth of certain native trees.[21] It can inhibit the supply of soil inorganic nitrogen while increasing nitrogen leaching, further affecting native plant regeneration.[14]

Harlequin maple (*Acer platanoides*)

MANAGEMENT GOALS

- Prevent or limit seed production by prioritizing management of mature trees.[22]
- Hand-pull or mow seedlings and saplings to prevent them from growing to maturity.[19,20]
- Avoid soil disturbance, which promotes seed germination[22], and canopy disturbance, which allows for rapid growth of persistent seedlings.[18]
- Education and outreach discouraging sale and new plantings of this species' horticultural cultivars should be key components of management efforts to help reduce its spread.[7,8,23]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

There are currently no biological control agents in use against this species. Some have been tested but unsuccessful,[24] and its similarity to the native sugar maple makes it an unlikely candidate for further biocontrol study.[22]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Seedlings can be pulled by hand[25] or dug out with a soil knife.[6] Small saplings can be pulled through the use of a weed wrench or dug out with a shovel or similar implement.[6,26] Take care to remove the entire root ball without snapping and leaving behind any roots fragments, which can resprout.[26] Consider applying this method when the soil is moist to allow for easier manual removal of roots.[26]

Cutting / Girdling

Cutting this species to the ground is not recommended, as this will produce vigorous resprouts. Alternatively, removing all branches from a mature tree while leaving the trunk standing may effectively limit resprouting and produce mortality in harlequin maple.

Girdling usually results in vigorous resprouting from the stump and is therefore not advisable, especially in the case of small trees.[7,22]

Some success has been shown in deeper girdling that fully severs the sapwood, but this may still require follow-up re-girdling (especially for trees > 10" DBH).[26]

Prescribed Grazing

This method is unlikely to be an effective control strategy, as harlequin maple is quite resistant to deer browse and readily resprouts from cutting. However, this technique remains largely untested by formal studies for this species, and there is some evidence of a synergistic effect between deer browse, insufficient organic matter, and moisture stress or inundation.[14]

Soil Tilling

Not advisable. This species easily resprouts from snapped roots, and soil disturbance can stimulate its germination in seed banks.[22]

Solarizing

Can be used for smaller trees in conjunction with cutting to prevent stump sprouts: cut several inches above ground level and cover the stump with something that completely blocks light for 1-2 years (e.g., a coffee can, or a heavy-duty black plastic bag zip-tied to the base of the stump).[27]

Flooding

As harlequin maple is fairly flood intolerant, there is evidence that restoring natural flood regimes to disturbed floodplain forests and along disturbed river/stream channels can reduce the abundance of this species.[28]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Light gaps left by senesced canopy trees may result in rapid growth of harlequin maple seedlings or establishment by other invasive species.[22] Monitor these gaps carefully for newly germinated harlequin maple seedlings and any emergent invasive species.[19] Consider planting native species at treatment sites if possible, to reduce the amount of bare soil present post-treatment.[22]

Follow-up treatments can be applied either annually by hand-pulling seedlings or every few years to remove saplings. Soil disturbance from hand-pulling or digging can result in slightly increased harlequin maple seedling density, and should be avoided in the first few years post-treatment.[22] The longevity of the seed bank is unknown.

Disposal Methods

Woody debris and seedlings from this species can be left to decompose *in situ* with roots exposed in the air for desiccation,[22,26] and still-standing girdled or cut trees can be left standing for wildlife value.[26]

In the following cases, *ex situ* disposal may be preferable:

- Seeds are present;
- Symptoms or signs of disease or pests are present;[26]
- A potential hazard is posed by proximity to nearby buildings, trails, or passersby.[26]

For e*x situ* disposal, woody debris and seedlings can be repurposed in several ways: chipped for mulch; burned for firewood; used for lumber; or brought to a commercial compost facility that accepts woody and seed materials (see Appendix A for more details).[26,29]

- Home composting of this material is not recommended, as these piles often do not achieve the temperatures needed for effective processing.[29,30]

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Fact sheet prepared by Kathryn Natale, Andrew Leonardi, and Erik Kiviat (Hudsonia).

TREE-OF-HEAVEN

Ailanthus altissima

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DESCRIPTION

Tree-of-heaven (*Ailanthus altissima*) is a medium to large tree in the Simaroubaceae family.[1] It can reach heights of 98 ft and is incredibly fast-growing, with an annual growth rate of 3 to 6 ft while young.[1,2] The tree has large, pinnately compound leaves ranging from 1 to 4 ft long,[2] with 11 to 41 leaflets.[3] In spring, the leaves first appear with a bronze hue before deepening to a darker green as they mature.[2] The leaves and stems have a strong, unpleasant odor (likened to stale peanut butter) when crushed.[4,5] In summer and fall, large drooping clusters of winged seeds are visible.[2] Tree-of-heaven tends to form colonies through shoots arising from its underground organs.

Biological Category
Plants

NY Legal Status
Not Regulated

Species Type
Tree

Habitat
Terrestrial

IDENTIFICATION FEATURES

Leaves: Pinnately compound (11-41 leaflets), alternate, deciduous, and long (~1-3 ft).[3] Typically at least two teeth at the base of each leaflet, each tooth with a large gland.[3,6] Strong odor, likened to stale peanut butter or popcorn, when bruised or crushed.[4,5]

Flowers: Yellowish-green, approximately 0.2 in wide, in clusters.[3]

Fruit: Slightly twisted samaras about an inch long with a single seed in the middle. These seeds are 0.2 in in diameter, approximately 1.2-2 in long, and dispersed via wind.[3] Dioecious (female and male flowers on separate individuals; only female trees bear fruits). Fruits may overwinter on the tree.

Twigs: Stout, brittle, with large leaf scars and large spongy pith.

Bark: New growth bark is green and smooth; older bark is thin, gray, and slightly rough.[6]

SIMILAR SPECIES

Sumac (*Rhus*) species, such as *R. typhina, R. glabra,* or *R. copallinum*, can sometimes be confused with tree-of-heaven due to the pinnately compound leaf with many leaflets (7-31) per leaf; however, sumac leaflet margins are sharply toothed from base to tip. Various other genera, such as ash (*Fraxinus*), hickory (*Carya*), or bitternut and walnut (*Juglans*) have compound leaves, but have fewer, evenly toothed leaflets. Tree-of-heaven also has distinctive fruit shape and leaf smell when compared to these other genera.[3,4,6]

Tree-of-heaven (*Ailanthus altissima*)

INTRODUCTION HISTORY

Tree-of-heaven (Ailanthus altissima) is native to China and northern Vietnam,[7] but was introduced to Paris and the eastern US in the early 1780s as an ornamental tree.[1,8] It has since been spread to every continent except Antarctica.[7] It has been reported in 43 states and is most abundant in the Northeast and Mid-Atlantic regions.[9,10]

ECOLOGY AND HABITAT

Tree-of-heaven thrives in disturbed environments, including agricultural fields, moderately dense cityscapes, and transportation corridors.[11] Previously considered shade-averse, this species has demonstrated moderate resilience to low light conditions, producing numerous root sprouts[12,13]—extending as much as 65 ft from the trunk[14]—that can persist for decades in the understory, waiting for canopy gaps to open.[12,13] This behavior resembles that of shade-tolerant native forest tree seedlings..[12,13]

Urban development has been linked to the proliferation of tree-of-heaven. Transportation corridors play a significant role in the spread of tree-of-heaven from urban areas into forests, as it frequently establishes along railroad tracks, roadsides, fences, forest edges,[11] and wetland margins.[15] Tree-of-heaven is well adapted to urban conditions, showing resistance to both acidic and alkaline soils as well as pollution.[16] In more forested settings, however, it tends to favor areas with high rock cover and minimal leaf litter.[16] The species grows most successfully in warm, dry climates, making it widespread in Mediterranean regions and suggesting a degree of drought tolerance.[11] Logging facilitates tree-of-heaven colonization and spread.[17]

REPRODUCTION AND PHENOLOGY

Tree-of-heaven flowers in the spring, with its winged samaras maturing in late summer to fall. It produces an exceptional number of seeds, with individual trees capable of generating over one million seeds annually.[10] Research has shown a strong correlation between tree diameter and seed output, indicating that larger trees contribute disproportionately to reproduction.[10] The species also has a long reproductive window, and trees anywhere between 7 and 104 years old produce seeds at times exceeding 65% viability.[10] Seeds can remain viable in soil for five or more years.[18]

Seed dispersal occurs from fall through the following spring, primarily through wind and (to a lesser degree) water.[19] Although seed is its main mechanism of spread,[1] tree-of-heaven also spreads vegetatively from the roots, root crown, or trunk, producing new shoots up to 65 ft from the parent plant.[14] Efforts to control tree-of-heaven through cutting alone often lead to rapid regrowth due to its vigorous sprouting ability.[11] These resurgences tend to be most successful in paved areas and ruderal vegetation (waste ground habitats), where competition is minimal, compared to lawns or bare ground.[14]

Tree-of-heaven (*Ailanthus altissima*)

IMPACTS OF THIS SPECIES

Tree-of-heaven's most notable impacts may be the result of its preference for warm, dry climates, and its resistance to soil pollution and urban settings, which may make it more resistant to climate change.[16] In undisturbed forested settings, tree-of-heaven can release allelopathic chemicals from its roots and leaves, which can be harmful to surrounding plants, microbes, and rodents. This allows the species to establish localized zones where chemical, salt, or microbial imbalances discourage competition, helping it to develop single-species stands.[20]

Research suggests that tree-of-heaven invasions can lead to a decline in native understory plant diversity, though effects on the seedbank may be less pronounced. In some cases, its presence has also been associated with an increase in nonnative woody species diversity, with impacts on the composition of the woody understory becoming more pronounced over time.[21] Modelling suggests that while tree-of-heaven populations may expand in the short term (<100 years), long-term (>200 years) dominance over native species in forests is unlikely, except in drought-prone areas experiencing significant climate change.[22]

In disturbed and urban settings, the potential impacts of tree-of-heaven are more varied. Extensive and resilient roots can complicate excavation, damage infrastructure such as roads and pavement, and impact agricultural fields and archaeological sites.[11,14] Contact with its sap may cause severe rashes and allergic reactions in humans.[23,24] It has been linked to other illnesses including at least one case of myocarditis (heart inflammation) from contact between the sap and those removing tree-of-heaven.[25]

Tree-of-heaven is considered an important host for spotted lanternfly (SLF). While the insect can complete its full life cycle on other species, particularly black walnut (*Juglans nigra*),[26,27] overall SLF survival rates remain highest on tree-of-heaven.[28]

However, the species also contains pharmacologically active compounds, including ailanthone, which has shown potential in treating malaria, HIV, and Epstein-Barr infections.[11] Extracts from tree-of-heaven have been used in traditional Chinese medicine to treat conditions such as asthma, epilepsy, scabies, and seborrhea, and are valued for their astringent, antispasmodic, and antiparasitic properties.[11] Additionally, its extracts have demonstrated strong herbicidal and insecticidal effects.[11]

MANAGEMENT GOALS

- Remove trees in a way that minimizes soil disturbance and root or stump sprouting.[29]
- Prioritize removal of seed-producing (female) trees in areas of extensive invasion.[30,31]
- Wear protective gear (gloves, long sleeves, glasses) and avoid sap from the tree when manually removing or handling tree-of-heaven.[23–25]
- Methods that kill sapling-sized stems (> 3 ft tall) and mature trees slowly (over the course of one or two years) tend to result in fewer resprouts, while also reducing the chance of secondary invasion by other nonnative plants.[32,33]
- Treatment (especially of larger infestations) should focus first on edge populations and seed-producing trees to prevent further spread. The latter can be achieved by identifying female inflorescences during flowering and flagging those trees for later treatment.[30,31]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

There is currently no approved biocontrol available for tree-of-heaven. However, there are several organisms that show great potential for this purpose, some of which are already under formal review for release in the U.S.[34,35] Most promisingly, the native fungus *Verticillium nonalfalfae* is highly effective in controlling tree-of-heaven,[34,35] and a petition for its federal review has already been submitted.[35,36]

The weevil *Eucryptorrhynchus brandti* feeds extensively on tree-of-heaven in its home range of China, and it also has the ability to vector *V. nonalfalfae* (and therefore to boost its spread).[34] It was recommended for release by the USDA APHIS Technical Advisory Group for Biological Control of Weeds in 2022, and is now under review by the US Fish & Wildlife Service.[35]

- *E. brandti* may also be a potential biocontrol of SLF. However, the application of *E. brandti* for SLF is relatively new, and needs significantly more study.[37]

Although tree-of-heaven is a prominent host for spotted lanternfly (SLF), SLF is not considered an effective biocontrol for tree-of-heaven due to its wide host range and environmental impacts.[37,38]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Girdling and De-barking

Girdling usually results in vigorous resprouting from the stump and is therefore not advisable, especially in the case of small trees.[39]

Some success has been shown in deeper girdling that fully severs the sapwood, but this may still require follow-up re-girdling (especially for stems > ~10" DBH).[40]

However, two variations on traditional girdling have shown success in controlling tree-of-heaven:

- De-barking: This method is distinct from girdling in that it leaves the cambium intact.[29]
  - Using a carpenter's drawknife, remove 18-24 in long vertical strips of outer bark in a complete ring around the trunk, starting as low to the ground as you can.
  - This should be applied in summer for minimal resprouting, but can also be performed between late fall and early spring. Using this method over the winter may produce more resprouts than in summer, but will have the added benefit of leaving the exposed cambium susceptible to desiccation from the cold.[29]
  - With enough practice, this method can be applied in about one minute per 6 in DBH tree.[29]
  - This method can be combined with inoculation of edible mushrooms to produce a food crop.[29]

Figure 1.

De-barking technique for *Ailanthus* control.

Figure originally published in Baran et al. 2010.[29] Reproduced here with permission from Janell Baran.

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MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL (cont.)

Girdling and De-barking (cont.)

- The second girdling variation differs from traditional girdling in that the bark and cambium between the rings is left intact, significantly reducing application time.[32,33]
    - Use a Swiss Gertel (a European variation of a pruning billhook) or similar hand tool for trees under 4 in DBH and a chainsaw for larger trees.[32,33]
    - Make three parallel rings around the base of the trunk. Rings should be deep enough to pass through the bark and cambium, but should avoid sapwood damage.[32,33]
    - The lowest ring should be as close to the ground as possible, and with each subsequent ring spaced 2–4 in above the last.[32,33]
    - This method should be applied in late summer to limit resprouting but can be performed as early as late spring if need be.[32,33]
    - When using a chainsaw, the process only takes a few minutes,[32,33] but this should only be conducted by a trained chainsaw operator.[41]

Abb. 14. Ringelungsmethode nach Ziegler. Bei dieser Methode werden die Borke und das Kambium um den gesamten Stamm in drei Ringen durchtrennt. Zeichnung: *illustraziuns* Silvana Wölfle.

Figure 2. Novel girdling technique for *Ailanthus* control.

Translations:
Left of illustration: “Distance between rings is about 5-10 cm; First ring just above the root collar.”
Right of illustration: “Girdling depth only to just below the cambium.”
Below illustration: "Fig. 14. Ziegler girdling method. This method involves cutting the bark and cambium around the entire trunk in three rings. Drawing: illustrator Silvana Wölfle.”
Figure originally published in Knüsel et al. 2020.[33] Reproduced here with permission from Marco Conedera. Further reproduction or use of this image requires permission from the original authors.

Both techniques gradually kill the tree over 1–2 years while producing significantly fewer stump sprouts than standard cutting or girdling. They are also more cost-effective and time-efficient than most other methods, including herbicide control.

Unlike most other methods (whether manual, mechanical, or chemical), follow-up is minimal, and typically only requires stomping down a few resprouts with sturdy boots one year after treatment.[29,32,33,42]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL (cont.)

Pulling / Digging Up

Only recommended for seedlings and small saplings. Ensure all root fragments are removed, as even small pieces can resprout. Minimize soil disturbance as much as possible.[38]

Mowing

Not recommended, as this tends to result in significant resprouting while leaving exposed surfaces for secondary invasion by other nonnative plants.[38]

Cutting

Do not cut trunks or stems without further treatment: this results in abundant resprouting and can be worse than no treatment at all.[38,43,44]

Prescribed Fire

Not recommended as a sole treatment method, as a prescribed burn can significantly increase resprouts unless coupled with another treatment method.[38,45] However, studies on this method are limited to single prescribed burns, and further studies on the efficacy of repeat burns is needed.[45]

Prescribed Grazing

Can have a slight negative impact on tree-of-heaven, but is not generally considered to an effective control strategy for this species.[38,43]

Soil Tilling

Not recommended, as disturbance of seedbank or snapping of roots can lead to vigorous resprouts.[43]

Mulching / Smothering

Smothering tree-of-heaven with black plastic or mulch may be helpful when combined with other treatment methods, and mulch itself may be helpful in ameliorating soil disturbance and preventing seedbank germination.[46,47] However, information on this is extremely limited in the case of tree-of-heaven.

Flooding

Restoring natural flood regimes to disturbed floodplain forests can reduce tree-of-heaven populations in these habitats over time.[48] Tree-of-heaven tolerates frequent brief flooding as long as the soil drains freely.[15]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

After the main trunk and smaller stems have been treated, monitor annually for resprouts for at least 1-2 years,[29,33] and hand-pull new seedlings (< 2 ft tall) while minimizing soil disturbance.[46]

Spot-mulching after pulling seedlings may lessen soil disturbance and germination of tree-of-heaven and other invasive plants.[46]

Prevent or minimize canopy disturbance (including from silvicultural activities).[49]

Disposal Methods

Woody debris and seedlings from this species can be left to decompose *in situ* with roots exposed to the air for desiccation.[43,50]

Girdled trees can be left standing indefinitely for wildlife value—however, it should be noted that tree-of-heaven is fairly weak-wooded, and therefore dead standing trees of this species may pose a hazard if located near buildings, trails, or passersby.[38,40]

If *ex situ* disposal or applied use is preferred, woody debris can be taken offsite, left to dry out thoroughly, and repurposed in several ways:

- Composted at a commercial facility that accepts woody and/or seed materials (see Appendix A for more information);[50,51]
- Burned for firewood;[50,52]
- Mashed for pulp in paper-making;[38,50]
- Used for lumber or particle board;[38,52]
    - In the case of using tree-of-heaven wood for lumber or other building materials, extreme care must be taken throughout the drying process to prevent warping and mold development.[38]
    - Tree-of-heaven is currently not recommended for use as structural lumber due to its spongy pith and propensity towards warping while seasoning.[38]

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Fact sheet prepared by Kathryn Natale, Skye Caldwell, Andrew Leonardi, and Erik Kiviat (Hudsonia).

GARLIC MUSTARD

Alliaria petiolata

Photo © Erik Kiviat

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Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Forb

Habitat
Terrestrial

DESCRIPTION

Garlic mustard *(Alliaria petiolata)* is an herbaceous biennial in the Brassicaceae (mustard) family. During its first year, it germinates in the spring and grows into a rosette of basal leaves close to the ground. In the spring of its second year, it grows a tall (1-3 ft), flowering stalk, blooming in April through June. It releases a garlic-like odor when crushed, which distinguishes it from most other members of the mustard family.

IDENTIFICATION FEATURES

Leaves: Simple, deciduous, differ based on age of plant. First year leaves are basal and kidney or horseshoe shaped with bluntly toothed margins. Second year leaves are alternate, deltoid or heart shaped with coarsely toothed margins. Garlic odor when bruised or crushed.[1,2]

Flowers: Four petaled, white, 0.25-0.33 in wide, spreading at the summit of second year plants.[3]

Fruit: Tan to black seeds emerge from long, slender, ascending green pods (siliques).[2]

SIMILAR SPECIES

Other members of the mustard family (Brassicaceae) have four-parted flowers, white in certain species (such as toothworts and cresses [*Cardamine*]), but these species have different leaves. Species with similar looking basal leaves include golden ragwort (*Senecio aureus*), ground ivy (*Glechoma hederacea*), and some violets (*Viola*); however, none produce a garlic odor when crushed.[1]

Garlic mustard (*Alliaria petiolata*)

INTRODUCTION HISTORY

Garlic mustard is native to Europe and was repeatedly introduced to Canada and the northeastern United States beginning in 1868.[4–6]

ECOLOGY AND HABITAT

Garlic mustard typically establishes in moist, partly-shaded sites with disturbed soils, such as roadsides, trail edges, forest edges, rock ledges, and stream banks. Because it tolerates a wide range of soil types, moisture regimes, and light levels, it can quickly spread into a variety of habitats, including mature forests. Conditions that lead to the highest densities include moist, nitrogen-rich, high-pH soils; high densities of white-tailed deer; and frequent disturbance to forest canopies or soils.[7,8]

Photo © Elise Heffernan

REPRODUCTION AND PHENOLOGY

Garlic mustard has a slender, white taproot, with buds at the top of the root crown and along the upper taproot. These buds will form new leaves and stems if the top of the plant is cut. This species produces seeds either through cross-pollination or self-pollination. Seeds are numerous, in long narrow pods which mature by midsummer. Opening capsules can expel seeds 3-6 ft from the plant; flooding, humans, or other mammals can disperse them farther.[7–10] Although seeds typically germinate within the first two years,[11] they can persist in the seed bank for up to 13 years.[12]

IMPACTS OF THIS SPECIES

The impacts of garlic mustard vary widely across sites and over time. High concentrations of garlic mustard are associated with decreased native plant diversity and growth, reduced mycorrhizal fungus abundance, and lower survival rates of native arthropods such as butterflies and arachnids.[3] Garlic mustard may influence soil nutrient cycling, but its overall impact is unclear, as effects appear to vary by site.[13]

Research suggests that garlic mustard's impacts are often linked to allelochemicals, though most evidence comes from lab studies using plant extracts. Field studies indicate that microbial communities can rapidly degrade these chemicals, reducing their role in invasion. In smaller stands, allelochemical levels in soil may be too low to affect neighboring plants, regardless of their half-life.[4,13]

Pathogen community composition is another potential mechanism of invasion for garlic mustard. Some studies have suggested that pathogen accumulation can occur with garlic mustard invasion, which can harm the invading plants or spill into the co-occurring native plant community.[4]

Garlic mustard is also a strong competitor with itself; second-year plants compete for resources with first-year rosettes. Because of this self-suppression mechanism, competition for resources is not thought to be the plant's dominant method of invasion.[13]

Garlic mustard benefits from its extended growing season. Rosettes remain green into the winter, allowing production and storage of additional nutrients in the fall. Garlic mustard draws on these stored nutrients to leaf out earlier in spring than many other plants. Some researchers have therefore hypothesized that light availability is an important factor for garlic mustard success, though it may not always be the primary driver.[13]

MANAGEMENT GOALS

- Prevent establishment of new populations through annual monitoring and prompt removal of incipient populations and individuals in edge habitats.[14–16]
- Prioritize control of second-year plants and the prevention of seed production until seedbank is depleted.[8,17]
- Reduce or exclude onsite deer populations in tandem with or even prior to removal efforts.[18,19]
- Aid the re-establishment of a diverse assemblage of native understory plants (including tree seedlings) through seeding or planting, rather than relying solely on natural recruitment of native plants.[8,19]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Manual removal of garlic mustard is highly effective and, in some studies, has even outperformed chemical control.[14]

Second-year plants can be pulled or dug up in early spring prior to bolting. This can also be performed just after bolting but before seed maturation; however, this increases the risk of "falling behind" if the weather is disagreeable or other obstacles prevent management in the final hour.[20]

- In addition, garlic mustard is somewhat famous for going to seed even after the entire plant has been pulled from the ground, and waiting until after bolting greatly increases this risk.[7,8,20]

First-year rosettes should be left alone until all second-year plants have been managed, but can then be pulled or dug up at any time of year.[20]

Regardless of life stage, the entire root system should be removed,[8,20] and can be done so with relative ease using a soil knife, dandelion fork, or even by hand if the soil is workable. Attempting this when the soil is moist can make things easier.[21]

Mulching / Smothering

Information is limited, but smothering is noted to be effective for large patches of garlic mustard.[22]

Cutting / Girdling

Cut second-year plants at ground level just before or after bolting, and prior to seed set. As with pulling or digging, waiting until just after bolting can prove risky due to the possibility of falling behind in management or cut material still producing seed.[20]

- Plants can be cut manually with a number of tools, including pruners, sickles, or scythes.
- Power tools or equipment such as string trimmers, articulating hedge trimmers, mowers, or brush cutters may be more efficient along roadsides and forest/field edges, but they are also much more likely to disperse viable seeds, and therefore should be used well in advance of bolting.[8,20]
- It may be somewhat difficult to ensure a cut flush with the ground when using larger power equipment. Cuts should be as close to flush as possible, and preferably within 4" of the ground at most.[7,8]

Flooding

Restoring natural flood regimes to disturbed floodplain forests can reduce garlic mustard populations in these areas over time.[23]

MANAGEMENT METHODS: CULTURAL CONTROL

Reduce or exclude deer populations. This will aid recovery of native plants and which can slow population growth of garlic mustard through competition.[24–26] It may also help reduce garlic mustard's seed dispersal distances.[7,8,25]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

Two weevil species are candidates for biological control: the seed-eating *Ceutorhynchus constrictus*, and the root-mining *C. scrobicollis*.[27-31]

- *C. scrobicollis* was recommended for release in the US by the USDA APHIS Technical Advisory Group in 2017. It has since been under review by the US Fish & Wildlife Service.[27-31]
- Several releases of *C. scrobicollis* have been made in Canada since 2018. Its establishment there is being monitored, but it is too soon to make a determination on its success or failure.[27-29]
- *C. constrictus* is currently being petitioned for release in Canada, and may be petitioned for release in the US in the near future.[29,31]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Repeat fall and spring removal until seed bank is exhausted (usually <5-6 years).[17,32]

Minimize soil and canopy disturbance: this will slow spread and lower chances of reintroduction.[20]

Seed or transplant native species in the forest understory, which can reduce densities of garlic mustard once established.[33] Planting success may depend on removal of garlic mustard in dense stands and protection from deer.[24–26,34]

Disposal Methods

Cut or pulled plant material from second-year plants may still develop viable seed and therefore should not be left onsite.[35-37]

Instead, it can be brought to a commercial compost site that can effectively process seed material (see Appendix A for more information).[35-37]

Home composting of this material is not recommended, as these piles typically do not achieve the temperatures needed for effective processing.[35,38]

It can also be bagged for landfill, but should be solarized inside the bags for at least several weeks before disposal.[37]

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THUNBERG'S BARBERRY

Berberis thunbergii

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DESCRIPTION

Thunberg's barberry (*Berberis thunbergii*), also known as Japanese barberry, is a member of the barberry family (Burseraceae).[1] It is a deciduous shrub that typically grows between 2-6 ft tall, but occasionally reaching heights of 8-10 ft.[2,3] It leafs out early in the spring—up to a month before full canopy leaf-out in forests—and drops its leaves late in the fall, allowing a much longer growing season than most of its native competitors.[4] The leaves are obovate (wider above the middle) with smooth margins and on alternate sides of the stem. The leaves occur in clusters in an alternating pattern often accompanied by a simple spine.[2,5] In fall, fleshy fruits ripen to a rich red color, and often persist on the plant into winter.[3]

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Shrub

Habitat
Terrestrial

IDENTIFICATION FEATURES

Leaves: Small, simple, deciduous, clustered on alternate sides of the stem, obovate (egg shaped with narrow end near base) with smooth margins.[2,5]

Flowers: Yellow with six petals, in solitary or small clusters.[5]

Fruit: Red oblong berries ~0.33 in long which persist into winter.[2,5]

Growth form: A spiny shrub that typically grows between 2-6 ft tall, occasionally achieving heights of 8-10 ft.[2,3]

SIMILAR SPECIES

Common barberry (*Berberis vulgaris*) may resemble Thunberg's barberry but can be distinguished by its serrated leaf margins and branched thorns.[2,5]

Photo © B.E. Wofford and E.W. Chester http://tenn.bio.utk.edu/

Thunberg's barberry (*Berberis thunbergii*)

INTRODUCTION HISTORY

Thunberg's barberry was introduced to North America from Japan in the 19th century[6] as an ornamental plant intended to replace common barberry (Berberis vulgaris) in the event that black stem rust (an agricultural threat) wiped out the species.[7] Thunberg's barberry is currently found in 32 US states as well as six Canadian provinces.[8]

ECOLOGY AND HABITAT

This species tolerates a wide variety of soil and light conditions and typically inhabits disturbed areas, to the point where canopy disturbance can be used as a reliable predictor of its invasion.[9] It is commonly found in old fields, forest edges, deciduous and coniferous forest interiors, and drier portions of swamps.[4] It has been described as a "long term abandonment specialist" because its occurrence is strongly associated with pasture or cropland that returned to forest many decades ago.[10]

Although it requires adequate light and moisture for germination, once established, Thunberg's barberry can persist under dense canopies (< 1% sunlight) and in all but the driest sites.[4,10] It can influence ecosystem structure by altering soil pH, microbial activity, and nitrogen availability, while also creating warmer and more humid microclimates aboveground.[11] The presence of Thunberg's barberry has been linked to a profound decrease in native tree seedling density, which may have severe implications for the regeneration of North American forests.[11]

This species is unpalatable to white-tailed deer, which preferentially browse other species, reducing competition from native woody plants.[9,12] As a result, overabundant deer and selective browsing contribute to the increased abundance, growth rate, and height of Thunberg's barberry shrubs.[12,13]

REPRODUCTION AND PHENOLOGY

Thunberg's barberry leafs out early in the spring—up to a month before full canopy leaf out in forests—and drops its leaves late in the fall, allowing a much longer growing season than most of its native competitors.[4] It fruits prolifically under a full range of light and soil conditions. Birds are the primary dispersers of the relatively low-quality fruit, which is consumed late in the season.[14] Most seedlings are found within ~3 ft of fruiting shrubs, but occasional individuals occur up to ~260 ft or more from parent plants.[4] Thunberg's barberry can also spread vegetatively by sprouting from root crowns, rhizomes, or branch-tips that touch the ground. The seed bank is fairly short-lived, with germination rates dropping off steeply after one year (in one study, from 89% in the first year to 10% in the following year).[15]

IMPACTS OF THIS SPECIES

Thunberg's barberry can suppress nearby plant species through intense competition for limited resources and its ability to alter soil pH and microbial activity.[11,16] These mechanisms can contribute to a profound decline in native tree recruitment, which can have severe implications for the regeneration of North American forests.[11]

This species grows in dense thickets, altering the microclimate of the forest floor.[17,18] Research suggests this leads to significantly higher concentrations of black-legged ticks (*Ixodes scapularis*) carrying Lyme disease in comparison to areas without Thunberg's barberry. As a result, removing this plant can reduce tick abundance by 60%,[12] though this level of reduction may take up to five years.[7]

The high abundance of black-legged ticks in Thunberg's barberry stands may also be the result of trophic downgrading, as predatory arthropods such as spiders are found in lower densities on and its associated leaf litter compared to native vegetation. This reduction in predatory arthropods may then contribute to the proliferation of black-legged ticks, potentially increasing human exposure to disease vectors.[6]

Some wildlife species can use Thunberg's barberry thickets for nesting, foraging, or cover. Veeries successfully nest in dense stands,[19] while ovenbirds forage on its berries in winter.[20] The New England cottontail (*Sylvilagus transitionalis*), a Species of Special Concern in New York, may use these thickets for shelter,[21] though this may be the result of competition with nonnative eastern cottontails (*S. floridanus*), which avoid dense barberry stands.[22,23] High tick densities in barberry thickets have been linked to reduced juvenile survival in New England cottontails,[14,23] leading the New York State Department of Environmental Conservation to recommend barberry removal in cottontail habitats.[14,24]

Thunberg's barberry (*Berberis thunbergii*)

MANAGEMENT GOALS

- Eradicate small or light infestations early.
- For large or dense patches, reduce density and prevent fruiting.
- Large, homogeneous stands of Thunberg's barberry can be removed in a piecemeal fashion rather than cleared out all at once to minimize impacts to wildlife.[25]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

There is no available biocontrol at this time.

MANAGEMENT METHODS: CULTURAL CONTROL

Deer Management: Reduce or exclude deer populations. This will aid recovery of native plants, and as a result slow the growth and spread of Thunberg's barberry.[12,13]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Pulling or digging up seedlings and small Thunberg's barberry shrubs is highly effective,[26,27] but can be time-consuming.[4] It is therefore not recommended for large stands or shrubs of this species.[4,27]

Small plant removal can be accomplished fairly easily due to this species' shallow root system, but care should be taken to remove any snapped root fragments from the soil.[26,27]

Hand-pulling should be performed with thick gloves to avoid Thunberg's barberry's sharp spines.[26,27]

Cutting / Girdling

Annual cutting in summer will minimize or eliminate fruit production, but is unlikely to kill plants.[2,28] Avoid winter cutting, as this leads to vigorous resprouting.[28]

Prescribed Fire

Prescribed burns are generally not recommended for control of Thunberg's barberry, as vigorous resprouting is likely to result.[29]

Conversely, flame weeding has shown some success.[30,31]

In early spring, cut stems near ground level with a brush cutter or similar tool. After stems resprout, apply a directed flame treatment when the forest floor is damp or wet.[30,31]

Use a 100K or 400K BTU propane torch to apply a direct flame for 3-40 seconds per plant, until individual stems become carbonized and begin to glow.[30,31]

Two flame treatments (in summer and fall) with the 100K torch, or one treatment (summer) with the 400K torch may result in about 80% mortality.[30,31]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Monitor for and remove seedlings for 2-3 years following removal of fruiting shrubs.

After reductions in deer and Thunberg's barberry density, seed or transplant native plants in the forest understory. Native shrubs in particular can provide needed habitat for understory-nesting birds, in addition to covering bare soil to prevent reinvasion.[20]

Disposal Methods

Hang pulled shrubs in trees or place in a pile, roots up, to prevent re-rooting. The latter can have an additional benefit to wildlife seeking cover.[25]

If fruits are present, plants can be brought to a commercial composting where the piles reach high enough temperatures (or are processed long enough) to destroy weed seeds and roots (see Appendix A for more details).[32–34]

- Home composting of this material is not recommended, as these piles typically do not achieve the temperatures needed for effective processing.[33,35]
- If this option is not feasible, bagged material should be allowed to sit in the sun for several weeks to thoroughly dry down, then disposed of via burning or landfill.[32]

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Fact sheet prepared by Kathryn Natale, Jay Campos, Andrew Leonardi, and Erik Kiviat (Hudsonia).

ROUND-LEAVED BITTERSWEET

Celastrus orbiculatus


Photo © Erik Kiviat


Photo © Erik Kiviat


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DESCRIPTION

Round-leaved bittersweet (*Celastrus orbiculatus*), also known as oriental bittersweet, is a member of the bittersweet family Celastraceae native to East Asia.[1] It is a perennial, woody vine with an average length of 4.5 to 6.5 ft, but lengths of up to 66 ft have been reported.[2,3] The average stem diameter is about 2 in, occasionally reaching 5 in.[3,4] Round-leaved bittersweet can sprawl horizontally across open fields or forest floors, and twine vertically up trees, often girdling or smothering them in the process.[3–5] Its leaves are alternate and rounded, with scalloped edges and pointed tips. It has an adventitious root system that is bright orange in color.[3,4] The colorful fruits have made this species a popular ornamental plant and wreath component.[5,6] While the genus *Celastrus* consists of over 30 species globally, only one—American bittersweet (*Celastrus scandens*)—is native to North America.[1] American bittersweet and round-leaved bittersweet are commonly mistaken for one another, and the two occasionally hybridize.[6,7]

Biological Category
Plants

NY Legal Status
Prohibited

IDENTIFICATION FEATURES

Species Type
Liana

Leaves: Simple, deciduous, alternate, sub-orbicular (nearly round), with finely toothed or scalloped margins.[8] Young leaves may be more elongated and pointed.[9]

Fruit: Seed is enclosed in a fleshy red aril, which in turn is surrounded by a papery yellow capsule.[5,8]

Habitat
Terrestrial

Growth form: Woody vine that can form thickets along the ground or climb (and sometimes girdle) shrubs and trees.[5]

SIMILAR SPECIES

Round-leaved bittersweet (*Celastrus orbiculatus*) is commonly mistaken for its native (and rare) congener American bittersweet (*Celastrus scandens*), due to their nearly identical appearances.[10,11] Discerning between them is so difficult that plant nurseries have mistakenly sold round-leaved bittersweet in place of American bittersweet.[12,13] There have been many suggestions over the years as to which of their traits are distinct enough for identification purposes, but experimental comparisons of these traits show only a few that are reliably consistent across the plant's life stages and habitat conditions.[10,13,14]

SIMILAR SPECIES (cont.)

Each trait is helpful in distinguishing between round-leaved and American bittersweet at a slightly different phenological stage and time of year:

1. Leaf shape at bud break: early to mid-spring.

Opening leaves of round-leaved bittersweet are conduplicate (folded lengthwise) within the bud, whereas those of American bittersweet are involute (curl forms towards the top of the leaf).[10]

2. Pollen color: mid- to late spring.

The pollen of round-leaved bittersweet is white, while that of American bittersweet is yellow.[14]

3. Fruit arrangement and number of seeds per fruit: early summer to early winter.

The fruits of round-leaved bittersweet grow in axillary cymes along the stem, whereas those of American bittersweet develop in a terminal panicle.[10]

Additionally, seeds per fruit can be sampled and counted. A fruit containing five or more seeds is indicative of round-leaved bittersweet, while a fruit containing one or zero seeds is indicative of American bittersweet.[10]

A helpful guide for applying these features for identification can be found in [10].

Round-leaved bittersweet fruit along stem. Photo © Erik Kiviat

Round-leaved bittersweet (*Celastrus orbiculatus*)

INTRODUCTION HISTORY

Originating in East Asia, round-leaved bittersweet was introduced to the US via the east coast in 1874.[15] It has a variety of common names, including oriental bittersweet, Asiatic bittersweet, climbing spindle berry, and round-leaved bittersweet.[3,16]

Originally introduced as an ornamental liana, it gained popularity for its hardiness and brightly colored fruit.[12,15] However, as quickly as it gained popularity, by the mid-twentieth century it was recognized as a pest species.[3,15] It can be found throughout the eastern United States and Canada,[3] now occupying much of the native territory of American bittersweet.[6]

ECOLOGY AND HABITAT

Round-leaved bittersweet is most often found in dense along roadsides and fencelines, as well as in areas disturbed by logging, pest infestation, or storm damage.[2,17] From these disturbed habitats it can spread to the forest edge, into fields, and into forests with an interrupted canopy.[18] It is shade-tolerant,[3] persisting even in shaded areas exclusive to its native counterpart, American bittersweet.[7] Its growth is positively correlated with disturbance of the forest floor, especially in areas with minimal leaf litter.[2,3] Round-leaved bittersweet prefers acidic, mesic soils, but shows a tolerance to most soil conditions other than permanent dampness or dryness.[2,17] It is particularly vulnerable to drought while in the seedling stage, but becomes tolerant of dry soils once established.[17] A habitat preference of note is its negative correlation with the presence of oak trees.[3,17]

REPRODUCTION AND PHENOLOGY

Round-leaved bittersweet is usually dioecious, with each plant having either pistillate or staminate flowers.[1] The plant possesses an adventitious root system and is capable of resprouting from root fragments.[19] Root sprouting is especially energetic after the vine or roots are damaged, resulting in large patches at ground-level.[4] Controlled burns in fire-adapted systems increase the density of bittersweet by stimulating sprouting.[20] Flowering takes place in late spring, with fruit reaching maturity in September and October. Its most dedicated pollinators belong to the order Hymenoptera includes wasps, ants, and native bees. Birds act as the primary method of dispersal for the seeds within their round red fruits,[1] but spread can also occur via small mammals, water channels, and humans (due to the popularity of the berries as an ornamental plant or in wreaths).[4,13]

Compared to its US native congener, American bittersweet, round-leaved bittersweet produces nearly 200 times more male flowers and about 65 times more female flowers each year.[6] Germination rates in round-leaved bittersweet are high, and germination can occur even in shade and through an intact leaf litter layer.[19] Although seeds survive less than a year in the seedbank,[19,21] those that have germinated may persist as seedlings with little growth for years in the forest understory, and then quickly grow into the canopy when disturbance increases light availability.[3,22]

IMPACTS OF THIS SPECIES

Round-leaved bittersweet grows quickly, and large infestations can form tangled thickets, blanketing other vegetation. Bittersweet can harm or discourage other plants by shading, girdling, and breakage, and when it climbs high into trees the extra weight can increase damage and blowdowns from storm damage and snow load.[23,24] Dense patches of bittersweet interfere with forest regeneration by inhibiting growth and reproduction of native trees and shrubs.[18,25]

Declines in the native American bittersweet are in part due to hybridization with round-leaved bittersweet: in proximity to the nonnative species, the native bittersweet produces a majority of hybrid seedlings, while the nonnative produces very few hybrids.[6,11] These hybrids are largely infertile, reducing the risk that they will also outcompete American bittersweet, but their infertility simultaneously creates a dead-end of sorts for genetic material from American bittersweet and a waste of its resources.[6,11] Round-leaved bittersweet also produces much more pollen than American bittersweet, effectively "swamping" the latter's reproduction.[6,11]

Deer preferentially browse round-leaved bittersweet compared to other invasive species and may somewhat reduce its prevalence,[26] but not nearly to the same degree that they reduce cover and richness of native plants.[27,28] The fruits are consumed by native birds and small mammals, particularly in winter when other food sources are scarce.[3] Round-leaved bittersweet has traditionally been used in Chinese herbal medicine as an anti-inflammatory,[29] and shows some promise in the therapeutic treatment of cancers.[16,29]

Round-leaved bittersweet (*Celastrus orbiculatus*)

MANAGEMENT GOALS

- Prevent fruiting of mature vines. Reducing seed spread should be a top priority, as this plant mainly spreads through fresh seed rather than through an established seedbank.[19]
- Completely remove seedlings and small vines by thorough excavation of roots and all root fragments, starting with newly or minimally-infested areas.
- Treat larger vines and patches with repeated summer cutting at ground level. Prioritize vines that are growing up mature native trees.[25]
- Minimize canopy and forest floor disturbance as much as possible, as both are likely to stimulate bittersweet growth.[2,17]
- For open fields, mow or pasture livestock regularly and frequently (ideally, weekly) through the growing season for several years.[4,30,31]
- Monitor treated, uninfested, and minimally-infested areas annually for new seedlings.[19]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

There is no available biocontrol at this time.

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

This method can be used in conjunction with cutting for larger infestations,[32] or used on its own to eliminate small infestations of round-leaved bittersweet, but it will only be effective if the roots are completely removed. New shoots can sprout from fairly small root fragments.[19]

Hand-dig or pull seedlings, removing all roots and root fragments.[4,32]

Mowing

Mowing can eventually eliminate round-leaved bittersweet in open, high-light areas, but only if performed frequently and consistently (ideally, weekly throughout the growing season) for several years.[4]

Infrequent mowing, such as two to three times per year, is unlikely to be effective in high-light environments, as this will stimulate vigorous root sprouting.[4,13]

Cutting / Girdling

Cutting can be a highly effective treatment method in forested areas,[20,30,32] especially for larger vines (≥0.75 in basal diameter).[30]

In high-light environments and/or for smaller (<0.75 in basal diameter) vines,[30] cutting will need to increase in frequency (weekly, in high-light areas). In such cases, mowing, prescribed grazing, or hand-pulling may be preferable.[4,30,31]

Cut all mature vines near the base in July-August (prior to fruiting) to prevent fruiting and deplete stored carbohydrates. Cutting in late summer helps reduce subsequent resprouting (compared to cutting in spring or fall).[20,30,32]

Ensure cuts are as flush with the ground as possible, as cutting stems higher will result in more resprouts.[20,30,32]

Wherever possible, combine the cutting of larger vines with at least partial uprooting (by hand-pulling) to expose and desiccate roots.[32]

Prioritizing mature vines at the bases of native trees will relieve stress to the trees by reducing belowground competition and risks of wind damage or snow-load, as the once-heavy vines will dry and start to disintegrate.[23,30]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Prescribed Fire

Not advisable. Burning this plant can result in vigorous resprouting.[20,33]

Prescribed Grazing

Goats will readily consume round-leaved bittersweet and can be effective at eliminating the plant if allowed to graze throughout the growing season for several consecutive years.[31,34]

Goats will also suppress other woody plants, including desirable natives, but goat grazing or regular mowing may be appropriate where the goal is to maintain an open habitat without woody plants.[31,34]

Soil Tilling

Not advisable. Tilling will fragment roots and encourage re-sprouting.[18,35]

Mulching / Smothering

Information on this method is limited for this species. There is some evidence that a thick, continuous layer of leaf litter can hinder germination of round-leaved bittersweet seeds. However, this effect is slight, and may be attributable to the prevention of seed rain from reaching the soil surface.[19]

Flooding

Restoring natural flood regimes to disturbed floodplain forests can reduce bittersweet populations over time.[25]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Partner with land managers, foresters, and all relevant stakeholders to create a comprehensive and holistic management plan that minimizes future disturbance to forest floors and canopies.[25,30,36]

The seed bank may be repeatedly replenished by wildlife transporting seeds from nearby or fairly distant areas, so regular and frequent monitoring of treated areas (and all forest edges) is important.[13,32]

Scouting for new plants is best done in the fall, when bright yellow bittersweet leaves persist after most native trees have lost their leaves.[13]

Disposal Methods

Cut vines can be hung up or left in trees to wither but should not be left in contact with the ground.[4,36]

If fruits are present, the vines with attached fruits (along with any fallen fruit) can be taken to a commercial composting facility, where the piles reach high enough temperatures (or are processed long enough) to destroy weed seeds and roots (see Appendix A for more details).[37,38]

- Home composting of this material is not recommended, as these piles typically do not achieve the temperatures needed for effective processing.[38,39]
- If this option is not feasible, bagged material should be allowed to sit in the sun for several weeks to thoroughly dry down, then disposed of via burning or landfill.[37]

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Fact sheet prepared by Kathryn Natale, Skye Caldwell, Andrew Leonardi, and Erik Kiviat (Hudsonia).

GLOSSY BUCKTHORN

Frangula alnus = Rhamnus frangula


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Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Shrub

Habitat
Terrestrial

DESCRIPTION

Glossy buckthorn (*Frangula alnus*) is a deciduous shrub or small tree that invades a wide range of habitats, including wetlands, forests, and disturbed sites. Originally introduced to North America as an ornamental plant and for hedgerows, it has since become invasive, forming dense thickets that outcompete native vegetation. It primarily reproduces by seed, which is widely dispersed by birds. Due to its shade tolerance, rapid growth, and ability to colonize both wet and dry environments, glossy buckthorn has established in many North American ecosystems.[1]

IDENTIFICATION FEATURES

Leaves: Simple, deciduous, alternate, oval to obovate (egg shaped with wides part above middle), 2 to 3 in long and u to 2 in wide, with mostly entire margins and equally spaced parallel primary veins.[2,3]

Fruit: Small, superficially berry-like, stone fruit (drupe) red which turns black when ripe.[3]

Twigs: End bud without scales, minutely hairy branchlets dotted with lenticels (raised spots).[2]

SIMILAR SPECIES

Common buckthorn (*Rhamnus cathartica*; non-native) and alderleaf buckthorn (*Rhamnus alnifolia*; native) are similar to glossy buckthorn. However, both have leaves with finely toothed edges, scaly winter buds, and smooth undersides, whereas glossy buckthorn leaves have smooth edges and (occasionally) small hairs on the underside.

The native alderleaf buckthorn is far smaller at maturity than glossy buckthorn, with the former typically growing as a 4.5 ft shrub. Glossy and common buckthorn are of similar stature (20-23 ft tall), but to further differentiate them, common buckthorn has many leaves that are subopposite (not quite opposite) and small thorns at the tips of some twigs. Management methods described below apply to common buckthorn as well.

A dichotomous key or field guide is helpful to rule out glossy buckthorn look-a-likes with alternate leaves, such as winterberry holly (*Ilex verticillata*), alternate-leaved dogwood (*Cornus alternifolia*), alder (*Alnus* spp.), shadbush (*Amelanchier* spp.), and chokeberry (*Aronia* spp.).[3]

Glossy buckthorn (*Frangula alnus*)

INTRODUCTION HISTORY

Frangula alnus is native to Europe and parts of western Asia and North Africa. It was introduced to North America in the late 18th century for both ornamental plantings and hedgerows.[4] Early transatlantic trade routes facilitated its spread, with multiple introductions from various European ports leading to the establishment of genetically diverse populations in the US.[4] The plant eventually spread from urban landscapes near trade ports into natural areas, particularly wetlands and forests, where its ability to tolerate a wide range of conditions fostered its establishment and further spread. It is now widespread across the northeastern United States, the Great Lakes region, and parts of Canada.[4]

ECOLOGY AND HABITAT

Glossy buckthorn thrives in a variety of habitats, from wetlands to dry forests and open fields. It is highly adaptable and can establish under a wide range of light conditions, from full sun to moderate shade. It is commonly found in disturbed areas, including former agricultural fields, roadsides, and logged forests, where it benefits from increased light availability.[5] However, it can also invade intact forests, particularly those dominated by white pine (*Pinus strobus*). Patches also often occur in large, intact stands of red maple (*Acer rubrum*) and red oak (*Quercus rubra*), although not nearly to the same degree with which they are found amongst white pine.[5-7]

Unlike *Rhamnus cathartica* (common buckthorn), which is more common in upland forests and drier (usually mesic) sites, *Frangula alnus* is frequently associated with wetter environments, including swamps, fens, and wet meadows.[8] Glossy buckthorn densities decrease with increasing organic layer thickness, particularly in softwood forests, where its invasion potential is higher compared to mixed hardwood stands.[5]

REPRODUCTION AND PHENOLOGY

Glossy buckthorn blooms throughout the growing season, from late spring to early fall, and fruits ripen starting in mid-summer. A single plant may have flowers as well as unripe and ripe fruits present simultaneously. Flowers are pollinated by insects. The fruits drop to the ground when ripe, and as a result, much of the seed germination occurs beneath the parent plant. However, seeds are also dispersed by birds that consume the fruit, such as American robins, cedar waxwings, and European starlings.[9]

Small mammals also consume and disperse buckthorn seeds. Fruits float and can be water-dispersed as well. The germination rate is high,[10] and most seeds tend to germinate within one year of forming,[11] although the seed bank can persist for at least two years.[12,13] Sprouts can flower and fruit in their first year.[12] When mature glossy buckthorn stems are cut or injured, the root crown responds with abundant sprouting which then turn a single-stemmed plant into a multi-stemmed shrub or tree.[1]

IMPACTS OF THIS SPECIES

Glossy buckthorn has significant ecological impacts, altering soil chemistry, outcompeting native vegetation, and reducing habitat quality for wildlife. Its nitrogen-rich leaf litter accelerates nutrient cycling, potentially favoring further invasion and altering forest soil microbial communities.[32]

The dense thickets formed by Frangula alnus shade out native understory plants, reducing biodiversity in invaded ecosystems. Studies have found that its presence is associated with declines in native herbaceous cover and tree regeneration, particularly in white pine-dominated forests.[5]

Despite its negative effects on native vegetation, glossy buckthorn provides food for frugivorous birds. However, the nutritional quality of its fruit is lower than that of native species, and birds that rely heavily on buckthorn-dominated landscapes may experience reduced fitness.[9]

Some studies have explored potential practical applications for glossy buckthorn, aiming to make use of its overabundance. Extracts from the plant have been studied for their antimicrobial properties, though their efficacy and feasibility remain uncertain.[33]

Additionally, both glossy buckthorn and common buckthorn have been investigated as bioenergy materials due to their high biomass accumulation rates. While dense buckthorn stands in forests can reduce the biomass of nearby trees, lowering the overall availability of raw natural *materials*, researchers hope that identifying viable uses for buckthorn could provide both an incentive and a cost-effective strategy for its removal.[16]

Glossy buckthorn (*Frangula alnus*)

MANAGEMENT GOALS

- Prioritize management within high-quality wetlands and softwood forests with large stands of white pine (*Pinus strobus*).[5-7]
- In areas with large infestations and/or mature glossy buckthorn plants, prioritize removal or treatment of mature shrubs before focusing on seedling removal.[1,5] Eliminating seed sources will help slow this species' spread.[9]
- Combined treatment methods are often needed for buckthorn control (e.g., coupling cutting with prescribed burns).[14]
- Monitor annually and reapply treatment for at least 2-3 years, ensuring the seed bank and any remaining roots are depleted.[5,11,14,15]
- Monitor disturbed ground, canopy openings, and open wetlands for new plants and remove as needed.[5,13]
- In forested areas, include all forestry professionals and stakeholders in buckthorn management plans to create a comprehensive and holistic approach, as this often leads to more effective and long-term restoration outcomes.[5,6,13]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Hand-pulling is most effective for young seedlings and small plants, particularly in moist soil, as it allows for more complete root removal.[14]

For larger plants, a weed wrench is recommended, but excessive soil disturbance should be avoided, as it can promote germination of buckthorn and any other invasive species in the seed bank.[14,15]

Although effective, manual removal is labor-intensive and therefore best suited for small infestations or as a follow-up after initial control efforts.[14]

Mulching / Smothering

Information regarding this method is extremely limited for buckthorn control.

Formal studies pertaining to mulching buckthorn are limited to tests of mulching buckthorn stems onsite during their removal. This is not recommended, as it may encourage rather than smother resprouting of buckthorn roots and/or germination of buckthorn seedlings.[11,16]

Further research is needed to determine whether the observed response is specific to mulching with chipped buckthorn stems or if similar results would occur with mulch from other woody species. Additionally, studying the effects of different mulch depths could provide valuable insights into optimizing this method for buckthorn control.[17]

Cutting / Girdling

Cutting alone is not effective, as buckthorn readily resprouts from cut stumps.[14]

Cutting followed by solarization (wrapping stumps in black plastic) can prevent resprouting, but the covering must be completely intact, as even small tears or exposure to light can allow buckthorn to regenerate.[14] *(See the Solarizing section for more details.)*

Winter girdling is not effective, as the plant is dormant and does not respond as strongly to damage at this time.[18]

A study in New Hampshire found that cutting stems five times over two years reduced buckthorn density by ~80% and height by ~60%.[6]

Mowing

Mowing is not recommended as a standalone control method, as it removes competing vegetation and increases light availability, which can promote buckthorn regrowth.[15]

Forestry mowing is often counterproductive by increasing buckthorn density due to the immense disturbance it causes.[19]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL (cont.)

Prescribed Grazing

Prescribed grazing can effectively reduce young buckthorn plants, particularly when combined with other management strategies.[14] While livestock tend to prefer young shoots and lower leaves, making them less effective for older, established buckthorn,[14] a work-around (noted below) can be achieved to increase the efficacy of prescribed grazing for buckthorn.[20]

A successful grazing approach to buckthorn control (although not elimination) involves an initial brush hog or manual cut at ground level, followed by prescribed grazing, repeated for several consecutive years.[20]

- This method stimulates fresh regrowth that is more palatable and accessible to livestock, allowing them to browse effectively and help suppress buckthorn over time.[20]
- Goats and sheep may be more effective than large livestock for this purpose,[20] as they can more easily traverse difficult terrain, and tend to consume more woody material than do cattle (this is especially true of goats).[14,21]

In forested areas, grazing opens the understory and allows light to reach seedlings of both native plants and buckthorn, and may need follow-up with hand-pulling to prevent buckthorn reinvasion while allowing the regeneration of native species.[14]

Deer generally avoid buckthorn, reducing any potential for control through natural browsing.[15]

Prescribed Fire

Frangula alnus will resprout and germinate after a single burn, but repeated burns every 2-3 years over a 5-6 year period can significantly reduce the seed bank.[15,22]

Spring burns are the most effective, as they target young buckthorn seedlings before they establish.[22]

Many buckthorn-invaded sites lack sufficient fuel to sustain a burn. Planting native grasses beforehand can help increase fuel loads for prescribed burns, as long as the grasses are allowed to establish for a few years prior to a burn.[14]

Solarizing

Solarizing can be effective after manual or mechanical cutting of stems to the ground.[15]

A commercial product under the name “Buckthorn Baggies” is available and promoted specifically for covering buckthorn stumps post-cutting. There is some evidence of its efficacy as long as the bags are monitored regularly (preferably, monthly), as stumps can still resprout if the covering shifts or tears. However, additional testing as to its efficacy is lacking.[15]

Flooding

Although glossy buckthorn is commonly found in wetlands, it is flood-intolerant, making prolonged flooding a potential control strategy in riparian corridors.[23]

While this approach may not be practical or feasible for all situations, it can be an effective tool if incorporated into riparian restoration projects. Hydrological alteration is best suited for already disturbed riparian areas and requires careful planning.[23]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

- No effective biological control methods currently exist for *Frangula alnus*, but research is ongoing.
- The fungal pathogen *Chondrostereum purpureum* has been tested as a mycoherbicide on many invasive species,[24] including common buckthorn (*Rhamnus cathartica*), with one study showing it achieved over 90% mortality when applied to girdled buckthorn plants.[25]
    - While generally promising, further study is needed to determine the use of *C. purpureum* and its efficacy, safety, and feasibility for both common buckthorn and glossy buckthorn.[24]
    - *C. purpureum* has already made its way into at least one commercial mycoherbicide product in Canada and the U.S., but it is unclear how widely used (or how widely studied) this is.[24,26]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

After removal of glossy buckthorn from a forest, replanting with desirable native woody species may help prevent reinvasion of glossy buckthorn or secondary invasion of another species.[27]

Sites should be monitored annually for at least 2-3 years to remove subsequent resprouts and new seedlings.

Disposal Methods

Leaving cut material onsite is acceptable for small populations, but may assist seedling germination and establishment in disturbed areas (especially if chipped *in situ*).[11,16]

Composting can be effective in destroying buckthorn seeds and roots in as little as 15 days.[28]

- However, plant material of buckthorn and other invasive species should only be processed at a commercial composting facility, where the piles reach high enough temperatures (or are processed long enough) to destroy weed seeds and roots.[28-30] (*see Appendix A for more details).*
- Home composting of this material is not recommended, as these piles often do not achieve the temperatures needed for effective processing.[30,31]

If the above options are not feasible, bagged material should be allowed to sit in the sun for several weeks to thoroughly dry, then disposed of via burning or landfill.[16,29]

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Morrow's, Tatarian, & Bell's honeysuckle

Lonicera morrowii, *Lonicera tatarica*, & *Lonicera × bella*

Photo © Leslie J. Merhoff, University of Connecticut, bugwood.org

Photo © Erik Kiviat

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Shrub

Habitat
Terrestrial

DESCRIPTION

Morrow's honeysuckle (*Lonicera morrowii*), Tatarian honeysuckle (*Lonicera tatarica*), and their hybrid, Bell's honeysuckle (*Lonicera × bella*), are deciduous shrubs that invade a variety of habitats in North America. These nonnative bush honeysuckles exhibit rapid growth and form dense thickets that suppress native vegetation.[1] They produce abundant red or orange berries, which are primarily dispersed by birds.[2] They are highly tolerant of disturbed habitats, and are difficult to control.[3] Depending on the context, this guide may refer to these three species individually, or collectively as "nonnative bush honeysuckles" when they share similar characteristics or management approaches.

IDENTIFICATION FEATURES

Leaves: Small, opposite, simple, deciduous, elliptical, obtuse, and slightly hairy beneath, with smooth margins.[4]

Flowers: Bases of petals form tubes with tips of the 5 petals spreading. Petals are pink or white at first, becoming yellow over time.[4]

Fruit: Red to yellow berries that appear in pairs at the base of each leaf.[4]

SIMILAR SPECIES

Bell's honeysuckle typically shows a mix of traits from both of its parent species. While leaf and flower pubescence may help distinguish its parent species from one another, these traits vary widely in the hybrid, often leading to misidentifications in herbarium specimens.[5,6]

A close look-a-like, the nonnative Maack honeysuckle (*Lonicera maackii*), has larger leaves than Morrow's, Tatarian, or Bell's honeysuckle. Maack honeysuckle also has acuminate tips (gradually tapering to a sharp point).[5]

Morrow's, Tatarian, or Bell's honeysuckle also resemble the native fly honeysuckle (*Lonicera canadensis*) and northern bush honeysuckle (*Diervilla lonicera*). However, they can be distinguished from the latter two through their hollow stem piths and their smooth leaf margins.

Other, less common, native look-a-likes include: swamp fly honeysuckle (*Lonicera oblongifolia*), which has yellow flowers in the leaf axils; snowberry (*Symphoricarpos albus*), with hollow piths but white fruits; and coralberry (*S. orbiculatus*), with solid piths and coral to purple fruits.[4]

INTRODUCTION HISTORY

Morrow's honeysuckle and Tatarian honeysuckle were introduced to North America from Asia and Eastern Europe in the 1800s as ornamental plants and for erosion control.[1] The hybrid of these two species arose in North America as their ranges overlapped.[2]

These shrubs quickly escaped cultivation and spread across much of the northeastern and midwestern United States. Their ability to thrive in disturbed areas, combined with seed dispersal by birds and mammals, has allowed them to establish in a wide range of habitats.[3] In many areas, Morrow's honeysuckle and Bell's honeysuckle are more prevalent, while Tatarian honeysuckle is slightly less widespread.[7]

ECOLOGY AND HABITAT

Invasive bush honeysuckles grow in a variety of habitats, including forest edges, woodland fragments, open fields, abandoned pastures, roadsides, riparian areas, wetland edges, and disturbed sites. They prefer full sun but can tolerate partial shade, allowing them to invade both open and semi-forested landscapes.[1]

These shrubs thrive in a range of soil types and moisture conditions. However, Morrow's honeysuckle is less tolerant of prolonged flooding compared to other invasive bush honeysuckles.[7]

One key advantage of these honeysuckles is their ability to leaf out earlier in the spring and retain their foliage later in the fall, which gives them a competitive edge over many native plants. Their dense growth structure reduces light availability, suppressing the regeneration of native plant species, particularly in open areas.[2]

REPRODUCTION AND PHENOLOGY

These honeysuckles reproduce primarily through seeds, which are produced in large quantities and dispersed by birds, small mammals, and occasionally deer.[1] While most fruits fall to the ground and decay, the seeds that are consumed and excreted by birds contribute to long-distance dispersal.[2]

Seed germination typically occurs in the spring, with young plants establishing rapidly in suitable conditions. Unlike some other invasive shrubs, Morrow's honeysuckle and Bell's honeysuckle have a relatively short-lived seedbank, with most seeds remaining viable for only about one year.[3]

Flowering generally occurs in late spring to early summer, and fruit production peaks in mid-to-late summer. The flowers of these species are typically pollinated by bees and other insects, although their self-fertility allows for high reproductive output even in the absence of pollinators.[7]

The ability to resprout following mechanical damage makes these shrubs particularly persistent. Even after cutting or grazing, the plants frequently produce new shoots, which can lead to rapid recovery if follow-up control measures are not implemented.[3]

IMPACTS OF THIS SPECIES

Nonnative bush honeysuckles significantly disrupt native plant communities by forming dense thickets that suppress native vegetation through shading and competition for space. Their early leaf-out and extended growing season provide a significant competitive advantage.[3] These shrubs also interfere with forest regeneration by inhibiting native tree seedling establishment, and they may have allelopathic effects that further suppress native plant growth.[7]

Wildlife interactions with nonnative bush honeysuckles are mixed but often problematic. Dense thickets likely provide escape cover for small animals. Although birds consume honeysuckle berries, the fruits are nutritionally inferior to native alternatives, which may negatively impact bird health and reproduction.[2]

Additionally, while dense bush honeysuckle stands provide nesting habitat for some birds, they can simultaneously increase predation risks for ground-nesting bird species and reduce invertebrate abundance, disrupting food webs and pollination associations.[3,13]

MANAGEMENT GOALS

- Focus on mature shrubs in high-light environments (including forest edges and canopy gaps) first, since fruit production here will be much greater than in shaded conditions.[8]
- Remove seedlings until seed bank is depleted (typically 1-2 years).[1,3]
- Monitor annually to prevent re-establishment, especially if there are seed sources nearby.
- Plant or facilitate re-establishment of native plant species, with an emphasis on native fruiting shrubs such as viburnums, dogwoods, spicebush, highbush blueberry, and others to replace songbird nesting habitat and food resources.

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Hand-pulling or using tools such as weed wrenches can be effective for removing seedlings and small plants, especially in moist soils where roots are more easily extracted.[9]

Pulling must be repeated for several years to address seedling emergence from the seedbank.[1]

Care should be taken to minimize soil disturbance, as exposed soil can promote reinvasion by honeysuckles or other invasive species.[3]

Mulching / Smothering

Applying thick layers of mulch after removal can suppress honeysuckle regrowth by limiting light availability and discouraging seedling establishment but is not considered an effective control method overall.[3]

Mulch applications should be monitored for secondary invasions by other non-native species, such as garlic mustard (*Alliaria petiolata*), which can make use of the altered conditions.[10]

Soil Tilling

Tilling is generally not recommended for honeysuckle management, as these species regenerate from root fragments and may spread more easily if disturbed.[3]

In cases where invasive honeysuckles are present and tilling is used (such as in agricultural fields), tilling should be followed by native seeding to prevent reinvasion.[11]

Cutting / Girdling

Not recommended for plants that receive plentiful sunlight, as this results in vigorous resprouting, even when cuts are flush with the ground and/or performed annually.[12-14] If, however, bush honeysuckles in full-sunlight must be cut for some reason, doing so in spring produces somewhat fewer resprouts than at other times of year.[14]

Cutting has a far higher chance for success in shaded conditions, but it is unclear how many treatments per year are needed, with some studies finding success in an annual summer cut over several years, and others finding success only with biweekly cuts throughout the growing season, over several years.[12]

Winter cutting should be avoided entirely, regardless of light conditions, as this will produce the highest number of resprouts from this treatment method.

Avoid cutting plants when fruits are present, as seed rain during removal can result in reinvasion.[9]

Mowing

Mowing alone is generally not effective for controlling honeysuckle species, as plants can resprout vigorously from cut stems.[14]

If used, mowing should be combined with other treatments such as grazing or hand-pulling to weaken plants and prevent regrowth.[9]

Mowing should be conducted before fruit production to reduce seed dispersal.[3]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL (cont.)

Prescribed Grazing

Deer readily browse honeysuckle species, but their browsing is not enough to reduce honeysuckle spread or vitality.[15] In the case of Bell's honeysuckle, this may in part be due to higher allocations of defensive chemicals in its leaves during flowering and fruiting, which can deter leaf browsing during these critical reproductive periods.[16]

Prescribed livestock grazing on its own is not recommended for these bush honeysuckle species, as it will likely increase their density, but combining this treatment with others can be synergistically effective.[9,11]

Preceding and/or following grazing with a prescribed burn or mechanical mowing or cutting of stems (to within ~4 in of the ground) can reduce bush honeysuckle percent cover within 2-3 years (if repeated annually).[9,11] The positive effects of these combined treatments have been observed in areas of low- to medium-density infestations, but not in areas of high-density infestations.[9]

- It should be noted that the above outcomes resulted from grazing solely cattle, whose diets consist mainly of herbaceous species, and who may have a difficult time traversing difficult terrain.[9,17]
- More study is needed regarding prescribed grazing for honeysuckle species with other livestock such as goats,[9,11] who are both more agile and more ready consumers of woody plant species.[17]

Prescribed Fire

A single prescribed burn can be effective for reducing Bell's honeysuckle and both of its parent species if performed in late summer.[18]

A prescribed burn earlier or later in the year can be not only ineffective but counterproductive by increasing density of these species.[14,18]

However, repeat spring burns may be effective,[14,18] as may repeat interannual burns (such as one in early spring and one in fall).[1]

Solarizing

Solarization using black plastic or tarping can be effective for controlling small honeysuckle infestations by overheating the soil and killing seedlings.[3]

This method is most practical for localized infestations in open, sunny areas where high temperatures can be sustained for an extended period.[19]

Flooding

Restoring natural flood regimes to disturbed floodplain forests can reduce populations of Morrow's honeysuckle over time.[7] However, this has not been directly tested on Tatarian honeysuckle or Bell's honeysuckle.

In addition, flooding is not a viable large-scale control method and should only be considered in managed wetlands or riparian restoration projects.[7]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

There is currently no formally approved biocontrol available for these three honeysuckle species.[20]

Mycoherbicide made from the fungal pathogen *Chondrostereum purpureum* is very effective for controlling Bell's honeysuckle as well as both its parent species,[20] and is available in several commercially available products.[20-22] However, testing of its efficacy and safety is limited.[20]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

After fruiting shrubs have been cut or removed, focus on hand-pulling seedlings and pulling or cutting root sprouts. This will need to continue for several years, until both the seed bank and roots reserves are depleted.[1]

Soil disturbance may encourage establishment of new honeysuckle seedlings, so measures should be taken to minimize soil disturbance and quickly revegetate disturbed soils with native plant species.[1,3]

Controlling white-tailed deer populations alongside removal of nonnative bush honeysuckles can improve native plant restoration efforts. This should therefore be addressed before planting or seeding native species in cleared areas.[2,11,14]

Disposal Methods

All removed plant material from bush honeysuckles should be disposed of carefully, as both roots and moist cut stems are capable of re-rooting if left in contact with the ground.[1,12]

The material can be taken to a commercial composting facility, where the piles reach high enough temperatures (or are processed long enough) to destroy weed seeds and roots[19,23,24] (see Appendix A for more details).

- Home composting of this material is not recommended, as these piles typically do not achieve the temperatures needed for effective processing.[24,25]
- If this option is not feasible, bagged material should be allowed to sit in the sun for several weeks to thoroughly dry, then disposed of via burning or landfill.[19]

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Fact sheet prepared by Kathryn Natale, Andrew Leonardi, and Erik Kiviat (Hudsonia).

PURPLE LOOSESTRIFE

Lythrum salicaria


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DESCRIPTION

Purple loosestrife (*Lythrum salicaria*) is a bushy, semi-woody perennial forb. It is usually 40-98 in tall, but has a maximum recorded height of 134 in. Its stems are squarish, and its leaves are opposite (occasionally whorled or alternate), sessile, and ~3-4 in long. Stems and leaves have short, whitish hairs of varying density. Older plants, especially in fluctuating water levels, tend to form large, elevated, woody root crowns (called pedestals or hummocks), and grow to more than 8 in tall by 12 in wide. Purple loosestrife fruits grow as numerous small capsules in terminal spikes, and contain large numbers of tiny seeds. Stems and fruit clusters often stand through winter and well into the next growing season.[1–3]

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Forb

Habitat
Terrestrial

IDENTIFICATION FEATURES

Leaves: Simple, deciduous, opposite or occasionally in whorls of three, and lanceolate shaped with smooth margins.[1,2]

Flowers: Six parted, pinkish purple; found in spikes at the tops of branches. Often multiple flower spikes per plant.[1]

Fruit/Seed: Small capsules, each with many tiny seeds.[2]

Stems: Stout, six-sided, typically pubescent but can be smooth. Becomes woody with age.[1,2]

SIMILAR SPECIES

Native wetland plants that may be confused with purple loosestrife include: winged loosestrife (*Lythrum alatum*), which is much smaller in height (around 12 in tall) and has smaller, alternate or opposite leaves compared to purple loosestrife; and swamp loosestrife (*Decodon verticillatus*), a shrub with long, arching stems. Both winged loosestrife and swamp loosestrife have flowers at the bases of leaves, as opposed to the terminal branch spikes of purple loosestrife.

Blue vervain (*Verbena hastata*) has opposite leaves with toothed margins and small bluish-purple flowers which are found in more slender terminal spikes than those of purple loosestrife.[1]

Wand loosestrife (*Lythrum virgatum*) is a cultivated European plant that may be able to escape and spread.[4,5] It closely resembles purple loosestrife, and the two may hybridize.[5]

Purple loosestrife (*Lythrum salicaria*)

INTRODUCTION HISTORY

Purple loosestrife was introduced to North America from Europe around 1820. It has since spread throughout most of the northern US and southern Canada. It has reportedly been forming dense stands and displacing native species in eastern North American wetlands since the mid-1900s.[6]

ECOLOGY AND HABITAT

Purple loosestrife is a plant of freshwater wetlands, including marshes, wet meadows, fens, bogs, openings in forested swamps, intermittent streams and pools, pond and lake shores, stream banks, and ditches.[7] It is also common in fresh and brackish tidal wetlands. Loosestrife can establish on recently disturbed upland soils, although it remains smaller there (e.g., 40 in tall) than in wetlands.

In recently disturbed wetlands such as drawn-down ponds, abandoned beaver ponds, and abandoned pastures, loosestrife may become highly dominant. Purple loosestrife sometimes co-occurs with a reasonable diversity of other plants, even in wetlands where it is the dominant species; however, this may not be consistent throughout purple loosestrife's invaded range.[6]

REPRODUCTION AND PHENOLOGY

Purple loosestrife germinates best in sunny, wet, warm conditions, and seedlings quickly establish a woody taproot. Starting in the second season, plants may produce additional stems from the rootstock. Individual stems live for one year (standing dead stems may persist for one to two years), and plants may live over 20 years, attaining a maximum root crown width of 20 in and stem height of 118 in, with numerous basal stems.[7]

Purple loosestrife can flower in its first growing season. It blooms from late June through late September and is pollinated by many species of bees, including honeybees, as well as butterflies. It can hybridize with the native winged loosestrife (*Lythrum alatum* var. *alatum*), although this occurrence is uncommon.[8] It may also hybridize with European wand loosestrife (*Lythrum virgatum*), which is sold commercially in the US and may escape cultivation.[5]

This species' seeds are dispersed mainly by passive transport from water, humans, and wildlife, but may also spread over short distances via wind. The seed bank remains viable for at least three years and possibly far longer.[3,9] There are several modes of vegetative reproduction, including rooting of lodged stems or stem fragments.[10,11] Aboveground shoots arise from root crowns, which are typically found just below the soil surface, and stems, rather than arising from any point on the belowground roots.[12]

IMPACTS OF THIS SPECIES

Purple loosestrife has changed soil organic matter, nitrogen cycling, and water chemistry in New York wetlands, resulting in higher levels of available nitrogen.[13] At the same time, purple loosestrife is also very efficient at pollutant removal and wastewater treatment.[14,15] Its transpiration rate is twice that of cattail, and which can have a positive, cooling effect on its surroundings, but also has a potential negative effect of wetland drying.

This plant can outcompete cattail in high-nutrient conditions,[13] which in turn decreases habitat quality for cattail-browsing animals such as muskrat[7] and some bird species.[11]

Overall, purple loosestrife-dominated habitats tend to support higher densities but lower species richness of birds compared to other wetland vegetation types.[16] This plant may alter detrital food chains and suppress the growth of aquatic plants that are important food sources for wildlife, while reducing or eliminating open water and open mudflat areas important for foraging waterfowl.[7]

Conversely, purple loosestrife may benefit some arthropods as the flowers are attractive to insects (including pollinators) and their predators.[11] The leaves (and sometimes flowers) are eaten by a number of moth and beetle species,[11,17,18] and the hollow stems provide overwintering habitat (including for the larva of a micromoth, *Mompha eloisella*).[11]

Given the complex ecological impacts of purple loosestrife and the overall success of its relevant bioagents, management is only recommended where there is a demonstrable negative impact on native biodiversity, or where such an impact is likely to occur.[11]

MANAGEMENT GOALS

- Eradicate small/light infestations early (this is a general principle of managing invasive plants).[19,20] Hand-pulling or digging can be effective for small populations.[21,22]
- For large and/or dense patches, reduce height, plant mass, and seed production by cutting stems or deadheading flowers. Strive for functional eradication of large populations rather than full eradication.[22–25]
- Due to the establishment of loosestrife biocontrol species (two leaf-feeding beetles in the genus *Galerucella*) in New York, purple loosestrife populations that are stable (not increasing) may not need control or removal.[26]
- Assist biocontrol populations over time through monitoring, re-releases as needed, and creating or enhancing overwintering habitat for *Galerucella* spp.[24]
- Actively seed or plant native vegetation to increase native species richness and cover following loosestrife reductions by biocontrol species.[22,27]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

Since the early 1990s, four biocontrol agents have been released in the US and Canada to manage purple loosestrife: two leaf-feeding beetles (*Galerucella calmariensis* and *G. pusilla*), a flower bud-feeding weevil (*Nanophyes marmoratus*), and a root-feeding weevil (*Hylobius transversovittatus*).[3,28]

- All four have established populations in New York, but the *Galerucella* spp. are the most abundant and persistent.[3,29]

Each biocontrol species can significantly reduce purple loosestrife height, cover, and seed production, especially when combined.[3,22,29]

Creating or supporting terrestrial overwintering habitat can help sustain biocontrol populations and enhance loosestrife reduction.[24]

If considering additional biocontrol releases, review online records or monitor the site for existing populations first: some biocontrol species may outcompete others, and particularly small loosestrife patches may not support released bioagents.[9]

- If the site is deemed suitable for release, *Galerucella* beetles can be collected from field populations and reared on loosestrife[30–32] or purchased from suppliers.[28]
- See [9,28] for guidance on site assessments and [30–32] for biocontrol collection and rearing methods.

While *Galerucella* spp. do not typically impact native plants in the northeast US, dense populations may occasionally feed on related native species in the Lythraceae family, such as swamp loosestrife and winged loosestrife.[9,11] To minimize potential impacts, caution is advised when considering biocontrol releases in areas where native Lythraceae species are present.[11]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

For small or sparse patches, plants can be dug out with a spade or similar tool.[21,22]

In mucky or flooded conditions, a potato hook can aid in prying large plants from the ground after being loosened by a shovel and can help leverage plants onto shore.[21]

Waders may be needed to reach such populations further from shore.[21]

Soil disturbance should be minimized while digging to prevent root crown fragmentation, accidental seed spread,[22] or creation of a seedbed for other nonnative plants.[33]

Mowing

Regular mowing can slow the growth of purple loosestrife but is unlikely to be effective on its own.[9,34]

Mowing can be especially effective when used in conjunction with other methods, such as biocontrol agents.[34,35]

Before mowing in areas with potential or established biocontrol populations, review online records to identify which biocontrol species may be present onsite. Schedule mowing to minimize harm by considering the feeding periods of these biocontrol agents.[9,34,35]

- For example, mowing during flowering would seed set but allow for leaf-feeding by *Galerucella* spp. and root-feeding by *H. transversovittatus*, but would negatively impact *N. marmoratus*, which feeds on flower buds.[9]

Cutting / Girdling

Manual cutting is only recommended for small infestations and is most effective when combined with other management approaches, such as biocontrol.[9,34]

Deadheading or cutting stems to the ground during flowering (in early to late summer) prevents seed set, but reducing loosestrife density or biomass with this method requires follow-up treatments later in the year and repeated efforts over several years.[22]

If cutting takes place in areas with potential or established biocontrol populations, review online records to identify which biocontrol species may be present onsite. Time cutting to minimize harm by offsetting it from the feeding periods of these biocontrol agents.[9,34,35] *(See the Mowing section for an example.)*

Prescribed Grazing

Targeted rotational grazing of sheep, goats, or cattle can significantly reduce (although not eliminate) purple loosestrife cover and promote overall plant diversity onsite.[36–38] However, palatability of this plant varies by livestock species, and some may be deterred by the wet conditions in which purple loosestrife thrives.[38]

This method alone can decrease loosestrife density by up to 40% in a single year,[36,37] but must be maintained annually until the plant is eliminated, which can take upwards of 4-5 years.[39] It is therefore best used in conjunction with other management methods.[36,38]

Flooding

Generally considered ineffective for purple loosestrife management,[5,19,33] although it may show some success in controlling seedlings.[40]

Where possible, minimize water fluctuations that lead to areas of exposed, wet soils favorable for germination and establishment of purple loosestrife.[41]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Soil disturbance will promote loosestrife germination and resprouting, so hand-pulling must be repeated until seed bank and viable root crown fragments are depleted (2-3 years).[22]

Seeds (including those from previous years) are easily spread. To prevent this, be sure to clean boots, clothing, and equipment of any seeds, dirt, or mud before leaving the site.[9]

Monitor to prevent establishment of other nonnative wetland plants such as reed canarygrass (*Phalaris arundinacea*) or common reed (*Phragmites australis*).[33,42]

Disposal Methods

All plant parts can re-root and re-sprout (although, it is unclear whether this is the case for the true roots of this plant[11]).[10] As a result, all material should be taken off-site for disposal.[43]

The material can then be taken to a commercial composting facility, where the piles reach high enough temperatures (or are processed long enough) to destroy weed seeds and roots (see Appendix A for more details).[44,45]

- Home composting of this material is not recommended, as these piles often do not achieve the temperatures needed for effective processing.[45,46]
- If this option is not feasible, all material should be bagged and allowed to sit in the sun for several weeks, to desiccate the plant material before disposal via landfill.[44]

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Fact sheet prepared by Erik Kiviat, Kristen Bell-Travis, Kathryn Natale, and Andrew Leonardi (Hudsonia).

STILTGRASS

Microstegium vimineum

Photo © Elise Heffernan

Photo © Kristen Bell Travis

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DESCRIPTION

Microstegium vimineum, commonly known as stiltgrass, is an annual, warm-season grass[1] native to East Asia that has spread throughout the eastern United States.[2] It thrives in a wide range of habitats, from forest understories to roadsides and floodplains, forming dense mats that suppress native vegetation.[3,4] The species reproduces exclusively by seed, with a persistent seed bank that allows for reinvasion if management is not long-term.[3] Dispersal occurs through both natural means, such as water and animal movement, and human-mediated pathways, including contaminated footwear and vehicle tires.[4,5]

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Graminoid

Habitat
Terrestrial

IDENTIFICATION FEATURES

Leaves: Lanceolate to linear shaped blades, which are ~1-4 in long (and more than 4 times longer than they are wide), with a pronounced pale-silver band on the upper side parallel to the midrib.[6]

Flowers: Pairs of spikelets along inflorescence, extended from top of plant or enclosed within leaf sheath. Flowering stems erect.[1,6,7]

Growth Habit: An annual warm-season grass which grows low to the ground and forms dense carpets. Stems can grow up to 5 ft long, most of which creeps along the ground.[6,7]

SIMILAR SPECIES

This species can sometimes be confused with native white grass (*Leersia virginica*). The presence of the longitudinal pale-silver band on the leaves of stiltgrass is a significant characteristic that separates these two species. The nodes (enlarged spots on the stem where leaves originate) of white grass also have straight white hairs, which differs from the smooth nodes of stiltgrass.[7] The leaf blades and sheaths of white grass also have rough texture as compared to the smooth texture of stiltgrass.[7]

Stiltgrass (*Microstegium vimineum*)

INTRODUCTION HISTORY

Stiltgrass is native to East Asia, including China, Japan, Korea, and India.[3] It was first recorded in the US in 1919 near Knoxville, Tennessee, and was likely introduced through its use as packing material for porcelain and other goods imported.[8]

Following its introduction, stiltgrass spread rapidly across the eastern and midwestern US, particularly in disturbed habitats.[9] Human activity, such as the movement of contaminated soil by vehicles and foot traffic, has significantly contributed to its expansion, as has waterborne dispersal that allows seeds to travel downstream and establish in new areas.[4]

ECOLOGY AND HABITAT

Stiltgrass thrives in disturbed, moist, and partially shaded environments such as roadsides, streambanks, utility corridors, and floodplains. It can also tolerate full sun, full shade, drought, and periodic flooding.[4,5,9,10] A thick leaf litter layer hinders its seed germination, but not enough to prevent invasions into mesic forest, even with little seed input.[11]

A key factor in stiltgrass' spread is its dispersal along roadsides, which act as seed sources for spread into relatively undisturbed forests and wetlands nearby.[4,5] Stiltgrass can easily dominate the ground layer in floodplain and mesic forests, where moderate light and moisture promote its growth.[5,9]

REPRODUCTION AND PHENOLOGY

Stiltgrass completes its life cycle within a single growing season, relying entirely on seed production for persistence.[2] It can produce large numbers of seeds, but seed production is reduced during drought or in low light conditions.[12] This species produces both chasmogamous (open-pollinated) and cleistogamous (self-pollinating) flowers, allowing it to reproduce efficiently even in isolated populations.[13]

Dispersal occurs through multiple pathways, including wind, water, animals, and human activity. Seeds can be transported in contaminated soil, on vehicle tires, or through foot traffic, making trails and roads primary vectors for spread.[4] Once established, stiltgrass can rapidly take over disturbed areas.[9,13]

In the Northeast US, stiltgrass germinates in early spring (April–May), followed by rapid vegetative growth throughout the summer months. Flowering and seed production take place from late summer to early fall (August–October). The plants die at the first frost, but the seeds remain viable in the soil for 3–5 years and can survive fire and mechanical disturbance, enabling long-term persistence even after initial removal efforts.[14-16]

IMPACTS OF THIS SPECIES

Stiltgrass alters soil conditions by reducing leaf litter and organic matter while increasing pH, magnesium, and sometimes phosphorus and calcium, all of which can hinder native plant establishment even after stiltgrass removal.[17,18] Its dense, monospecific stands shade out native herbaceous and woody seedlings, leading to decreased plant diversity as its cover expands.[3-5,17]

Accumulated stiltgrass biomass can intensify wildfire severity, reducing native seedling survival and altering vegetation structure. However, this effect varies with soil moisture, season, and fire timing.[14-16]

Stiltgrass is largely unpalatable to deer, which preferentially browse other plants and reduce stiltgrass' competition.[19] In areas without deer, stiltgrass cover decreases, improving seedling survival of native woody species like oaks.[20,21]

Some native insects feed on stiltgrass, but their grazing has little impact on its populations.[3] The increased aboveground biomass from stiltgrass can alter arthropod communities, increasing arthropod abundance but reducing species richness.[22] This decline can have cascading effects on insectivorous birds and other wildlife, with ground- and understory-nesting birds being especially affected.[3,23]

In nitrogen-poor environments, stiltgrass can accelerate carbon cycling, leading to reduced microbial biomass and soil organic carbon.[24,25] Some research suggests stiltgrass has mild allelopathic effects, though results are inconsistent.[26,27] Despite its widespread presence and historical use for basket weaving, stiltgrass currently has limited practical use in North America, with little application for erosion control, forage, or ornamental use.[28]

Stiltgrass (*Microstegium vimineum*)

MANAGEMENT GOALS

- Manage stiltgrass prior to seed set or just as it is beginning in late-summer.[29,30]
- Prioritize the removal of small, outlier patches within or near natural areas that are relatively uninvaded by stiltgrass. This should include patches along nearby roadsides and trails, which are often the source of seed for forest invasions.[3,4]
- Integrate multiple manual and mechanical control strategies to maximize effectiveness while limiting soil disturbance and non-target damage.[28]
- Monitor and address seed bank persistence annually for at least 2-5 years after the initial treatment.[14,30]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

There is no approved biological control agent available at this time. However, several fungal pathogens (mainly of the *Bipolaris* and *Puccinia* genera)[8] that are known to affect stiltgrass are under investigation for biocontrol applications.[31-35]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Hand-pulling is effective for small infestations but must be done before seed set (ideally once flowering begins or is at its peak)[30] in mid- to late-summer.

Remove stiltgrass crowns and roots while limiting soil disturbance as much as possible.[28,30] Repeat annually for several years, until the seed bank is exhausted.

Hand-pulling is the best method for managing stiltgrass while supporting native woody plant regeneration[12] and a diverse community of native plants.[36]

Avoid hand-pulling multiple times in a season, if possible, as this can disturb soil and increase recruitment of other invasive plants.[37]

Cutting / Girdling

Cutting can be effective if performed once a year in either early- or late-summer (prior to seed set) for multiple consecutive years.[20,23] Cuts should be as flush with the ground as possible, and no higher than 2 in from the ground at most.[28,30]

If plants are close to seeding, cut stems can be gathered by raking and should be disposed of offsite, as research has shown that 99% of cut stiltgrass stems can re-root and produce seed if placed in soil.[28,30]

Mowing

Mowing as close to ground level as possible between July-September is often the most effective strategy, reducing biomass and seed production by up to 99%.[28,38] However, this strategy can also hinder native plant populations and therefore should only be applied in highly invaded communities.

Mowing earlier in the year will stimulate stiltgrass seed production on lower (and more difficult to mow) stems, and is not recommended.[29, 30]

If mowing flush with the ground is not feasible due to the potential damage of equipment blades, an articulating hedge trimmer or string trimmer may be needed for larger stands, while hand-pulling or manual cutting may be easier for smaller patches.[30,39]

Higher mowing heights (> 2 in from the ground) are generally less effective for stiltgrass control,[28,30] and may encourage the growth of other invasive species (e.g., *Lonicera japonica*) if they are present onsite.[28]

Repeated mowing or string trimming over multiple years is necessary for long-term suppression due to a persistent seed bank.[14, 30]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL (cont.)

Prescribed Fire

Prescribed burns can be effective in reducing stiltgrass biomass and density if performed in the early fall, but it should be noted that stiltgrass burns at any time of year may increase fire intensity and continuity, which can negatively impact native tree regeneration.[14,16]

- In some cases, prescribed burns can even increase stiltgrass density, although this tends to vary with soil moisture and the time of year for the burn.[14,40]
- In addition, prescribed burns alone do not eliminate stiltgrass seed banks, enabling post-burn recolonization if management is not continued.[15,16]

Alternatively, direct torching can be effective for stiltgrass management, although it is less efficient for large patches than string trimming or mowing.

- A 400K BTU propane torch can be used on stiltgrass once a year in early summer.[22] On days following or during rains (when leaf litter is thoroughly wet), apply direct flame to plants until the leaves are severely wilted. Be careful not to ignite any litter. [22]
- Direct torching may be more effective when combined with cutting. Cutting plants to the ground in early- to late-summer (prior to seed set) can be

Prescribed Grazing

Stiltgrass is generally avoided by deer, indicating that prescribed grazing of other ruminants may be an ineffective control strategy.[19]

Conversely, managing deer populations through population control or exclosures can indirectly reduce stiltgrass abundance by allowing native plants, which deer preferentially browse, to regenerate and compete more effectively.[19]

Soil Tilling

Not recommended, as soil disturbance can promote seed bank germination and reinvasion.[28,30]

Mulching / Smothering

Leaf mulch that is at least 3 in deep can significantly reduce stiltgrass biomass, cover, and seed production. Although it is not as effective as mowing, it is less likely to negatively impact native plant communities, making it a viable option for sensitive habitats.[28]

Flooding

Stiltgrass can tolerate extended flooding and may even benefit from water dispersal of seeds in riparian areas, making flooding an ineffective control strategy.[41]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Repeat annual treatment (regardless of method used) for at least 3 years to prevent reinvasion from the seed bank.[30,37,38] Stiltgrass cover may increase after the first year of treatment (depending on method), but this effect is temporary if management is performed consistently each subsequent year.[37]

Secondary invasions from other invasive species onsite or nearby should be monitored post-treatment. This risk of secondary invasion can come from the amount of bare soil that may be left behind by stiltgrass as well as the stimulation of growth in other species (e.g., *Lonicera japonica*, *Celastrus orbiculatus*) that can be caused by cutting.[28]

Minimize soil and canopy disturbance to treatment sites and nearby natural areas to slow spread and reduce the chance of reintroduction.[37]

Disposal Methods

If hand-pulling plants (without seeds present) in warm, dry weather, plants can be left in a sunny area (with roots exposed) to dry thoroughly for several days to a week. This can occur *in situ* if enough sun is available.[39]

If plants are close to (or past) flowering, rake and remove all plant material from the site for *ex situ* disposal.[28,30]

Plants with seed material can be taken to a commercial composting facility, where the piles reach high enough temperatures (or are processed long enough) to destroy weed seeds and roots (see Appendix A for more details).[5,42,43]

- Home composting of seed material is not recommended, as these piles typically do not achieve the temperatures needed for effective processing.[43,44]
- If this option is not feasible, the material can be bagged and allowed to sit in the sun for several weeks to thoroughly dry, then disposed of via burning or landfill.[42]

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Fact sheet prepared by Kathryn Natale, Andrew Leonardi, and Erik Kiviat (Hudsonia).

MILE-A-MINUTE

Persicaria perfoliata = Polygonum perfoliatum

Photo © Erik Kiviat

Photo © Erik Kiviat

Photo © Erik Kiviat

DESCRIPTION

Mile-a-minute (*Persicaria perfoliata*) is a fast-growing, herbaceous annual vine in the Polygonaceae family. It is characterized by distinctive triangular leaves, circular leafy ocrea at each node, recurved barbs along stems and petioles, and bright blue fleshy fruits containing a single seed.[1] It is highly invasive in the eastern United States, where it forms dense mats over other vegetation, blocking sunlight and suppressing native plant communities.[2] This species spreads rapidly through water, human activity, and possibly deer, with seeds remaining viable in the soil for up to six years.[3]

Biological Category

Plants

NY Legal Status

Prohibited

Species Type

Liana

Habitat

Terrestrial

IDENTIFICATION FEATURES

Leaves: Simple, alternate, deciduous, thin, glabrous, waxy, and light green to red.[4] Leaves can be triangular or heart shaped, are approximately 1-3 in long and wide, with reflexed prickles on the main veins.[4] Prominent leafy sheath (ocrea) at the base of petiole (leaf stem).[5]

Flowers: Small ~0.125 to 0.2 in long, commonly greenish white, rarely pink. Flowers are at the end of branches in short spikes approximately 0.4 – 0.8 in long.[4]

Fruit: Shiny metallic blue, berry-like fruit with round, shiny, black seeds.[4]

Stems: Covered with reflexed prickles, up to ~23 ft long, and can become woody with age.[4]

SIMILAR SPECIES

The prominent stem prickles and distinctive triangular leaf shape can be used to differentiate mile-a-minute from other vine species.[4,5] Additionally, the prominent ocrea around the base of the petiole of the leaves can be used to differentiate mile a minute from other smart weed (*Persicaria*) species such as halberd-leaved tearthumb (*P. arifolia*) or arrow-leaved tearthumb (*P. sagittata*) which have non-leafy ocreae.[5]

Mile-a-minute (*Persicaria perfoliata*)

INTRODUCTION HISTORY

Mile-a-minute is native to temperate and subtropical regions of Asia, including China, Japan, Korea, India, and the Philippines.[6] It was first introduced to the United States through Pennsylvania in the 1930s, likely through contaminated nursery stock.[6] Initially, its spread was limited, but by the late 20th century, its range had expanded significantly.[2]

This species is now widespread in the Mid-Atlantic and northeastern US, with recent reports in the Midwest, including Ohio, Indiana, and Iowa.[7] Long-distance dispersal is attributed to the horticultural trade and water transport, particularly in riparian areas.[2] Wildlife dispersal is also thought to play a role in its dispersal, but this relationship remains unclear.[2]

ECOLOGY AND HABITAT

Mile-a-minute thrives in disturbed environments, including roadsides, power line corridors, forest edges, open fields, riparian zones, and disturbed woodlands.[1] It prefers full-sun environments but can tolerate partial shade, with plants in high-light conditions exhibiting greater growth and reproductive output.[8,9] Moist soil conditions favor establishment, but the species is adaptable to a range of environmental conditions, including moderate drought and variable soil types.[10] The vine's climbing ability, facilitated by recurved barbs, allows it to overtop shrubs and young trees, suppressing native vegetation by physically smothering competitors and reducing light availability.[11]

REPRODUCTION AND PHENOLOGY

Mile-a-minute primarily reproduces by seed, with water and human activity acting as major dispersal vectors.[3] Seeds exhibit high viability and can persist in the soil for up to six years, making long-term management difficult.[3]

The species begins flowering in early summer, with peak fruit production occurring from mid-summer to early fall.[9] Seed dispersal begins in late summer and continues through early winter.[1] Individual plants can produce thousands of seeds per season, contributing to rapid population growth in suitable habitats.[8]

Seed germination of mile-a-minute is greatly influenced by burial depth, with seeds buried deeper than 2.5 in experiencing significantly reduced germination rates.[12] Soil moisture also plays a large role in its seed germination, and years with high rainfall often see sharp mile-a-minute population increases.[13]

IMPACTS OF THIS SPECIES

Mile-a-minute has significant ecological impacts, primarily through competitive exclusion of native vegetation. The vines form dense mats that block sunlight, reduce native plant diversity, and inhibit the establishment of tree seedlings, particularly in habitats with full- to part-sun conditions.[2] This impact is especially apparent in shrublands, young forests, and riparian zones.[11]

Wildlife interactions with mile-a-minute are complex and require further research.[14] While some bird species are known to disperse its seeds, there is limited evidence that birds preferentially consume its fruits. Deer, on the other hand, more frequently consume the fruits compared to bird species, and potentially aid in its dispersal.[3] Mile-a-minute can affect pollinators by altering floral resource availability and changing the structure of invaded plant communities.[8]

Mile-a-minute (*Persicaria perfoliata*)

MANAGEMENT GOALS

- Eradicate small patches by preventing seed production until seed bank is depleted (typically three to six years).[15]
- Limit spread and reduce density of large populations by implementing management prior to seed production each year.
- Target patches along roadsides and trails, as these populations often serve as seed sources for dispersal into forests.[16]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

Biological control efforts have focused on a specialist herbivore: the mile-a-minute weevil (*Rhinoncomimus latipes*). This weevil feeds almost exclusively on the stems and leaves of mile-a-minute, reducing plant vigor and seed production.[7] It was approved for release in the US in 2004 and is notably well-established throughout the country. It is quite effective in its impact, but its efficacy can vary depending on overall weather and climatic conditions.[17]

Integrating biocontrol and native seeding can have additive effects: in one study, this significantly reduced mile-a-minute biomass by up to 75%.[8]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Hand pulling is effective for small infestations but should be conducted before flowering to prevent seed dispersal.[16,18]

Plants should be pulled using gloves to avoid injury from this plant's prickly stems.[18]

Repeated manual removal for three to six consecutive years is required to exhaust the seed bank.[2,15]

Manual removal combined with native seeding improves long-term suppression by introducing competition.[8]

Mowing

Monthly mowing throughout the growing season for at least three consecutive years (but up to six) can exhaust the seed bank.[18.19]

This can also favor native grasses if they already exist in the seed bank or are overseeded as part of management.[18,19]

Flooding

Mile-a-minute is highly tolerant of moisture variations, but extreme flooding events may reduce seedling establishment.[10]

Cutting / Girdling

Cutting can be performed in the same manner as mowing: once monthly throughout the growing season, for at least three consecutive years (but up to six) to exhaust the seed bank.[18]

- Cuts should be as low to the ground as possible, as plants cut too high may resprout in time to produce fruit.[20]

Prescribed Grazing

Intensive rotational grazing using sheep can significantly reduce mile-a-minute cover and prevent flowering.[21]

- Grazing cycles should be timed to synchronize with peak mile-a-minute growth and last two to three days per enclosure before rotation.[21]

Mulching / Smothering

Burying mile-a-minute seeds to a depth of ~2 in or more can significantly prevent germination of its seeds, suggesting that mulching and thick leaf litter layers may overall be an effective strategy.[12,22]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Monitor sites for at least three to six years due to mile-a-minute's persistent seed bank.[2]

Annual surveys should be conducted to check for new seedlings and reinfestations.[18]

Follow-up manual removal or grazing may be necessary to prevent resurgence.[21]

If using biological control, periodic assessments of *Rhinoncomimus latipes* populations and their impact on mile-a-minute are recommended.[23]

Disposal Methods

Pulled plants should be collected and composted or incinerated to prevent seed dispersal.[18]

The material can be taken to a commercial composting facility, where the piles reach high enough temperatures (or are processed long enough) to destroy weed seeds and roots (see Appendix A for more details).[24,25]

- Home composting of this material is not recommended, as these piles typically do not achieve the temperatures needed for effective processing.[25,26]
- If this option is not feasible, bagged material should be allowed to sit in the sun for several weeks to thoroughly dry, then disposed of via burning or landfill.[18,24]

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Fact sheet prepared by Kathryn Natale, Andrew Leonardi, and Erik Kiviat (Hudsonia).

COMMON REED

Phragmites australis ssp. *australis*

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DESCRIPTION

Common reed (*Phragmites australis* ssp. *australis*) is an extremely large grass, reaching heights of 12 ft or more. It tends to form dense and highly dominant stands, often along roadsides, wetlands, and waterways.[1]

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Graminoid

Habitat
Terrestrial

IDENTIFICATION FEATURES

Leaves: Deciduous (although leaf sheaths persist), ~8 -24 in long by ~0.4-1.2 in wide, lanceolate (tapered to a point) with entire margins that can be rough or sharp, and dark green-dark gray-green in color.[1–3]

Flowers: Inflorescence is a large plume at the top of the plant. The plume is purple at first but turns light brown with age.[1] Each individual spikelet is made up of 3-7 florets.[2]

Fruit/Seed: Small, light, and wind-dispersed.[4] Sources regarding seed viability are contradictory.[5]

Stems: Stout at base, ~6.5-13 ft tall.[2]

Underground structures: Stout horizontal and vertical rhizomes (to nearly 1 in diameter) can form a dense network nearly 3 ft deep in the soil.[6] Underground biomass often exceeds aboveground biomass in vigorous stands.[7]

SIMILAR SPECIES

American reed (*Phragmites australis* ssp. *americanus*) is a genetically distinct native lineage of reed.[7]

Characteristics of common reed that can help differentiate the two species include:

- Ligules (membranous or hairy structures at the base of leaves) are 0.016-0.035 in, which are shorter than that of the American subspecies (0.039 – 0.067 in);
- Leaf sheaths that are difficult to remove from the stem in the fall when compared to the ease of removal in American reed; and
- Dull, ridged, or tan nature of the upper internodes (area of stem between raised nodes where leaves grow from) as compared to the smooth, lustrous, and red-brown colored upper internodes in American reed.[3]

Common reed can also be confused with reed canary grass (*Phalaris arundinacea*) as both produce a large plume flower structure at the top of the plant.[2] Common reed differs from reed canary grass by being considerably larger in stature and having a ligule made of hairs, whereas the ligules of reed canary grass are membranous.[1,2]

Common reed (*Phragmites australis* ssp. *australis*)

INTRODUCTION HISTORY

Common reed (*Phragmites australis* ssp. *australis*) is considered an Old World subspecies. Its broad native range stretches from Europe through Asia, and to parts of Northern and Southern Africa.[8,9] It is often deemed one of the most widespread and successful invasive plants around the world.[10] It was originally introduced to North America through contaminated soil sometime in the late 18th or early 19th century.[11] As of 2024, this subspecies has been reported in every US state except Alaska.[12] American reed grass (*Phragmites australis* ssp. *americanus*) is native to most of North America including the Northeast US,[13,14] although its modern-day occurrence in New York is rare.[15] Other forms of common reed, including intraspecific and interspecific hybrids, occur in the Southern US.[8]

Most biologists who study common reed genetics consider the Old World and American lineages to be subspecies of the *Phragmites* genus. However, some botanists consider American reed a unique species, rather than a subspecies (e.g., *Phragmites americanus*).[3,15] Both genetic differences and morphological characters have been used to separate American reed and common reed,[16] but the two are not easily distinguished.[5]

ECOLOGY AND HABITAT

Common reed is most often found in wet areas around marshes, ponds, lakes, springs, seeps, ditches, streams, and rivers. While common reed can tolerate brackish conditions that are up to half the salinity of the sea, it is more vigorous in fresh or only slightly brackish water. It is also common in disturbed upland soils where it is typically stunted.[5]

This species does best in full sun, and is therefore shorter and sparser in shaded conditions.[17] Along the Hudson River, common reed occurs in the supratidal and upper intertidal zones, and sometimes in the middle intertidal zone.[18] After establishing, it spreads until it encounters an obstacle such as deep water.[18] Storms and soil disturbance appear to be important for its dispersal and establishment, but stands often reach higher densities in the absence of any disturbance.[17]

Common reed stands can share resources through their collective rhizome network (i.e., clonal integration) and can easily expand vegetatively into less favorable habitats.[19] This clonal integration process means that management treatments must address the entire stand. Although tall, dense reedbeds are common, stands of common reed mixed with other plants also occur.[5]

REPRODUCTION AND PHENOLOGY

Common reed mainly reproduces vegetatively, through spreading rhizomes (underground stems) or stolons (aboveground, horizontal stems). It can also spread through rhizome or stem fragments. Rhizome fragments are commonly spread through water (especially due to storms and flooding) and passively by machinery, humans, or other animals. Common reed is often noted to not produce viable seeds,[1] but it may produce at least some, and seeds may contribute to reed establishment and spread under certain conditions.[20] True seedlings occur infrequently, and in some areas, they reportedly occur only in highly disturbed soils.[5]

IMPACTS OF THIS SPECIES

Common reed typically forms dense, tall, high-biomass stands that significantly alter soil, hydrology, microclimate, and vegetation.[17] These stands often displace native plant communities like cordgrass, cattails, and sedges, reducing plant diversity and habitat complexity. Vigorous stands in tidal marshes can fill in small depressions holding water at low tide, which are used by small fish and aquatic invertebrates.

Reedbeds can also fill larger, shallow pools in nontidal marshes that constitute important habitat elements for certain bird species. Chemical treatments of common reed stands can affect macroinvertebrate populations, with herbicide treatments causing prolonged shifts in aquatic food webs.[21,22] The significant amount of biomass in reedbeds that have grown next to structures may constitute a fire hazard.[18]

Common reed can provide some beneficial ecosystem services despite their negative impacts. The plant also tolerates pollution, and sequesters heavy metals and excess nutrients to improve water quality, and is used in wastewater treatment and sewage sludge dewatering.[23] They can stabilize soils, increase sediment deposition, and sequester carbon, which may benefit wetlands at risk from sea level rise or erosion.[24] Various lineages of common reed were (in some places, may still be) an important resource plant for Native Americans.[25]

Additionally, common reed can offer forage for livestock and cover for birds and mammals.[17] More often, however, its dense stands reduce habitat complexity, plant diversity, bird diversity, and aquatic access for fish and crabs, outweighing many of its benefits in natural ecosystems.[23] Common reed can negatively affect estuarine faunas, but these impacts vary by geography, habitat, species group, and life stage.[26]

Common reed (*Phragmites australis* ssp. *australis*)

MANAGEMENT GOALS

- Prevent new invasions by limiting human-mediated spread of rhizome and stem fragments.
- Reduce the extent and density of existing stands to allow native vegetation to recover.
- Dig out all roots and rhizomes from small patches to prevent spread. Follow with seeding or planting of native vegetation.
- In large stands, prioritize containment and prevention of spread rather than elimination.
- Implement long-term monitoring and adaptive management strategies to detect and suppress reinvasion.

MANAGEMENT METHODS: BIOLOGICAL CONTROL

Two stem-boring moth species (*Archanara neurica* and *A. geminipuncta*) have shown success in managing common reed.[10,27] Releases in Canada have been made since 2019, and so far the moths have established at 92% of Canadian sites.[10]

A petition for release in the US was made for both moth species in 2019, but is still under review.[28] Because the introduced moths may impact the native American reed grass in addition to the non-native common reed, additional rigorous review is warranted.[29]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Hand-digging can be effective in very small stands, but the entire rhizome system (including small root and rhizome fragments) must be removed.[18]

Mowing

Mowing regularly (e.g., at least twice a year during the growing season for four years or more) and removing cut material can reduce reed biomass, inhibit seed production, and increase plant species richness.[18,30,31]

When feasible, mowing at least once per month up to once per week during the growing season can significantly reduce density, biomass, and percent cover of common reed in less than four years. Mowing heights should remain as low to the ground as possible, and up to 4 in high at most.[30]

Mowing in wetlands can compact and damage soils.[18,30,31] In such cases where a mower may do more harm than good, a string trimmer or brush hog may be more practical.[30]

Cutting / Girdling

Cutting will require repeated applications for consistent suppression.[30,32]

In areas with consistently flooded conditions, cut stems in summer below the water level and raise or maintain high water levels as much as possible. Keeping roots and stems fully submerged can result in significant mortality.[33,34]

If submerging roots and cut stems is not feasible, cutting stems to the ground once per year in June (with a hand-held brush-cutter) and removing cut material can result in reduced reed cover and allow for increased cover of other plants, but all cut treatments must be consistently applied for many years.[30,35]

Prescribed Fire

Prescribed burns can be used to manage common reed, with different outcomes depending on soil conditions. When conducted on wet soil, burns primarily remove aboveground biomass without harming rhizomes. In contrast, burns that penetrate dry organic soil may kill rhizomes and create open patches or pools, potentially benefiting habitat diversity.[36,37]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL (cont.)

Mulching / Smothering

Mulching can be effective if applied over a layer of thick cardboard. Pieces of cardboard should have a generous overlap to prevent light gaps, and the mulch layer above should be thick enough to both hold the cardboard in place and to create a secondary barrier should any stems make it past the cardboard layer. This method must be reapplied with fresh cardboard and mulch at the start of every growing season for several years.[42]

Stems that escape the edges of or gaps within the cardboard and mulch should be hand-dug, including all root and rhizome materials, or cut and covered with additional cardboard and mulch.[42]

Smothering with cardboard and mulch is suitable for smaller patches of common reed in drier areas, while solarizing with black plastic is more feasible for larger and muckier areas.[42] However, cardboard offers the advantage of breaking down naturally over time, eliminating the risk of plastic residues persisting in the soil after prolonged use.[42]

Solarizing

Solarization with heavy-duty black plastic or landscaping fabric can be an effective method for controlling common reed, particularly when maintained for at least two years.[42]

Best practices include cutting and removing or flattening stems before covering the entire stand, along with a buffer zone, to maximize effectiveness.[42]

Flooding

Restoring natural hydrology through flooding or raising water levels can deter common reed by reducing its establishment success and fragmenting large stands, while also improving marsh and water bird habitat.[18,43,44]

Reintroducing tidal flow to diked salt marshes increases salinity, further reducing common reed dominance.[18]

In large wetlands, creating shallow pools or dredging ponds to increase water depth can prevent or reduce common reed presence and enhance habitat for marsh and water birds.[18]

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POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Post-treatment monitoring is essential for successful management. Treated areas should be surveyed annually for at least five years to detect and eliminate regrowth. Complete control can take many years.[18]

Integrating community-level monitoring, soil health assessments, and adaptive management frameworks could offer valuable insights for sustaining wetland restoration efforts in areas heavily invaded by common reed.[45]

Monitoring: Mark the boundary of a stand with stakes, establish onsite photopoints, or analyze aerial photos (small or low-density stands may not be visible on aerial photos). Reexamine every 1-2 years, with no management necessary as long as the boundary is stable, declining, or slowly expanding. If rapid expansion occurs, management can start promptly.[18]

Combine any of the above methods with the planting of native trees (such as willows) or shrubs to create a shaded canopy and discourage further *Phragmites* resprouting.[43,46]

- Common reed around plantings will need to be frequently cut and removed to allow the plantings to establish and grow.[46]
- Managing nearby areas for maximum canopy density will help limit spread and establishment of new populations. Assisting native community regeneration in wetland and riparian areas has many other benefits as well, including habitat improvement for breeding birds. [46]
- Note that larger trees and shrubs may establish a canopy more quickly, but can also cause further soil disturbance during the planting process. Source young seedlings or saplings for planting rather than larger nursery stock.[43]

Native seeding or planting of herbaceous plants should be performed once removal treatments have ceased, and further disturbance of the site should be prevented if possible.[47]

Disposal Methods

Collect all cut or dug plant material for off-site disposal.[34]

Composting common reed roots, rhizomes, and seeds is possible with proper treatment,[42,48,49] but should only be performed at a commercial composting facility, where the piles reach high enough temperatures (or are processed long enough) to destroy weed seeds and roots (see Appendix A for more details).[48,49]

- Home composting is not recommended, as these piles rarely reach the necessary temperatures to neutralize invasive plant material effectively. Commercial composting ensures safe and complete processing of common reed.[50]

Collected material can also be dried thoroughly for burning,[34] if piled on impermeable surface or solarized in bags.[49]

Common reed material can be added to other organic wastes and byproducts in an anaerobic digester or a pyrolysis kiln to produce biomass fuels. Common reed material can also be pelletized but special equipment is required.[51]

If none of these options are feasible, material can be bagged, allowed to sit in the sun for several weeks to thoroughly dry, and disposed of in a landfill.[49]

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Fact sheet prepared by Erik Kiviat, Kristen Bell-Travis, Kathryn Natale, and Andrew Leonardi (Hudsonia).

KNOTWEED (ITADORI, GIANT, & BOHEMIAN)

Reynoutria japonica, *R. sachalinensis*, & *R.* × *bohemica*


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Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Herbaceous

Habitat
Terrestrial

DESCRIPTION

Three *Reynoutria* species—itadori knotweed (*Reynoutria japonica*), giant knotweed (*R. sachalinensis*), and their hybrid, Bohemian knotweed (*R.* × *bohemica*)—are currently present and considered invasive in the US.[1–3] These species have historically been classified under several different genera, such as *Fallopia* and *Polygonum*, which some are still used by some botanists. Because they are difficult to distinguish and share similar ecological characteristics,[4–6] they are discussed here collectively as "knotweed", except in cases where they differ significantly. Despite their similarities, management efficacy may differ among knotweed species due to genetic variabiity.[7,8] Therefore, although identification can be challenging, distinguishing them to a species level is recommended prior to setting a management strategy.[7,8]

Knotweed (*Reynoutria japonica*, *R. sachalinensis*, & *R.* × *bohemica*)

IDENTIFICATION FEATURES

Itadori knotweed (*Reynoutria japonica*)

Leaves: Simple, deciduous, alternate, broadly ovate or wedge shaped, truncate (abruptly ending) at the base. Margin is entire. Leaves are approximately 3-6 in long by 2-5 in wide.[9]

Flowers: White or greenish white in color. Inflorescence (flowering structure) is elongated, born mid-stem, and as long as or longer than subtending leaf.[10]

Stem: Stout, erect, with hollow internodes, ca. 3-10 ft tall. Cylindrical and smooth, but can have longitudinal ridges.[9] Basal diameter of stems can exceed 2 in.[11]

Giant knotweed (*Reynoutria sachalinensis*)

Leaves: Simple, deciduous, alternate, ovate (egg shaped) with heart-shaped bases and smooth margins, and multi-celled hairs on leaf undersides. Leaves are approximately 4-12 in long by 3-8 in wide.[10]

Flowers: White or greenish white in color. Inflorescence is elongated, born mid-branch, and much smaller than subtending leaf.[10]

Stems: Stout, erect, and angular with hollow internodes.[9]

Bohemian knotweed (*Reynoutria* × *bohemica*)

Leaves: Simple, deciduous, alternate, broadly ovate to wedge shaped with either truncate or heart-shaped lea bases. Undersides have minute (yet firm) one- to two-celled conical hairs.[10]

Flowers: White or greenish white in color. Grow in an elongated inflorescence.[10]

Stems: Stout, erect, and cylindrical, with hollow internodes.[10]

SIMILAR SPECIES

These three knotweeds greatly resemble one another, albeit to varying degrees. They can also appear quite like bamboo, including (but not limited to) species in the *Pleioblastus* genus.

Some key characteristics for their discernment are:

- Itadori knotweed (*Reynoutria japonica*) and giant knotweed (*Reynoutria sachalinensis*):

  Itadori knotweed has smaller leaves that are truncate at the base, with hairless leaf undersides, and larger inflorescences. Giant knotweed has larger leaves with heart-shaped bases, hairy leaf undersides, and smaller inflorescences. [9,10]

- Bohemian knotweed (*Reynoutria* × *bohemica*) and its parent species (*R. japonica* and *R. sachalinensis*):

  Bohemian knotweed has one- to two-celled conical hairs on its leaf undersides, which are shorter than the multi-celled hairs found on the undersides of giant knotweed leaves. The undersides of itadori knotweed leaves are hairless.[10]

- Knotweed and bamboo (e.g., *Pleioblastus*):

  Knotweed stems are less woody than bamboo and lack the latter's grass-like leaves.[12]

Photo © Erik Kiviat

Best Management Practices for Priority Invasive Plants

Knotweed (*Reynoutria japonica*, *R. sachalinensis*, & *R.* × *bohemica*)

INTRODUCTION HISTORY

Itadori and giant knotweed are native to East Asia and were introduced to North America in the late 19th century as ornamental plants. Bohemian knotweed is a naturally occurring hybrid that arose where itadori and giant knotweed co-occur. Itadori and giant knotweed currently extend further south than Bohemian knotweed, but all three species are present and considered invasive in many parts of the Northeast, Midwest, and Northwest US.[1–3]

ECOLOGY AND HABITAT

Knotweed is usually found in riparian areas (stream and river banks, floodplains), roadsides, urban and suburban yards and vacant lots, dumps, and similar locations where soils have been heavily disturbed or transported (either by humans or water).[13] Knotweed plants are most productive and competitive under high-light conditions, and patches tend to be less dense under forest canopies.[14] Knotweed stems often stand erect through winter in the Northeast US after dying back nearly to the ground. During the second growing season, stems usually break or bend to the ground, creating a deep layer of prostrate dead stems sheltering spiders, insects, and other small invertebrates and vertebrates.[11]

REPRODUCTION AND PHENOLOGY

Itadori knotweed is usually spread by transportation of rhizome or stem fragments, either by water or humans (in fill material).[13] A new plant can sprout from fragments as small as ca. 0.4 in. Most itadori knotweed in North America is genetically a single (female) clone and produces sterile seed unless a pollen source is nearby,[15] while both giant knotweed and the hybrid Bohemian knotweed produce viable pollen and seed.[16] Seeds mature in August-October and often remain on the plant through winter. The majority of seed falls near the parent plant,[15] but seeds can also be dispersed via water or wind.[17,18] Longevity of the seed bank is currently unknown.[18]

IMPACTS OF THIS SPECIES

Once established, knotweed forms dense, high-biomass stands that exclude most native vascular plants and bryophytes, reducing species richness and regeneration.[19–22] It produces abundant leaf litter with a high carbon-to-nitrogen ratio, potentially altering nutrient cycling in riparian ecosystems.[23] Knotweed may have allelopathic properties,[17,18] but findings from laboratory studies are conflicting,[24,25] and further field research is needed.

Knotweed can also accumulate heavy metals in its large roots and rhizomes, which may have implications for soil and water quality.[26] While knotweed may stabilize streambank soils more effectively than other herbaceous plants,[26] it can actually cause streambank erosion when compared to native woody plants due to differences in rooting structure and depth. However, many existing studies have not consistently accounted for confounding factors such as preexisting erosion conditions.[11,27]

Knotweed blooms in late summer and serves as a nectar and pollen source for a variety of pollinators, including honeybees, native bees, wasps, and flies.[28,29] Pollination can contribute to its spread by seed, though some seeds may be consumed by birds such as house sparrows.[30] Its leaves support various insect species such as moths, butterflies, flies, ants, and beetles,[28] and preliminary research has recorded approximately 200 insect associations.[31] Japanese beetles (*Popillia japonica*) feed on knotweed in both its native and introduced ranges, though with a lower impact on the plant in North America, suggesting partial enemy release.[28]

Beyond its role as a food source, knotweed provides structural habitat for various organisms. In winter, its dead, hollow stems offer shelter and potential food sources for insects, spiders, sowbugs, and millipedes.[11] Additionally, about 20 bird species reportedly nest in knotweed stands in the northern US and southern Canada.[32]

MANAGEMENT GOALS

- When possible, identify plants to the species level before implementing control measures, as best management practices may vary slightly by knotweed taxon.[7,8]
- Refer to the "Similar Species" section above for distinguishing characteristics, and consult sources [33] and [34] for photos highlighting key identification features.
- Prioritize control efforts in sparsely invaded areas, smaller patches, and sites that are more shaded and less disturbed, as these conditions are more likely to support native plant recovery once knotweed is reduced.[35]
- Eliminate small patches by manually digging out small sprouts,[36] ensuring all stems, rhizomes, and crowns are removed from the soil.[37,38]
- Reduce large patches through repeated cutting over several years, which will diminish seed production, vigor, and density.[39,40]
- Apply multiple management strategies for a synergistic effect. Cutting or mowing combined with a physical barrier over the area or the planting of native trees to shade out knotweed can greatly enhance efficacy.[14,41]
- Limit further spread by carefully disposing of all cut or dug material.[37,40,42,43]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

A leaf-feeding psyllid (*Aphalara itadori*) has been released as a knotweed biocontrol agent in both the US (since 2019) and Canada (since 2014). Although promising, it is still too soon to tell whether this species will effectively establish and diminish knotweed stands in the US.[44,45]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Small patches can be removed by digging,[36,46,47] but all rhizome, crown, and stem fragments must be removed to prevent regeneration.[37,38] While stem fragments are less likely to resprout, they should still be removed.[7,37]

This method is labor-intensive and may disturb the soil, potentially stimulating any remaining rhizomes or crowns. It is therefore only recommended for small patches of knotweed.[48]

Digging is best performed early in the infestation, as rhizomes only remain small enough for hand removal until their second spring; after which, they become increasingly difficult to extract manually.[46]


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Mowing

Mowing can suppress (but not eliminate) knotweed stands,[40,49] making it useful mainly in managing large infestations where the primary goals should be suppression and preventing spread.[40]

Frequent and consistent mowing is necessary for control. Mowing at least twice per year (once in spring and once in summer[40]) for two to five consecutive years can reduce stand vigor,[40,41] while monthly or biweekly mowing will yield even better results.[41,50]

Cutting, whether mechanical or manual, is more effective when paired with other control methods, such as smothering, solarizing, wire mesh girdling, and/or native replanting (especially of native trees such as willows).[41,51,52]

Avoid partial or one-time mowing of stands, as this may stimulate growth of any uncut stems and regrowth of cut stems, respectively.[51,53] To ensure complete coverage in difficult areas, use hand tools (string trimmers, sickles, pruners) where mowers cannot reach.[40,41]

Bohemian knotweed may be more resistant to cutting and mowing than either of its parent species, but further research is needed.[7,8]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL (cont.)

Cutting / Girdling

Repeated cutting can significantly weaken knotweed but must be done frequently and for multiple years.[40,41,50]

Monthly or biweekly cutting from late spring through fall for at least two to three consecutive years produces the best results from this method.[8,41,50]

Cutting just twice a year—once in spring and once in summer—can also be highly effective, but should be done for at least three to five consecutive years.[40,41]

Cutting, whether mechanical or manual, is more effective when paired with other control methods, such as smothering, solarizing, wire mesh girdling, and/or native replanting (especially of native trees such as willows).[41]

- Sturdy wire mesh (such as hardware cloth) with 0.5 in openings can be installed over the entire area after cutting to supplement efforts. Subsequent regrowth from cutting will rise through the mesh openings and then be gradually girdled as they expand, exhausting root reserves over time.[47,54,55]
    - Wire mesh only works well if held tightly to the ground, and can therefore be difficult to implement on irregular terrain.[54]
    - If combining cutting, wire mesh, and tree planting, trees should not be planted near the mesh, as it can girdle young woody plants in addition to knotweed stems.[41]

Prescribed Fire

Information is limited, but burning is likely ineffective as a standalone control method due to the high moisture content of knotweed rhizomes.[17,47]

Prescribed Grazing

Grazing alone is unlikely to control knotweed, as animals primarily consume foliage and therefore stimulate growth without affecting rhizomes. However, it may aid suppression when combined with other methods.[47,56]

Soil Tilling

Not recommended. Tilling breaks up rhizomes and can lead to further spread of infestations, unless all fragments are meticulously removed.[7,37,39]

Mulching / Smothering

Heavy-duty barriers (e.g., landscape fabric, tarps, thick cardboard[39,40]) can suppress knotweed regrowth when applied after cutting stems to the ground.[36,39,57,58]

For best results, barriers should extend 6–8 ft beyond the stand,[39,58] and remain in place for several years with annual monitoring for punctures or sprouting.[36,39,57,58]

Layering multiple barriers improves efficacy. This is especially true when using cardboard, which must be covered with a heavier material like mulch to strengthen suppression.[39,40]

Proper site preparation can also be key. Leveling the ground (mechanically[57] or by flattening cut stems underfoot[39]) before placing a barrier reduces regrowth through gaps, while trenching around the edges helps prevent sprouting at the perimeter.[39,57]

Solarizing

Solarization, using clear or black plastic to trap heat and destroy rhizomes, can work in areas with intense summer sunlight. It is most effective on young or small populations.[57]

Flooding

Research on this method is extremely limited but suggests it is ineffective,[59] and may introduce the potential for spread of knotweed rhizome fragments in water.[30,59] However, it may struggle in persistently saturated soils, and further study is therefore needed to assess the viability of flooding as a management strategy.[11]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Regular monitoring and follow-up is essential to detect and prevent regrowth, as dormant rhizomes can sprout even after years of treatment.[46,57]

Promote dense canopy cover along streambanks and floodplains to shade and suppress knotweed establishment or regrowth.[14,41]

Monitor high-risk areas (such as riparian zones and roadsides near unmanaged stands) annually to prevent new infestations.[46,60]

- If flooding occurs in a high-risk area, survey the following summer for any new sprouts and carefully dig out all roots and rhizomes. Survey again the second spring after the flood event and repeat.[46]

Disposal Methods

Composting knotweed rhizomes and seeds is possible with proper treatment,[40,42,43] but should only be conducted at a commercial composting facility, where the piles reach high enough temperatures (or are processed long enough) to destroy weed seeds, rhizomes, and thick stems (see Appendix A for more details).[40,42,61]

- Home composting is not recommended, as these piles rarely reach the necessary temperatures to neutralize invasive plant material effectively.[62]

If this option is not feasible, the material can be bagged and allowed to sit in the sun for several weeks to thoroughly dry, then disposed of via burning or landfill.[42]

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Fact sheet prepared by Erik Kiviat, Kristen Bell-Travis, Kathryn Natale, and Andrew Leonardi (Hudsonia).

MULTIFLORA ROSE

Rosa multiflora

Photo © Erik Kiviat

Photo © Kristen Bell Travis

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DESCRIPTION

Multiflora rose (*Rosa multiflora*) is a fast-growing, highly invasive shrub in the rose family (Rosaceae), originally introduced to North America as an ornamental species.[1] Characterized by its arching, thorny canes and clusters of small white flowers, it spreads readily by means of both seeds and clonal expansion, forming dense thickets that suppress native vegetation.[2] Once promoted as an efficient "living fence" as well as erosion control measure,[1] multiflora rose has since become a problematic invasive species across much of the eastern and midwestern United States. Its vigorous resprouting after cutting and prolific seed production make it difficult to eradicate.[1,2]

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Shrub

Habitat
Terrestrial

IDENTIFICATION FEATURES

Leaves: Alternate, compound, deciduous, 5-11 serrate leaflets; leaflets elliptic to obovate; leaflets up to 1 inch long.[3] Stipules (leafy structures at the base of the leaf stem) fringed.[3,4]

Flowers: White or pink, five petals, 0.33-1 in wide, many (1-30) flowers per plant.[3,4]

Fruit: Clusters of small, red, fleshy or pulpy fruit (hips), fruit persists into winter.[4,5]

Stem: Woody with reflexed thorns, climbing or scrambling, up to 10 feet or higher in trees.[3,4]

SIMILAR SPECIES

Multiflora rose can be distinguished from other roses (*Rosa* spp.) by the fringed stipules on its leaf stems, as the stipules of other rose stipules are toothed or leafy.[4] The numerous small fruits are also distinctive.

Multiflora rose (*Rosa multiflora*)

INTRODUCTION HISTORY

Multiflora rose is native to East Asia, and was introduced to the United States as early as 1811 as a thornless variety for ornamental plantings and rootstock for common garden roses.[1,6,7] By the early 20th century, it was promoted by the U.S. Soil Conservation Service for erosion control plantings and food sources for birds, with thorned varieties of the species recommended as 'living fences' for livestock paddocks.[1,2,7,8] Farmers and conservationists were encouraged to plant multiflora rose throughout the mid-Atlantic and Midwest, where it was considered beneficial for its hardiness and ability to establish on poor soils.[1,2]

By the mid- to late-20th century, multiflora rose was spreading vigorously, forming dense thickets that outcompeted native plants. Its high seed production and bird-dispersed fruits contributed to its rapid expansion.[2] Today, it is found throughout the eastern and central U.S., with particularly high densities in disturbed grasslands, forests, and riparian areas.[2]

ECOLOGY AND HABITAT

Multiflora rose thrives in a wide variety of habitats, particularly in disturbed areas, such as roadsides, pastures, old fields, and forest edges and trails.[9,10] It is highly adaptable to different soil types but prefers well-drained, moderately fertile soils. The species grows best in full sun but can also tolerate partial shade, allowing it to invade forest understories where it disrupts native plant communities.[9,10]

One of the key factors contributing to multiflora rose's spread is its resilience to environmental stressors.[10] It is highly resistant to drought, browsing, and mechanical damage,[1] making it difficult to control.[2] While it is generally intolerant of prolonged flooding, its presence in riparian zones and wetland edges suggests that periodic flooding does not significantly limit its spread.[11]

REPRODUCTION AND PHENOLOGY

Multiflora rose reproduces both by seed and vegetatively (via root suckers and layering of canes).[12] Seeds are primarily dispersed by birds, particularly cedar waxwings,[13] American robins, and red-winged blackbirds, which consume the bright red hips and spread the seeds.[14,15,16] Birds so commonly consume the fruits that in the early 1900s, this species was recommended for wildlife plantings to support overwintering birds.[7] Leaf-out occurs in early spring (March–April), followed by flowering in late spring (May to June), with dense clusters of small white flowers that attract pollinators. Fruits ripen in late summer to early fall (August–October) and remain on the plant through winter. Plants remain semi-dormant in winter but retain some green foliage, particularly in mild climates.[14]

Although this species produces an impressive quantity of seed, references stating that mature plants can produce up to 500,000 seeds per year (or in some instances, reportedly up to one million seeds per year) appear to all come from an initial misinterpreted or nonexistent source, and cannot be verified.[17] A similarly common and unsupported citation is that of the seed bank longevity for this species, often noted as 10 to 20 years. It is unclear where this information originated from, and there is no evidence of its being tested or reported by any initial source.[17,18]

IMPACTS OF THIS SPECIES

Multiflora rose is a widespread invasive species in the eastern United States, where it readily establishes in disturbed areas, forest edges, and open fields. Its ability to thrive in a range of conditions allows it to outcompete native vegetation, particularly in high-light environments where it has superior water use efficiency and faster growth rates.[10]

Dense thickets of multiflora rose can suppress native plant diversity, alter habitat structure, and make forests more vulnerable to further invasion, particularly following canopy loss. In ecosystems with high deer populations, this species is often left untouched by browsing, giving it a competitive advantage over more palatable native plants.[37]

Additionally, multiflora rose serves as a reservoir for rose rosette disease (RRD), which then spreads to cultivated and (to a lesser degree) native rose species, posing challenges for maintenance of this additional species.[38]

Birds frequently nest in multiflora rose.[39] Dense growth and prickly canes may deter some predator birds and mammals.[40] Nests initiated in multiflora rose which is subsequently subject to leaf drop from RRD may become visible and experience higher rates of predation.[41]

Multiflora rose may be a favorable shrubland habitat component for New England cottontail (New York Special Concern) but more information is needed.[42,43] Multiflora rose is attractive to pollinating bees and seems to have little effect on pollinator networks of native plants.[44]

Multiflora rose (*Rosa multiflora*)

MANAGEMENT GOALS

- Suppress further spread by controlling seed dispersal and clonal expansion.
- Encourage native plant regeneration to prevent re-establishment of multiflora rose after removal. [19]
- Utilize a combination of manual, mechanical, and cultural control methods (such as prescribed grazing) for long-term suppression.[19]
- In areas where multiflora rose and rose rosette disease (RRD) pose a risk to ornamental roses, consider outreach and collaboration with homeowners, gardeners, nursery growers, and other relevant stakeholders. Since recommendations for protecting ornamental roses from RRD often prioritize removing nearby multiflora rose,[20,21] engaging these groups can help build support and resources for removal efforts while achieving a common goal.

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Hand-pulling and digging can be effective for small plants, but mature plants can be quite difficult to remove, and will require removal of the entire root system to prevent resprouting.[18]

Mowing

Repeated mowing can suppress multiflora rose by depleting its stored root energy, but single mowings often result in vigorous regrowth. However, a one-time or once-annual mow can be helping in preventing fruiting for a given season if performed just before or during flowering.[18]

Prescribed Fire

Fire may help weaken plants when combined with other control methods, such as grazing or mechanical removal, but is largely untested for this species in particular. Based on the stimulated growth response of other rose species after prescribed burns, however, some have extrapolated that this method may be similarly ineffective for multiflora rose.[16]

Flooding

Multiflora rose is flood-intolerant, meaning restoring wetland hydrology may help suppress its establishment in disturbed floodplain forests.[11]

Cutting / Girdling

Cutting on its own is noted to be ineffective for control of multiflora rose. However, it is often a helpful first step in conjunction with other management methods such as prescribed grazing or manually digging out plants (in the case of the latter, the goal is mainly to avoid the prickly canes while digging.

Prescribed Grazing

Goats and sheep can effectively suppress multiflora rose by browsing its leaves and stems, reducing plant height and cover.[19,22, 23]

Prescribed grazing alone can show declines of 90% or more within a single year, but should regardless be continued for at least several consecutive years for long-term control.[22]

Cutting mature and/or large (>2 inch diameter near the root crown) canes to the ground prior to grazing can enhance the impact on multiflora rose, as well as allow for lower stocking densities and less targeted grazing.[23] This creates more palatable and easily accessible browse for livestock that would otherwise not be able to reach (or not be interested in) larger, woodier stems.[23]

Intensive rotational grazing of this species with cattle has also been tested and is recommended by some studies,[24] but cattle may not be as effective browsers of thorned plant species as goats or sheep.[25]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

Rose rosette disease (RRD), a viral disease spread by a native eriophyid mite (*Phyllocoptes fructiphilus*), was first noted in the U.S. in the early 1940s. It is unknown whether the virus itself is native to the US, or whether it was introduced unintentionally.[26,27] RRD causes severe damage and mortality in multiflora rose over time, with mortality typically taking from 2 to as many as 5-6 years.[27,28]

Rose rosette disease on multiflora rose. Photo © Erik Kiviat

This disease was initially thought to be a potential biocontrol for multiflora rose, but has not proven effective for control of multiflora rose populations.[27,29] This is likely due to the amount of time the disease takes to sufficiently weaken the plant before it stops producing seed and senesces, allowing for the reproduction of ample viable seed in the meantime.[14,27,30] Multiflora rose now more often viewed as an initial host (and indirect vector of the disease to ornamental roses than as a casualty of the disease. [20,27]

Risks of RRD to the ornamental rose trade have played a role in slowing further study of more virulent strains of RRD for multiflora rose control. At the same time, this risk to ornamental roses has created an incentive for homeowners, gardeners, and nursery growers to advocate for multiflora rose removal.[20,21]

A seed-feeding chalcid wasp (*Megastigmus aculeatus* var. *nigroflavus*), introduced to the U.S. unintentionally, has been observed to reduce seed viability of multiflora rose. At this time, its overall impact on this plant species is variable, and further study is needed. [29, 31]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Sites should be monitored for at least three* years post-treatment to address resprouting and new seedling emergence.

Introducing native vegetation can help stabilize treated areas and prevent reinvasion.[19]

In grazing treatments and/or areas with high deer densities, exclosures or other barriers to exclude ruminants can assist with native plant regeneration and establishment.[19]

*Although it is often noted that the seeds of multiflora rose can remain viable in seed banks for 10-20 years, there is no clear source of this information, and no evidence of its being tested.[17,18]

Disposal Methods

Plant material infected with RRD should be burned or bagged and removed, as the virus may persist in cut material.[32]

Although this material may be successfully composted if piles reach high enough temperatures (or are processed long enough) to destroy weed seeds and roots,[33,34] not all facilities will accept material with thorns. Check with your local composting facility prior to transporting materials there.[35]

Home composting of this material is not recommended even if the thorns themselves are not considered an issue, as these piles typically do not achieve the temperatures needed for effective processing of weedy material (in this case, seeds, roots, and canes with the ability to take root).[34,36]

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WATER CHESTNUT

Trapa natans

Photo © Erik Kiviat

Photo © Erik Kiviat

Photo © Lea Stickle

DESCRIPTION

Water chestnut (*Trapa natans*) is an annual, rooted, floating-leaf aquatic plant native to temperate and tropical regions of Europe, Asia, and Africa. It has become invasive in parts of North America and Australia, spreading in areas such as ponds, lakes, wetlands, slow-moving parts of rivers, and estuaries, where water is fresh to slightly brackish and between 0.5 to 12 ft deep (usually 6 ft or less). It prefers full sun, soft bottom sediments, and nutrient-rich, sluggish freshwater.[1]

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Forb

Habitat
Aquatic

IDENTIFICATION FEATURES

Leaves: Floating rhomboidal or triangular leaves in a densely clustered rosette, alternate, sharply serrate, and with inflated petioles (leaf stems) which help the leaves float.[2,3] Submerged leaves are opposite and highly dissected or feathery.[3] Some botanists do not consider this submerged foliage to be true leaves.[1]

Fruit: Stout, four-pronged, resembling the shape of a caltrop.[2,3]

Growth habitat: Stems can grow approximately 6.5-13.5 feet long.[4] Stems are branching, with each branch ending in a floating rosette of leaves. Most of the vegetation is submerged, with submerged vegetation somewhat variable in morphology.[1]

Water chestnut (*Trapa natans*)

INTRODUCTION HISTORY

Water chestnut is native to Eurasia and Africa and was introduced to North America in the 1870s.[2] In the US, it is invasive in the northeastern states from Virginia up through the Great Lakes basin.[1]

ECOLOGY AND HABITAT

Water chestnut is found in ponds, lakes, flooded wetlands, slow-moving parts of rivers, and estuaries, where water is fresh to slightly brackish and between 0.5 to 12 ft deep. Water chestnut is an annual and develops anew each year from fruits that overwintered at the sediment surface. It prefers full sun, soft bottom sediments, and sluggish, nutrient-rich fresh water.[1]

REPRODUCTION AND PHENOLOGY

Plants emerge in spring from seeds in bottom sediments and bloom from July to August. Each flower produces a one-seeded fruit ("nut") with barbed spines, which ripens by mid- July or later.[1] The nut sinks to the bottom and may remain viable for up to 12 years (potentially more[5]), enabling a persistent seed bank.[1,6] Seeds spread via humans, boats, or water birds. Uprooted stems can survive and mature seeds.[7]

MANAGEMENT GOALS

- Eliminate small infestations as early as possible through annual hand-pulling until the seed bank is depleted.[5,11]
- Reduce the density of large infestations using a combination of mechanical harvesting and manual removal.[5,6]
- Prevent new introductions by inspecting and cleaning boats, nets, and equipment.[5,6]
- Properly dispose of plant material to prevent unintentional spread.[5,6,12]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

Research on the potential biocontrol agent *Galerucella birmanica*, a beetle from water chestnut's native range, is still in the stages of testing.[13] This beetle feeds extensively on water chestnut leaves, and has the potential to severely decrease water chestnut's populations in its non-native range.[13,14]

However, host-specificity tests show it also feeds and oviposits on a non-target, native plant—water shield (*Brasenia schreberi*).[13] Although this non-target impact is thought to be slight, further testing is still needed prior to approval of *G. birmanica* in the U.S. At this time, no official petition for its release has been submitted.[13,14]

IMPACTS OF THIS SPECIES

Once established in a water body with suitable conditions, water chestnut can spread rapidly. Under ideal conditions, it forms dense mats that intercept 95% of sunlight and nearly cover the water's surface, shading out submergent aquatic vegetation and reducing dissolved oxygen to levels lethal to many fishes and other aquatic organisms.[1,8] Fish found in water chestnut beds are limited to pollution-tolerant species adapted to low dissolved oxygen and high turbidity.[1,8] Additionally, water chestnut beds can interfere with swimming, fishing, and boating.[6]

Dense water chestnut beds can lead to the release of significant amounts of methane, a greenhouse gas.[9] These dense beds can also inhibit establishment and reduce overall richness of other aquatic plants (although several species of duckweeds may flourish in small spaces among water chestnut leaves[1]). Vegetation development and establishment of other aquatic plants (whether native or nonnative) following water chestnut removal are not well-studied.[7]

While water chestnut has adverse ecological impacts, it provides some ecosystem services. It removes large amounts of inorganic nitrogen from waterways[10] and accumulates heavy metals, offering potential for phytoremediation.[1,5] Water chestnut beds are used by snapping turtles, blue crabs, marsh and water birds, and mammals such as beaver, muskrat, and red squirrel, some of which consume its seeds.[1] Cedar waxwings glean insects from the upper surfaces of leaves.[1] However, beds of native submerged aquatic vegetation provide more food for waterfowl and support higher microorganism, algal, and macroinvertebrate diversity, leading to more diverse fish assemblages than water chestnut beds.[1,8]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Manual removal is highly effective for small infestations.[5,6] Pull plants early in the growing season, prior to seed maturation in early- to mid-summer, to help prevent further spread.[5,14] Ensure all parts of the plant are removed, including roots, stems, and leaves, as even small rosettes can regrow or produce fruits.[5,12]

Work from a canoe or small boat with enough cargo space to haul plant material back to shore for proper disposal.[8] Use a rake to aid in reaching plants and pulling roots, as well as a laundry basket or plastic tub to collect all pulled plant materials while out on the water.[12,15]

Plant material can brought to shore when collection baskets are full, and dumped out of boats onto a tarp[15] or into a truck bed.[5]

Hand-pulling is labor-intensive but minimizes environmental disturbance. Community efforts, such as volunteer hand-pulling events, can improve both the efficacy and long-term feasibility of this approach.[5,12]

Follow up one month after hand-pulling, to remove any plants and/or fruits that were missed during the initial removal attempt. Use thick gloves to protect hands from sharp, spiny fruits.[5]

Mulching / Smothering

Benthic barriers (weighted tarps or mats) can be used to smother water chestnut by blocking sunlight and preventing growth. These barriers are most effective in small, localized infestations but may negatively affect native aquatic species and habitats.[5]

Mechanical harvesting

For larger infestations, mechanical harvesters can remove substantial biomass more quickly and with less labor than hand-pulling.[6] However, repeated treatments are necessary to exhaust the seed bank, and care must be taken to minimize turbidity during harvesting. Hand-pulling may be necessary alongside mechanical harvesting to remove plants from areas the harvester cannot reach, such as those with water depths of less than 2–3 ft.[5]

Cutting / Girdling

Cutting this plant below the waterline can reduce biomass, but this is best performed by a mechanical harvester rather than by hand. Floating fragments can mature seeds, so hand-collection may be needed to remove material cut but not collected by a mechanical harvester.[5]

Flooding

Water chestnut inhabits flooded environments, so increasing flooding is not a viable management technique. Conversely, lowering water levels (drawdowns) in late spring to early summer (when plants have sprouted) can expose plants to desiccation and reduce their density. However, drawdowns can have varying impacts on wildlife and other plants, so they should be planned with great care.[5]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Regular monitoring is essential to prevent re-establishment of water chestnut. Monitoring efforts should focus on identifying and removing new growth, particularly from the seed bank, which can remain viable for years (and potentially more).[5] Community engagement and public awareness campaigns can aid in early detection and rapid response to re-infestations.[5,12,16]

Disposal Methods

Proper disposal of all removed water chestnut material is critical to prevent reintroduction. Avoid disposing of plant material near water bodies to minimize the risk of seeds re-entering aquatic environments.

Recommendations include:

- Drying: Spread plant material on land to dry completely, ensuring seeds are no longer viable.[5,15] Such disposal should occur far enough that nutrients from decomposition, or the harvested material itself, do not enter a water body.
- Composting: Water chestnut can be composted at a commercial processing facility, where the piles reach high enough temperatures (or are processed long enough) to destroy viable roots (see Appendix A for more details).[5,17,18]
    - Home composting of this material is not recommended, as these piles often do not achieve the temperatures needed for effective processing.[17,19]
- Burning: Allow plants to dry down thoroughly before burning, piling them in the sun far from any waterbodies.[5,12]

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Fact sheet prepared by Erik Kiviat, Kristen Bell-Travis, Kathryn Natale, and Andrew Leonardi (Hudsonia).

BLACK SWALLOWWORT

Vincetoxicum nigrum = Cynanchum louiseae

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Photo © Leslie J. Merhoff, University of Connecticut, bugwood.org

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Vine

Habitat
Terrestrial

DESCRIPTION

Vincetoxicum nigrum is a perennial, herbaceous vine in the Apocynaceae (dogbane) family, characterized by twining stems, opposite ovate or lanceolate leaves, and dark purple star-shaped flowers with yellow centers.[1,2] Native to southern Europe, this species has become a significant invasive plant in North America, particularly in the northeastern United States and southeastern Canada.[2] *V. nigrum* spreads readily through wind-dispersed seeds and vegetative root expansion, sometimes forming dense stands that displace native vegetation and alter ecosystem processes.[2] It thrives in disturbed environments, grasslands, forest edges, and riparian zones, where it can quickly establish and dominate available space.[2]

Studies on black swallowwort are somewhat limited compared to the more extensive body of research regarding another non-native species, pale swallowwort (*Vincetoxicum rossicum*). As a result, many of the control methods suggested below have been tested on pale swallowwort rather than black swallowwort, but are likely applicable to both species due to their strong genetic and morphological similarities.[2,3]

IDENTIFICATION FEATURES

Leaves: Simple, opposite, deciduous, ovate (egg shaped) to somewhat lanceolate (lance-shaped), dark green, ~2-5 inches long, smooth margins.[1,4]

Flowers: Fleshy, purple-black in color, 5 petaled, approximately 0.25 inch wide, and often in clusters of 6-10. There are fine hairs on the margins of petals.[4]

Seeds: Light green elongate pods approximately ~1.5-2.8 inches in length house many small brown seeds with numerous fluffy white hairs.[1,5] Black swallowwort fruits and seeds resemble miniature common milkweed parts.

Habit: Black swallowwort is a twining perennial herb which often climbs other vegetation. It also grows in dense patches in forest understories and in fields without canopy.[4]

SIMILAR SPECIES

Pale swallowwort (*Vincetoxicum rossicum*) is nearly identical to black swallowwort, but its flowers are larger, a lighter color of pink to maroon, with no fine hairs on the petals.[1] Although much less common in the lower Hudson Valley, pale swallowwort is just as invasive as black swallowwort and very similar ecologically. Gold-and-silver honeysuckle (*Lonicera japonica*) is another non-native, invasive vine with opposite leaves—but its leaves are oval, lacking the long, pointed tips of swallowwort leaves and it has large white or beige flowers.[4]

Black swallowwort (*Vincetoxicum nigrum*)

INTRODUCTION HISTORY

Vincetoxicum nigrum is native to southwestern Europe, including Portugal, Spain, France, and Italy.[6] It was introduced to North America in the late 19th century, likely for horticultural and ornamental purposes due to its climbing habit and unusual dark flowers. Early records indicate it was planted in botanical gardens and urban landscapes, but it soon escaped cultivation and spread into natural ecosystems.[7]

By the mid-20th century, *V. nigrum* was widely naturalized in parts of the northeastern United States, particularly in New York, Massachusetts, and Connecticut. Its wind-dispersed seeds allowed rapid expansion, and by the 1980s and 1990s, its dense populations were noted in grasslands, roadsides, and disturbed forests. Today, it is found throughout eastern and midwestern North America, with particularly high densities in New York, Ontario, and surrounding regions.[8]

ECOLOGY AND HABITAT

Black swallowwort is highly adaptable and thrives in a wide range of habitats, particularly in disturbed areas such as roadsides, old fields, abandoned pastures, and forest edges.[7] It exhibits a high drought tolerance, allowing it to persist in dry, well-drained soils, but it can also establish in moist environments, including streambanks and floodplain forests,[2,6] and wetland edges.[9]

Although black swallowwort prefers full sun, it is capable of persisting in shaded environments, particularly in forest understories.[8] Higher light availability increases its biomass and seed production, making open fields and grasslands particularly vulnerable to invasion,[7] which in turn can act as seed sources for more shaded natural areas nearby.[2]

Black swallowwort can climb over and smother native vegetation, reducing biodiversity and altering ecosystem structure.[6] Additionally, there is some evidence of allelopathic properties that inhibit the germination and growth of native plants, further increasing its

REPRODUCTION AND PHENOLOGY

Vincetoxicum nigrum spreads by seed. Each mature plant can produce hundreds of seed pods containing small, fluffy seeds with pappus-like structures that facilitate wind dispersal, allowing it to spread over long distances.[7,8] Peak seed dispersal in the northeast U.S. occurs in late summer and fall, particularly in August and September.[8] In addition to wind, seeds can also be spread by water movement in riparian areas or through accidental transport by human activity.[6]

Germination in the Northeast begins in May and continues at lower rates through late summer and fall.[7] Flowering occurs from late May to early July, peaking in June.[12] Seed pods typically mature by August and seeds disperse through September and October.[8] The plants die back during winter but resprout vigorously from the root crown in early spring, typically in April or May.[6]

V. nigrum forms a persistent yet relatively short-lived seedbank, with seeds remaining viable for 3-4 years.[8] Seedling establishment is most successful in disturbed soils, particularly following mechanical disturbances such as tilling.[7]

IMPACTS OF THIS SPECIES

Vincetoxicum nigrum has significant ecological impacts, outcompeting native plants, altering community structure, and disrupting ecological interactions.[7,8] It may also release allelochemicals that inhibit germination and growth of native plants, further reducing biodiversity.[10] This species' rapid growth and prolific reproduction are supported by its ability to alter soil fungal communities, efficiently acquire resources, and deeply shade the soil.[8,10]

V. nigrum affects wildlife both directly and indirectly. Its toxic foliage offers little to no food value to herbivores and makes it unpalatable to grazing livestock.[2,13] The dense growth of swallowwort can also reduce arthropod diversity,[14] affecting grassland-breeding birds and other organisms reliant on arthropods for nutrition and habitat.[7,10] These cascading effects disrupt forest regeneration and stability.[7,8]

A commonly noted concern is that black and pale swallowwort may act as ecological traps for monarch butterflies, which occasionally lay eggs on both swallowworts, with subsequently lower survival of larvae.[7,8] However, monarchs still strongly prefer their primary host, common milkweed (*Asclepias syriaca*), when it is available, and the threat of swallowworts to monarchs may only lie in the ability of swallowwort to displace common milkweed. Ultimately, the greatest threats to eastern North American monarch populations stem from climate change and habitat loss (e.g., deforestation), making swallowwort's impact a minor concern.[7,15]

As with many invasive plants, there is a need for more data from longitudinal studies across the nonnative range of black swallowwort.

Black swallowwort (*Vincetoxicum nigrum*)

MANAGEMENT GOALS

- Monitor carefully to catch any invasion early and remove new patches swiftly.[4]
- Eliminate small satellite patches near vulnerable areas or prevent their seed set if removal is not feasible.[16]
- Keep large patches from spreading by preventing seed production in mature plants.[16,17] Prioritize management of the edges of the infestation,[10,18] vines that are climbing up taller vegetation (particularly trees),[19] and infestations in full sun areas.[16,20]
- Establish native plants after swallowwort removal, focusing mainly on native grasses.[10,21]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

There is currently no formally approved biocontrol available for these three *Lonicera* spp.[20]

Biocontrol is considered the most viable method for swallow-wort control overall.[18,21,22] The most promising candidate is a leaf-feeding moth (*Hypena opulenta*) although its full efficacy and probability of establishment remain uncertain. It was released in Canada about a decade ago and in the U.S. in 2017.[23] Established populations exist in some release sites, with evidence of impact, but widespread establishment in both countries remains a challenge.[16,18,22,24]

Several other species have previously been tested or are still being tested for swallowwort biocontrol, including the seed-eating insect *Abrostola asclepiadis*[25], the seed predator *Euphranta connexa*,[16,25] and the leafspot fungi *Agroathelia rolfsii* [26] and *Passalora bellynckii*.[18] However, these species have not shown as much promise as *H. opulenta*, and continued research is needed to determine their efficacy in swallow-wort management.

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

For small patches or recently established plants, plants can be dug out by hand prior to seed set. Remove the entire root crown as well as any root fragments.

Digging is more effective than cutting or herbicide, but can be far more labor-intensive.[16,21] Follow-up the next spring to check for any plants missed during removal.[21]

Hand-pulling plants by the stem is not recommended, as they will likely snap off at the root crown.[4] Removing seed pods by hand can, however, be helpful if management is not feasible before seed set.[16]

Cutting / Girdling

Cutting plants 3x per year can reduce black swallow-wort biomass for the rest of the growing season and prevent seed set (if performed just before flowering).[18,28] However, it is unlikely to impact vigor in the long-run or induce mortality, even when performed for many years.[7,27]

Mowing

As with cutting, mowing 3 times per year can reduce plant biomass and prevent seed production within a single growing-season, but is unlikely to reduce plant vigor or induce mortality even if performed for many years (in one study, even 7 continuous years of mowing was not enough).[7,27]

If mowing is the most feasible form of management, however, it can be performed at a height of 3 in from the ground 3x per year,[27] with the first mow occurring during or just after flowering.[16] Keep in mind that the expectation for this method is the prevention of seed set/spread rather than elimination of the plant.[16,27,28]

Prescribed Fire

Not advisable. A single burn will stimulate vigorous regrowth, and repeat burns will at best prevent seed spread but can also spur regrowth.[7,16] If a prescribed burn is needed in an area with black swallow-wort, apply another control method (such as cutting) at least once prior to the burn.[16]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL (cont.)

Prescribed Grazing

Not advisable. Cattle will graze swallowwort enough that it does not invade active cattle pastures, but this species may be toxic to other mammals.[2,7]

Soil Tilling

Agricultural fields can be tilled to a depth of at least 4 inches to suppress black-swallowwort and reduce its germination and/or resprouting.[17] This should be followed-up with the planting of annual crops until the seed bank is depleted (3-5 years).[16,17] Tilling is not recommended in natural areas due to the inherent disturbance it causes.[16]

Solarizing

For small to medium patches, cut and remove all top growth, then cover with a heavy tarp or heavy-duty black plastic for two years. Black plastic is damaged more easily, and plants will regrow through any holes, but this method may reduce density enough for hand-digging.[2]

Flooding

Restoring natural flood regimes to disturbed floodplain forests can reduce black swallow-wort populations over time.[17]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Seed or transplant native plants shortly after swallowwort removal. Native grass species should make up the majority of overall plant material selected, and native asters should account for most of the forbs selected.[10,21] See references [10] and [21] for specific plant recommendations.

- A recent study has suggested that seeding or planting common milkweed (*Asclepias syriaca*) in swallow-wort conditioned soils may actually encourage swallow-wort growth and suppress native plant growth.[10] However, past studies on *A. syriaca* and swallow-wort interactions have found the former actually suppresses the latter,[29] so this relationship remains unclear, and further research is needed.

Monitor carefully for swallow-wort reinvasion and secondary invasion by another nonnative species for at least two years[17] (or preferably, up to five years[13,16]) following treatment.[17]

Disposal Methods

All plant material other than leaves and stems should be taken off-site for disposal. Root crowns and fragments can resprout if left in contact with the ground,[2] and seed pods can still release ripened seed post-removal.[16]

Plant material can be brought to a commercial composting site that can effectively process seed material (see Appendix A for more information).[30,31]

- Home composting of this material is not recommended, as these piles often do not achieve the temperatures needed for effective processing.[31,32]
- If this option is not feasible, bagged material should be allowed to sit in the sun for several weeks to thoroughly dry, then disposed of via burning or landfill.[30]

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NEW SPECIES ACCOUNTS

The following section introduces species that were not included in the original 2016 report.

They have been newly added for the 2025 edition.

PORCELAIN BERRY

Ampelopsis glandulosa = A. brevipedunculata

Photo © Erik Kiviat

Photo © Erik Kiviat

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Liana

Habitat
Terrestrial

DESCRIPTION

Porcelain berry (*Ampelopsis glandulosa*) is a woody climber (liana) with a perennial, weakly woody stem. It climbs by means of tendrils, attaching to a woody plant (or a robust semi-woody plant such as knotweed or common reed) or structures such as a fence. Fruits vary in color and are ornamental, possibly encouraging collection for display or planting.

IDENTIFICATION FEATURES

Leaves: Simple, deciduous, alternate, 3-5 lobed but sometimes not deeply cleft, pubescent main veins on underside of leaves, young twigs hairy.[1,2 4]

Flowers: Five pale-yellow petals per flower, born in clusters.

Fruit: Thin-skinned, fleshy, 2-4 seeds, bright blue marbled to white.[1]

Stem: May reach 25 ft in length.

Bark: Gray-brown, close furrows resulting in smooth bark, small glands.[2]

SIMILAR SPECIES

Porcelain berry resembles grape species (*Vitis* spp.) in growth form and leaf shape but can be distinguished by its pink-purple-blue fruit coloration.[1] Its gray-brown bark has close furrows and small glands, whereas grapevine bark is brown with long, exfoliating strips.[2] Additionally, porcelain berry has a white pith, while grapes have a brown pith.[3]

Porcelain berry can also resemble *Parthenocissus* species, such as the native Virginia creeper (*P. quinquefolia*). Virginia creeper has compound leaves with 3–5 leaflets and an expanded disk at the end of its tendrils.[1]

Poison ivy can be mistaken for porcelain berry, but it is distinguishable by its compound leaves with three leaflets and the abundance of aerial roots along its climbing stems.[1]

Another look-alike is the less common raccoon-grape (*Ampelopsis cordata*), but porcelain berry typically has more deeply lobed leaves and hairier twigs.[1]

Porcelain berry (*Ampelopsis glandulosa*)

INTRODUCTION HISTORY

Porcelain berry is native to eastern Asia and was introduced for ornamental purposes in the 1870s.[3,4,5]

ECOLOGY AND HABITAT

Porcelain berry does well in moist, fertile soils in edge habitats, such as woodland edges, roadsides, old fields, and other disturbed areas.[3,4] It is not usually found where soil is permanently wet.[4] This species is shade intolerant, and vigorous only in full sun or partial shade.[4] It climbs on a wide, perhaps limitless range of other species and structures.

Porcelain berry is often locally abundant in urban waste grounds and greenspaces in the southern portions of the LH PRISM region.[6] It is spreading northward but is currently rare in northern Dutchess County.[6] Porcelain berry, unlike many weeds of Eurasian origin, is said to be slow to leaf out in spring.[7]

REPRODUCTION AND PHENOLOGY

Porcelain berry reproduces locally and long-distance by seed which is spread by the animals that eat the fruits (primarily by birds however there is some evidence of deer consumption)[3,5,8,9]; possibly also dispersed by water.[5,10] Mammals may be repelled from consuming berries due to chemicals released during chewing that can damage the mouth.[11] Various modes of vegetative reproduction have been suggested[5,7,12] but hard evidence may be lacking. Porcelain berry seeds may survive in the soil for several years.[12]

IMPACTS OF THIS SPECIES

Porcelain berry, in common with other vines, can overgrow or weave itself among spontaneous and planted vegetation. It shades out supporting plants and makes trees more vulnerable to storm damage.[13,14] It is unclear if this species physically smothers other plants.

The tangles and mats of porcelain berry vines modify the habitat functions of their hosts (the supporting vegetation), and although this dense growth may exclude larger animals, it may facilitate increased growth of other weeds (e.g. common reed) and density of escape and nesting cover for small animals. This species also hosts a pathogen and insects which are harmful to cultivated grapes.[15]

MANAGEMENT GOALS

- Remove vines from native host plants to relieve them of the weight, heavy shade, and competition for soil nutrients caused by porcelain berry vines.
- Trees should be a priority for vine removal.[16]
- Cut vines before they begin to fruit to prevent further spread.
- Monitor and repeat treatments yearly until the vines' root reserves are exhausted.

MANAGEMENT METHODS: BIOLOGICAL CONTROL

Four potential biocontrol agents were identified in 2006.[17] However, little information has been released since then, and no biocontrol agent is available or under formal review at this time.[17]

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Pulling vines down from their support followed by cutting may be effective for smaller patches.[5]

Manually pulling up vines by the roots is more feasible with young plants.[4] This may be more effective than cutting for seedlings/small plants, but is not effective for larger vines.[12]

Vines resprout from a taproot, and several years of pulling or cutting during the growing season are typically required to successfully control this plant.[12]

Mowing

Mowing has been reported to have no effect[19], but information regarding this management method is extremely limited.

This method is typically not applicable to management of porcelain berry in natural areas and/or situations where vines are growing on native vegetation.

Cutting / Girdling

As with other lianas, porcelain berry vines can be cut near the base[13], but can be labor-intensive for larger patches of vines.[16]

Prioritize vines growing up mature trees followed by saplings, to prevent or ameliorate tree damage that can be caused by large vines.[16]

Repeated cuttings will be required to exhaust root reserves, as this plant is difficult to control and resprouts from cutting.[5]

No information is available regarding the girdling of this species' vines.

Shading

Planting fast-growing trees and keeping them free of vines may shade and weaken porcelain berry in the long term.[5,19]

Porcelain berry climbing on Phragmites. Photo © Erik Kiviat

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Fact sheet prepared by Erik Kiviat (Hudsonia).

ANGELICA TREE

Aralia elata

Photo © Erik Kiviat

Photo © Erik Kiviat

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Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Small Tree

Habitat
Terrestrial

DESCRIPTION

Angelica tree is a small, colonial tree with very large (up to 3 ft long), twice- or thrice-compound leaves. The stout twigs, branches, and leaves all sharp prickles. This species can reach heights of about 33 ft with diameters of 4 in or more. Angelica tree forms colonies by underground spread.

IDENTIFICATION

Leaves: Up to 3.3 feet long, twice- or partially-thrice-compound, deciduous, leaflets ovate (egg shaped) with sharply toothed margins. Abaxial (underside or side facing stem) surface of leaves pubescent (with hairs). Branchlets holding leaflets gray, stout, and prickly.[1]

Flowers: Abundant, small, whitish or yellowish flowers in a widely spreading compound inflorescence that is typically ~1-2 ft long borne near leaf bases on the tree.[2]

Fruit: Small black berries. Pedicels and peduncles (stems of fruit) may be red.

Growth Form: Shrub or small tree, growing up to ~ 33 ft.[1]

Bark: Brownish gray with stout prickles.[1]

SIMILAR SPECIES

Potential misidentification of angelica tree is possible as it looks very similar to the native devil's walking stick (*Aralia spinosa*). Many reports and specimens of devil's walking stick are actually misidentified angelica tree.[4] Key characters to look out for include main lateral veins, which in angelica tree reach the tip of teeth along leaf margin, while devil's walking stick branch and diminish in size before reaching the margin.[1,4] Angelica tree inflorescence (flower structure) is shorter, typically 1-2 ft long without a distinct central axis, while devil's walking stick has 3.3-3.9 ft long inflorescence around a central axis that is typically longer than wide; the base of the inflorescence in devil's walking stick is usually elevated above foliage.[1] Branchlets of angelica tree are light gray, while branchlets of devil's walking stick are light brown.[1]

Angelica tree (*Aralia elata*)

INTRODUCTION HISTORY

Angelica tree is native to East Asia. It has been in North America since the 1800s and is now widely distributed.[5] Near the Hudson River in Barrytown (Dutchess County), there was already a grove of large angelica trees ca. 1980, possibly originally planted there.[7]

ECOLOGY AND HABITAT

Angelica tree is found in woodlands, woodland edges, treefall gaps, windthrow areas, rights-of-way, stream banks, and other disturbed open areas.[5,8] It does well on rocky substrates with shallow soils but is not limited to those areas. Occasionally establishes beneath a forest canopy.

REPRODUCTION AND PHENOLOGY

Angelica tree spreads by seed, dispersed by birds that eat the fruits.[5] There is also local spread by underground organs allowing colony formation.[9] Angelica tree sprouts profusely after cutting.[10]

IMPACTS OF THIS SPECIES

Effects on other species and habitats are poorly known. Although angelica tree is not yet forming large dense patches in our region, it is reported to form dense stands that overgrow and shade out herbs and shrubs elsewhere in its nonnative range.[7,8,9] Therefore, it is considered invasive and may be competing with native plants including rare species. For example, at one location in Bear Mountain State Park, angelica tree is colonizing rocky woodlands at the edges of stands of the regionally-rare prickly-pear cactus (*Opuntia humifusa*).[7] There are potentially some beneficial impacts of angelica tree. In Philadelphia, angelica tree was reported an important pollen source for bees.[11] Deer use the stems for buck rubs; unclear whether deer eat the plant.[9] The species is also valued and cultivated in China and Japan for edible shoots and medicinal uses. [12]

MANAGEMENT GOALS

- Practice early detection, rapid response (EDRR) to discover newly established plants and remove before larger colonies form.[9]
- Confirm identity to minimize risk of removal of native plants
    - Confirm it is a woody plant before treating to reduce risk of removing the native spikenard (*Aralia racemosa*) which could be mistaken for a young angelica tree.
    - It is likely safe to assume that a woody *Aralia* in the LH PRISM region is the nonnative angelica tree and not the native devil's walking stick.

MANAGEMENT METHODS: BIOLOGICAL CONTROL

There is no available biocontrol at this time.

Angelica tree (*Aralia elata*)

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Small seedlings can be hand-pulled when the soil is most,[2] larger stems could be pulled with a weed wrench, and multi-stemmed plants can be removed with manual/powered saw or loppers at ground level.[2] Follow up treatment to cut back shoots. It may be difficult to pull shoots from an underground network though they may appear to be seedlings. Pulling disturbs soil and may stimulate germination from the seed bank. Tamp soil firmly after pulling to minimize these effects.[8]

Mowing

A forestry mower could be tried on larger colonies. Mowing should occur frequently.

Solarizing

No information. Cutting and tarping could be tried on small colonies.

Cutting / Girdling

Although angelica tree stems are reported to resprout vigorously after cutting, we presume that if all the aboveground stems in a colony are cut frequently the underground storage organs will eventually be exhausted and the plant will die. Covering cut stumps with close-tied black plastic bags ("Buckthorn baggies") might prevent resprouting. Girdling has not been reported but should be tried, given its utility for controlling tree-of-heaven which is also a vigorously sprouting colonial tree (see LH PRISM 2025 fact sheet on this species). Deadheading (removing flowers or immature fruits to prevent ripening and dispersal of seeds) can be used as a containment measure although it will not contain potential underground expansion of the colony.

Hot Foam Spray

No information. We would not expect this technique to work on a woody plant with well-developed underground organs.

POST-TREATMENT CONSIDERATIONS

There is very little information available on non-chemical methods and carefully documented experimentation is needed. Small seedlings can be hand-pulled and larger plants cut. Although cutting angelica tree is reported to stimulate sprouting, we presume that frequently repeated cutting of an entire colony can exhaust underground storage and eventually weaken and kill the plant.

Monitoring / Follow-up

Check for resprouting and repeat treatment frequently for several years until sprouting ceases. This approach is hypothetical and needs careful testing. The entire colony must be treated as colonial plants typically are able to share resources through the rhizome network, thus non-treated (e.g., non-cut) stems can potentially continue to feed the treated portions of a colony. Angelica tree is shade-intolerant[5]; mechanical control may be more effective beneath a forest canopy.

Disposal Methods

As angelica tree is a colonial tree of non-wetland soils, we would not expect cuttings to root, but this needs to be tested. Can be chipped and composted.

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Fact sheet prepared by Erik Kiviat (Hudsonia).

MUGWORT

Artemisia vulgaris

Photo © Erik Kiviat

Photo © Erik Kiviat

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Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Herbaceous

Habitat
Terrestrial

DESCRIPTION

Artemisia vulgaris, commonly known as mugwort, is a deciduous perennial forb typically found in temperate or cold-temperate zones. It can be recognized by its distinctive smell, which is especially potent when fresh leaves are crushed.[1] This plant is often used as a spice in East Asia and in traditional medicine practices around the globe.[1] Its flowering stems grow between 3-8 feet tall and become slightly woody as they mature.[2] Mugwort usually spreads through rhizomes, forming dense colonies. However, it can display high morphological, genetic, and phytochemical variation depending on the geographic region and habitat.[1]

IDENTIFICATION FEATURES

Leaves: Uniformly distributed, alternate, simple, lobed, approximately ovate (egg shaped) although the shape is variable.[3] Leaves are bicolor with smooth to minutely hairy dark green tops and densely hairy, silvery-white undersides.[4]

Flowers: Flowers are small and symmetrical, ranging in color from greenish yellow to dark pink or red-brown, and are ovoid in shape.[5,6] They are crowned by numerous aromatic floret clusters.[6]

Growth Form: Perennial and herbaceous, growing in a simple branching pattern.[4] Mature stems are semi-woody and reddish-purple.[4] At the end of the growing season, fallen dead stems can create a deep layer of tough litter that crunches when stepped on. Mugwort tends to develop a dense mass of roots and rhizomes to almost 8 inches in depth.[7]

Mugwort (*Artemisia vulgaris*)

INTRODUCTION HISTORY

Native to Eurasia, the Middle East, and Africa where it is common both in the wild and in cultivation. Used widely for medicine in the Old World.

ECOLOGY AND HABITAT

Mugwort typically establishes in bare mineral soil and other disturbed substrates in transportation corridors, agricultural fields and pastures, wetland fill, landfill cover, turfgrass, nursery beds, woods edges, waste grounds, waterway banks, and similar habitats. It occurs in soils with a range of fertility. Some laboratory studies have found mugwort toxic (allelopathic) to other plants,[8] but this trait needs further testing in-field. The susceptibility of different habitats to invasion by mugwort, as well as the overall invasive potential of mugwort, are both variable.[9]

REPRODUCTION AND PHENOLOGY

Mugwort reproduces mainly vegetatively, by rhizomes (including from small rhizome fragments).[3,6] Although it does produce seed, few are viable and therefore, seedlings are uncommon.[2] Flowering and seeding occur from July through October.[2]

IMPACTS OF THIS SPECIES

Mugwort can form dense stands in soils intended for gardens, pollinator meadows, or crops, limiting cultivation and spontaneous establishment of native plants. Its thick mats of roots and rhizomes can dominate the soil.[10] The pollen is an airborne allergen.[11] Mugwort may be a fire hazard near structures, railroads, or solar arrays.[12–14]

Although there are few publications discussing the non-chemical treatment of mugwort, there is a large body of literature describing its potential uses and interesting ecological interactions. For example, mugwort has been experimented with as a bioenergy crop,[15] for phytoremediation of soil contaminated with cadmium,[16] and in emmenagogue, nervine, digestive, diuretic and diaphoretic herbal remedies.[6]

MANAGEMENT GOALS

- Repeat mowing over several consecutive years can reduce plant vigor and eventually control existing stands.[17–19]
- Follow management efforts with seeding or planting of competitive species such as native forbs,[17] grasses,[19] or alfalfa[20].

MANAGEMENT METHODS: BIOLOGICAL CONTROL

None reported.

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Mowing

Although published studies on mechanical management of mugwort are few and sometimes conflict,[6,9,21] several land managers in the lower Hudson Valley have reported promising results with repeated mowing of established stands.[18,19,22]

Mowing once a month from May through October for at least three years has been reported to reduce dense stands from 75-100% cover to 25-50% cover.[17,18]

Preliminary data from an informal study in Greene County, NY suggests that mowing mugwort 3–4 times per year between May and September, for at least two consecutive years, has promising results (especially in shaded areas).

- This study is ongoing, with further data and analysis expected in 2026.[22] Additional variables being assessed include the impacts of various mowing frequencies, overseeding mowed areas with native grasses, and light availability in mowed areas.[22]

In areas where repeat or early-season mowing may not be feasible, mowing should be accomplished by early September to help prevent seed maturation.[23]

Pulling / Digging Up

Long rhizomes of mature plants make pulling more difficult, whereas small plants can be pulled in spring or early summer before rhizomes form.[23]

Prescribed Fire

Information regarding this technique for mugwort control is extremely limited, but at least one study shows that dormant season fires may not affect mugwort.[21]

Because mugwort stands sometimes accumulate large amounts of semi-woody stem litter, a light fire might be beneficial to some competitors; however, the use of prescribed fire requires permits and any benefits must be balanced against the greenhouse gas emissions and particulate air pollution.[24]

Soil Tilling

Information is limited and somewhat conflicting,[7,25] but this method is generally not recommended for mugwort control. Cultivation is likely to spread and stimulate viable rhizome fragments.[7,17]

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Establishing grass (especially turfgrass)[19] or native forb[17] cover on bare soil can inhibit mugwort establishment and help suppress reinvasion after several years of mowing.[18,19,23]

- Seeds or small plugs are preferable over larger, potted plants to minimize soil disturbance.[26]
- Planting or seeding of native forbs or graminoids should not take place until bare soil becomes apparent after consistent management.[17,26] However, turfgrass may be overseeded at any point in the management process.[19]

Alfalfa inhibits mugwort allelopathically[20] and possibly could be planted in a stand of mugwort to overcome dominance.[24]

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Fact sheet prepared by Erik Kiviat, Kathryn Natale, and Andrew Leonardi (Hudsonia).

AUTUMN OLIVE

Elaeagnus umbellata

Photo © Erik Kiviat

Photo © Erik Kiviat

Biological Category
Plants

NY Legal Status
Prohibited

Species Type
Tall shrub

Habitat
Terrestrial

DESCRIPTION

Autumn olive is a shrub (or small tree) to 15 ft tall that fixes nitrogen in the soil. Leaves and twigs are covered with minute silvery scales[1] that give the plant a distinctive shiny gestalt. Autumn olive bears strongly sweet-smelling flowers.

IDENTIFICATION FEATURES

Leaves: Deciduous, simple, Alternate, petioled (with leaf stem), elliptic to ovate-oblong shape with entire margins. Leaf tops are green and smooth while leaf undersides are silvery-white with some brown and silver scales.[2]

Flowers: With four stamens (male reproductive part)[2], small, whitish, and are very sweet-smelling.

Fruit/Seeds: Edible berry-like red fruit which is dotted with silver scales.[2] Acidic taste.

Growth Form: Tall shrub or small tree to ~16 ft.[2]

Bark: Gray-brown, thorns sometimes present.[3]

SIMILAR SPECIES

Russian olive (*Elaeagnus angustifolia*) resembles autumn olive but has leaves that average narrower with a slightly different color and it grows to tree size (10m, ~33 feet).[4] Russian olive has leaves that are 3-8 times as long as they are wide, while autumn olive leaves are up to 3 times as long as they are wide.[3] Russian olive fruit are yellow to silver, while autumn olive fruit is red with silver scales[2,3]; however, the silver scales can be challenging to interpret. Russian olive appears to be quite rare in the LH PRISM region but is abundant and pestiferous in the western states.

Autumn olive (*Elaeagnus umbellata*)

INTRODUCTION HISTORY

Native to China. Introduced for ornamental planting in the 1800s.

ECOLOGY AND HABITAT

Autumn olive occurs in oldfields (post-agricultural fields), roadsides, cut-and-fill areas, abandoned mines, and other habitats, commonly where vegetation and soil have been disturbed. Tolerates infertile soils.[4] Possibly autumn olive does especially well on coarse-textured (gravelly or sandy) soils. Autumn olive is shade-intolerant.[5]

REPRODUCTION AND PHENOLOGY

Autumn olive reproduces and spreads by seed. Animals that eat the fruits are presumably the dispersal vectors. It is unclear to what extent, if any, the plant may spread locally or disperse by vegetative propagules or by rooting fragments. Not reported to be colonial. Autumn-olive sprouts after cutting or burning.[7]

IMPACTS OF THIS SPECIES

Autumn olive can abundantly colonize and occupy space that would potentially be used by native shrubs and herbs. The species fixes atmospheric nitrogen into the soil; as a result, autumn olive may be able to facilitate other invasive plants.[6] Autumn olive nitrogen fixation promoted growth of white oak. [8] A comparison of an infested and an uninfested area in Illinois detected no impact of autumn olive on small mammals.[9] Jellies for human consumption can be made from the fruits. Medicinal value was discussed by.[10]

MANAGEMENT GOALS

- Prevent or limit seed production by cutting mature trees and plant native species following cutting.[11]
- Grazing can reduce vigor of Shrubs can be cut near the ground in winter followed by aggressive grazing of stump sprouts in spring.[12,13]
- Aggressive control in sunny gaps and forest edges given the shade intolerance of autumn olive.[14]

MANAGEMENT METHODS: BIOLOGICAL CONTROL

None reported.

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Hand-pulling seedlings and shoots, with care to remove the entire root ball.[15] Mechanical removal with a backhoe to dig up the root ball.[16]

Mowing

Presumably, a forestry mower or brush hog could be used on larger stands. Frequent cutting would be necessary to deplete underground storage organs.

Cutting / Girdling

Frequent cutting (as often as sprouts form) would likely exhaust underground storage and kill the plants over time. There is no information regarding the efficacy of girdling vs. cutting. One cut promoted native tree growth, and although a combined cut-stump and herbicide treatment has been shown to result in 100% control, the cutting of mature stands appears to allow for sufficient control to promote establishment of native species within two years.[11]

Prescribed Grazing

Mixed goat and cattle grazing reduced vigor of autumn olive on a reclaimed coal mine in Virginia.[12] Webb et al. 2011 noted that leaf regrowth was significant after four to six weeks and rotational patterns should reflect this to limit the capacity for autumn olive to resprout following treatment. Management that combined cutting and livestock grazing has been successful for some practitioners: in winter, autumn olive shrubs are cut near the ground, then regrowth (stump sprouts) are grazed aggressively by sheep in spring.[13]

Hot Foam Spray

While this treatment might top-kill plants, it is unlikely to exhaust root systems.

POST-TREATMENT CONSIDERATIONS

Monitoring / Follow-up

Treated plants need to be checked for sprouting and re-treated as needed.

Disposal Methods

Unknown if cut or chipped material can root if left on the soil; this needs to be tested.

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Fact sheet prepared by Erik Kiviat (Hudsonia).

WINGED EUONYMUS

Euonymus alatus

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Biological Category
Plants

NY Legal Status
Regulated

Species Type
Shrub

Habitat
Terrestrial

DESCRIPTION

Winged euonymus (*Euonymus alatus*), also known as burning bush, is a shrub potentially reaching about 8 feet in height with opposite leaves and strongly winged twigs and branchlets. Leaves and small fleshy fruits turn brilliant red in fall.[1]

IDENTIFICATION FEATURES

Leaves: Simple, deciduous, opposite, toothed margin, with stout petiole (leaf stem). In fall, leaves turn bright red before falling.[1]

Flowers: Four parted, small, pale in color.[1]

Fruit: Smooth, orange-red, fleshy, and smooth. Fruit becomes wrinkled or rough when dried.[1] The aril opens, exposing the contrastingly-colored capsule.[2]

Twigs: Two-four conspicuous light brown corky wings.[1,3,4]

SIMILAR SPECIES

Other species in the spindle tree genus (*Euonymus*) are distinct from winged euonymus by the absence of pronounced corky wings on their branchlets.[1] Additionally, the leaves of the rest of the genus turn yellow-green to yellow or purple in the fall, which contrasts with the bright red fall leaves of winged euonymus.[1,4]

Possible confusion with seedling or sapling-size cork elm (*Ulmus thomasii*) which has alternate leaves or a stray individual of blue ash (*Fraxinus quadrangulata*) which has compound leaves. Potential confusion also with winged elm (*Ulmus alata*) and sweetgum, but these two species have twigs that are two-winged rather than four-winged.[5]

Winged euonymus (*Euonymus alatus*)

INTRODUCTION HISTORY

Native to northeastern Asia, Japan, and Central China. This species was introduced to the US in the 1860s for ornamental purposes.[6]

ECOLOGY AND HABITAT

Winged euonymus occurs along roadsides, in woods and woods edges, and other mesic and subxeric (medium moisture and dryish) habitats.[2] Tolerates a wide variety of soils.[7] The species does not seem to require much disturbance to establish and mature as is it often found in both disturbed and undisturbed forests in dense thickets.[2,8] In the Lower Hudson PRISM region, it does not typically form dense stands but most often is found as single or a few individual stems.[9] It has often been planted for ornament due to the bright red fruits and foliage in autumn.

REPRODUCTION AND PHENOLOGY

Winged euonymus reproduces by seeds spread by birds that eat the fruits. Reproductive success varies among cultivars and habitats, but purportedly non-invasive cultivars may still contribute to spread.[10] A sterile cultivar has been genetically engineered by Chen et al. (2008).[11] It can be rooted from cuttings artificially (10). Reputedly able to reproduce vegetatively but no details given.[5] Sprouts from root system following top-kill from herbicide or presumably cutting.[2]

IMPACTS OF THIS SPECIES

Winged euonymus has been a popular ornamental. This species may be in an early stage of colonization and spread in the LH PRISM region; although frequent, it rarely occurs in dense thickets.[9] Birds eat and spread the fruits.[8] As with other fleshy-fruited nonnative shrubs and vines, questions have been raised about nutritive value of the fruits to birds in fall and winter. Winged euonymus had lower spider diversity and abundance compared to native vegetation in Ohio.[12,13]

MANAGEMENT GOALS

- Prevent fruiting to control spread.
- Manage smaller plants through hand-pulling.
- Manual or mechanical cutting will likely require additional monitoring and follow-up treatments.

MANAGEMENT METHODS: BIOLOGICAL CONTROL

Application of a commercial mycoherbicide using a native fungus resulted in shorter, but not fewer, resprouts after cutting in southern Ontario[14]; the product may be licensed for use in the US.

A virus causing dieback[15] might have biocontrol potential.

MANAGEMENT METHODS: MANUAL OR MECHANICAL CONTROL

Pulling / Digging Up

Seedlings 2 ft tall or smaller can be hand-pulled.[2]

Cutting / Girdling

Pruning to remove fruits before they mature can help keep the plant from spreading where it is not desired.

Mowing

Large plants can be cut with a brush hog[8] but are likely to resprout,[15] requiring additional follow-up treatments.[16]

POST-TREATMENT CONSIDERATIONS

Disposal Methods

Either dry cut material thoroughly or place in plastic bags for disposal, with special care for fruiting material.[5]

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Fact sheet prepared by Erik Kiviat (Hudsonia).

APPENDIX A: COMPOSTING INVASIVE PLANTS – A PRACTICAL APPROACH

Disposing of invasive plant material is a major challenge, with most guidelines defaulting to landfill disposal. However, Aleks Jagiello, a seasoned composting professional and manager of Westchester County's CompostED Facility, has successfully processed invasive plants—including weed seeds, roots, and other resilient plant parts—through controlled composting methods for over a decade.

This appendix presents a composting process for invasive plants based on Aleks' expertise, offering an effective and sustainable alternative to landfill disposal.

An expert in municipal, institutional, and commercial composting, Aleks played a key role in developing, implementing, and managing Westchester County's first municipal food waste composting site, and has managed large-scale operations in both urban and rural settings. In a previous role as the Composting Operations Coordinator at the Queens Botanical Garden (QBG), he collaborated with QBG's Horticulture Department to compost invasive plant material on-site, returning the finished compost back into garden spaces onsite as well as to local community gardens.

After several years in large-scale commercial composting in the Hudson Valley, Aleks now operates CompostED, a DEC-registered municipal site in Westchester County that processes food waste from community members and food banks, reducing landfill use and disposal costs. He also provides compost training and technical support for municipalities, parks, gardens, and farms. Passionate about all things compost, Aleks has dedicated his career to refining innovative, effective composting techniques and to empowering others to do the same.

(Note: The following is intended for commercial compost operations, and is not recommend for home composting methods or "cold" piles, as efficient heat is needed to process invasive plant materials.)

Composting Process — Overview

Commercial composting operations are required to reduce pathogens in compost piles by allowing internal pile temperatures to reach 131°F for multiple days to fulfill permit requirements. This standard is referred to as the "Process to Further Reduce Pathogens", and is typically achieved through one of the following methods:

1. Windrow composting method – Compost pile needs to stay at or above 131°F for 15 days, during which it must be turned 5 times.

Or

2. Aerated static pile (ASP) method – Compost pile needs to stay at or above 131°F for 3 consecutive days.

Commercial compost piles often not only meet but surpass the base temperature and time requirements of the "Process to Further Reduce Pathogens" standard.

Composting Process — Step-By-Step

Professional composters have also developed their own unique methods for creating compost, which can lead to effective methods for disposing of invasive plant species and ensuring mortality of all viable reproductive material.

Below is the general process used by Aleks Jagiello at the CompostED facility:

Weeks 1-2 (0-14 days): The initial composting phase where the pile is made up of fresh undigested materials such as food waste, ground yard trimmings, and leaves.

- Ground yard trimmings improve porosity, allowing airflow and oxygen to the pile.
- This mix ensures a good carbon-to-nitrogen ratio, and moisture is added if needed.
- A forced aeration system is used to maintain high oxygen levels and stimulate biology within the compost heap.
- After 3 days, the core of the pile reaches around 160°F, with approximately 90% of the material at > 140°F.
- A core temperature of 160°F is maintained for 11 more days, while the outside and bottom remain cooler.

Weeks 3-4 (15-28 days): Mixing of compost allows outside material to gain access to optimal composting conditions in the core of the pile.

- Compost material is removed from bay and is thoroughly mixed/blended which restores porosity of the pile.
- Temperatures may rise to 175°F, which should be prevented by blowing more air into the pile with the ASP system to cool it down. The optimal core temperature is approximately 160°F.
- The pile maintains an average temperature of 155°F for the next 2 weeks.

Weeks 5-6 (29-42 days): Mixing of pile.

- Remix pile again after 28 days to give biology access to new material and restore porosity.
- Materials should stay at an average temperature of 145°F for the next 2 weeks.

Weeks 6-12 (43-84 days): Turning/ “curing”

- Turn compost pile every two weeks.
- No additional aeration from ASP system needed at this point.
- Average temperatures will vary by season, with summer temperatures of about 155°F, and winter temperatures a bit lower.

Additional Comments on This Process

- The average compost heap average temperature is about 150°F for 6 consecutive weeks, with 3 turns, followed by temperatures above 131°F for another 6 weeks with at least 3 turns.
- The consistent high temperatures ensure all materials spend significant time in very hot conditions.
- Weed seeds' viability is impacted by temperature, time, and moisture, but long-term biological degradation also plays a key role in reducing their viability.

Not all commercial compost operations will manage materials so meticulously, but will at the very least aim for higher temperatures (131–160°F) for rapid degradation. This is especially true when processing food waste and ground yard trimmings, which are typically accepted, and which promote high temperatures for effective material breakdown.

Metrics Tested in a Typical Commercial Compost Analysis (Prior to Distribution of Finished Compost):

Compost stability –

- Respiration by soil microbes and is reported in mg CO2-C or g OM/day

Compost maturity –

- Ammonia nitrogen:nitrate N
- Ammonia nitrogen ppm
- Nitrate N ppm
- Cucumber emergence

Compost safe regarding health –

- Fecal coliform (bacteria)
- Salmonella
- Metals

Compost providing nutrients or organic matter –

- Nutrients (N + P2O5 + K2O)
- AgIndex (Nutrients/sodium and chloride salts
- Plant available nitrogen (PAN)
- Carbon to nitrogen (C/N) ratio
- Soluble available nutrients and salts
- Lime content (CaCO3)

Physical properties of compost –

- Percent ash
- Sieve size percent > 6.3 MM (0.25 inches)