



Managing Invasive Exotic Plant Species on Legacy Mine Lands

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More than 2 million acres have been surface mined in the Appalachians (Zipper et al. 2011; OSMRE). Today, many mining firms are attempting to establish functional forests as a post-mining land use. However, many of the lands that were surface-mined for coal and reclaimed to meet legal standards in the past do not support thriving forest ecosystems. These lands, referred to as “legacy” surface mines (Burger et al. 2013), are often dominated by invasive exotic plant species (IES) which can interfere with successful reforestation (Zipper et al. 2011b). This advisory explains the issues related to IES plants on legacy mine sites. It also presents guidance on methods to combat and control the spread of IES to ensure successful reforestation. Finally, it describes characteristics of some exotic invasive plant species that are problematic on mine sites (see Appendix).

What are invasive exotic plant species?

“Exotic” plants are species that are not native to a given ecosystem. Many of the exotic species found on Appalachian mines are native to Europe and Asia. The term “invasive” describes species that are able to rapidly invade local ecosystems when introduced accidentally or even on purpose. These invasive species are able to spread quickly through a variety of mechanisms:

- Movement of seeds by wind (e.g., tree of heaven, princess tree; see the Appendix for scientific names)
- Movement of seeds by wildlife that ingest seed-bearing fruits or seeds and deposit the viable seed in other locations (e.g., autumn olive, multiflora rose, bush honeysuckle)
- Movement of seeds by flowing water (e.g., Oriental bittersweet, mile-a-minute vine)

- Movement of rhizomes or other viable plant-parts by flowing water (e.g. Japanese knotweed)
- Movement of seeds by physical attachment to wildlife or humans for deposition at other locations (e.g., Japanese stiltgrass, Johnsongrass)
- Vegetative dispersal through root or shoot extensions (e.g., kudzu, Japanese honeysuckle, Chinese silvergrass).

Why are invasive plants a concern on reclaimed mine lands?

Unvegetated or newly reclaimed surface mine sites afford readily accessible land for colonization by aggressive pioneer plants. Hence the need to quickly revegetate mined sites with desirable species, rather than leaving them open for IES plants. The presence of IES on reclaimed mines is not consistent with ARRI’s goal of establishing plant communities similar to native Appalachian forests. IES are of particular concern because they may:

- prevent establishment of native plant communities (Stinson et al. 2006, Flory and Clay 2010);
- permanently decrease biodiversity and wildlife habitat (Sax and Gaines 2008);
- alter ecological processes such as nutrient cycling (Weidenhamer and Callaway 2010);
- create extreme fire hazards to forests and homes;
- harbor exotic invasive insects and pathogens (Liebhold et al. 2012).

Finally, many IES plants can persist in the understory of developing forests, continuing to threaten successful reforestation over time (Miller et al. 2013). Once IES become

established, they are difficult to eradicate. Therefore, it is best to prevent establishment of IES and to manage IES in the early stages of invasion before they become well-established. However, this is not always feasible, particularly on legacy and abandoned mine land properties.

Guidance for IES on Legacy Mines

Control of competing vegetation, much of which is IES, will be essential on virtually all legacy mines targeted for reforestation. Methods for successful control of IES on legacy mine sites will be site-specific. In some cases, a single species may require eradication while other vegetation is retained. In other cases, all the vegetation may need to be removed so the site can be reforested. In each instance, land managers should start with a reforestation plan carefully designed for the specific needs of the given site.

On legacy mines, there are 4 steps to successful reforestation, as described by Burger et al. (2013):

1. Plan: Assess the site and develop a plan.
2. Prepare the site for planting.
3. Plant native trees.
4. Protect the planted trees.

Dealing with IES involves planning, appropriate site preparation, and protection of the planted trees. We discuss these briefly here.

PLAN: Assess the Site and Develop a Plan

The first step is to develop a reforestation plan or strategy by assessing site conditions. Land managers should visit the site, assess vegetation, soil, and site conditions, and develop a vegetation management strategy that will enable planted trees to become established. It is important to know which IES are present because they often have different growth, competition and reproductive strategies. An important part of the planning

process is to identify site-specific challenges (such as IES, compacted soil, poor nutrient and chemical conditions) and to develop strategies for mitigating them.

Prepare the Mined Site for Planting

Competing non-forest vegetation, especially IES, must be controlled; otherwise, it may outcompete planted trees for sunlight, water, and nutrients. A variety of control methods are available for removing IES plants (see below). It may require a combination of methods or repeated treatments to reach an adequate level of control. Vegetation control should generally be performed prior to deep tillage and tree planting for best results.

Protect Planted Trees

Young trees are vulnerable and may need additional protection after planting. A primary threat is competing vegetation that prevents seedlings from accessing sunlight, water, and soil nutrients. Also, rodents may be attracted and sheltered by heavy herbaceous vegetation; they can kill the trees by girdling or de-barking them as a winter food source. If herbaceous vegetation is not killed prior to tree planting, it is still possible for the planted trees to be successful as long as post-planting vegetation control is properly applied in a timely manner (as described below).

Control Methods

A variety of methods exist to control IES plants where they are already established and are a threat to reforestation success. Below, we provide descriptions of some of these control methods, along with some recommendations about timing.

Chemical Herbicide

Applications of chemical herbicides to control IES can be either targeted or broadcast. Targeted application focuses on specific plants

or patches of plants to be killed and is best used when desired native species are intermixed with IES at a site. Targeting specific plants allows the manager to remove undesired species while leaving the desired species to grow. Popular methods for selective chemical treatment are basal bark spray, hack-and-squirt (Figure 1), cut-stump, foliar spray, and soil treatment at the base of unwanted species. Note that many of these treatments are ineffective if applied in the spring.



Figure 1. Hack-and-squirt herbicide application method to remove undesirable woody vegetation. A cut is made in the stem with a hatchet, and the herbicide is sprayed into the cut (Kochenderfer et al. 2012).

Box 1. Herbicide Safety

When using herbicides, read and follow all instructions on the label. A pesticide applicator license may be required by law in some instances. The following precautions should be taken when selecting and handling herbicides:

- Select the appropriate herbicide for the specific job. It is important to carefully read labels for information on specific uses and proper application types. Some herbicides are designed for specific jobs or landscapes (e.g., Rodeo for aquatic habitats).
- Follow all guidelines for proper handling and mixing of herbicides. The labels give dilution instructions including the correct ratio of chemical to water for specific application types
- Carry copies of all herbicide labels and safety precautions.
- An eyewash station should be accessible in case herbicide is splashed into eyes.
- Operators should wear proper personal protective equipment, including gloves, eye protection, dust mask, and protective clothing to prevent herbicide contact, and should carry a clean change of clothes for when the treatment is completed. Hands must be thoroughly washed before eating, smoking, or leaving the work site.

Broadcast treatments are used when all the plants in an entire area must be killed to allow for planting or re-growth of desired species. Broadcast treatment can be sprayed either on foliage or soil, and can be done using a hand or backpack sprayer for smaller jobs or using ATVs (Figure 2), tractors, or even aircraft for larger areas. Broadcast applications can be used with specific herbicides that are selective for broadleaves vs. grasses to tailor control.



Figure 2. An ATV is used to broadcast-spray an herbicide to control a variety of IES on a legacy surface-mine site.

Manual Methods

Manual IES removal involves hand-pulling or cutting with hand tools to eradicate vegetation. It is a labor- and time-intensive strategy. Manual methods are best when removing small species or vine-like plants that may tangle in equipment, or when targeting a particular species within a mix of desired native species. Manual removal generally minimizes disturbance of surrounding vegetation on the site. However, it may be less effective than chemical control, particularly if it removes only aboveground parts of the plant or stimulates dispersal of seeds or vegetative propagules; and it may require repeated treatments or combination with chemical methods to be effective.

Mechanical Methods

Mechanical IES control refers to any method that involves the use of equipment to remove plants. Forms of mechanical control are chainsaw or brushsaw removal, girdling, mowing, tilling, bulldozing, and mulching (Figure 3). It may be necessary to follow up mechanical techniques with an herbicide treatment. For example, removal of woody vegetation using a chain saw will often require a follow-up “cut-stump” treatment with a strong herbicide to minimize sprouting from the cut stump or from lateral roots. This treatment is best when the goal is to remove woody IES mixed with desired native vegetation. Girdling is another method used to kill undesirable woody vegetation. By cutting the bark and cambium around the base of a plant in order to stop flow of water and nutrients within the plant, this method essentially starves the plant and it dies over time. This method does not work on all species, however, because it may stimulate root sprouting (many IES are prolific root sprouters). Also, mechanical removal in the fall is ineffective for many IES species, so timing is an important consideration.



Figure 3. Chainsaws can be used to selectively remove above-ground parts of IES trees and shrubs, such as the autumn olive (silvery leaves) in the above photo. Successful treatment requires a follow-up herbicide application (cut-stump treatment) to kill the roots.

Mowing, tilling, bulldozing, and mulching methods are best used when the goal is to remove all undesirable vegetation from a given area in order to start fresh re-growth of desired species. These methods have the potential to spread seed or root shoots, so careful consideration of the particular plants and their regeneration ability is critical. Tilling may also promote germination of IES seeds in the soil. Tilling twice, a month apart in the spring, can reduce IES, as the first stimulates seed germination and the second kills young plants before they become established. Typically, a plant that regenerates by root suckers should not be mulched, dug, or tilled because the process will spread root fragments which can sprout new stems. Careful understanding of the landscape, the plant species present, and the desired outcome is necessary before implementing mechanical IES control.

Aggressive IES grasses, legumes and shrubs such as fescue, lespedeza, and autumn olive were widely distributed in the past before their use on mine sites was discouraged. Because the sources of seed from these plants are so widespread and because of their highly invasive nature, they are especially problematic on legacy mine sites. Many commonly available herbicides can kill fescue, lespedeza, and autumn olive and provide a short window for planted tree seedlings to get a start. However, the use of herbicide against these species and certain other IES has been shown to provide limited control where there are copious amounts of seed and live root propagules in the soil which can germinate and outcompete the tree seedlings.

One way to address this problem is a follow-up IES control after tree planting by spot-spraying herbicide as needed to protect the growing trees; when this strategy is used, multiple spot-spray applications may be required, in some cases over multiple years. As another strategy, forestry reclamation practitioners in Kentucky and Ohio have experienced success by scraping

the vegetative cover, roots and seedbank down to the bare mineral soil and pushing it up into windrows on the periphery of the disturbed area with a D-6 or equivalent bulldozer (Figure 4). The bare mineral soil is then cross-ripped to alleviate compaction and planted with trees (Burger et al. 2013). Windrows can be treated with herbicide, if necessary, or planted to native trees. The windrows around the disturbed area range in height from 4 to 8 feet and can provide the added benefit of reducing erosion from the planting site. Although this method is an added expense, it significantly reduces or eliminates herbicide use and has demonstrated some success as an initial step in controlling IES when reforesting legacy mine sites.



Figure 4. A bulldozer is scraping IES off a site in preparation for tree-planting. This approach may reduce future IES pressure by removing much of the soil seedbank.

Prescribed Burning

Prescribed burning is the controlled use of fire to remove undesirable vegetation including IES or to create a proper growing environment for desired native species (Figure 5). Burning can be a relatively inexpensive form of vegetation control; however, it is not without risks. Prescribed burning can only be done under certain moisture and wind conditions and may require permitting from state or local agencies. Prescribed burning should only be performed by experienced crews, in accordance with all

state and local laws and regulations, and with all applicable permits and approvals.

Prescribed fire can kill and remove the top growth of plants and consume some IES seeds in the litter layer. However, root sprouting vegetation is very hard to control using prescribed fire. The disturbance generally kills the aboveground stems but roots remain healthy and can sprout and outcompete desired vegetation (even newly planted stock) on disturbed sites. Burning may also create an ideal seedbed for germination of some IES. It may be necessary to follow-up burn treatments with an herbicide application should re-growth occur. Alternatively, burning repeatedly for 2-3 years can be effective at controlling cool season grasses such as fescue.



Figure 5. Prescribed fire in eastern Kentucky.

Biological Control

Biological IES control uses living organisms to kill or control the spread of unwanted plant species. These methods include the use of livestock grazing or insect and pathogen release. Livestock such as goats, cows, sheep, and horses can be used to reduce IES infestations by grazing on above-ground vegetation and seeds. One benefit of this method is that soil, particularly poor-quality mine soils, can be fertilized by manure being naturally applied by livestock. However, this method is only possible if the IES targeted is

palatable and nontoxic to the animal, the survival of other vegetation is not desired, and the area is fenced. Livestock may eat and trample all vegetation in the grazing grounds, or they may select native species over IES. Careful management is necessary to prevent overgrazing which leaves soils vulnerable to erosion, or compaction. Also, it is important to be aware that the livestock themselves may disperse seeds of certain species through consumption and subsequent defecation. In such cases, additional treatment to control the invasive plants may be necessary following the livestock grazing.

Biological control through release of insects or pathogens is rarely used in wildland settings. The introduced insect or pathogen targets specific plants for which a natural predator or control does not exist, to reduce the infestation of IES. One successful example is the use of weevil species to control two species of knapweed (*Centaurea*; Seastadt 2015) in the western U.S. However, this method requires a great deal of research and monitoring over many years. The costs make it impractical on most mined lands, and it is necessary to consult with a specialist when considering this method. Methods using insect or pathogen control are not known for the IES commonly found on legacy mines in Appalachia.

Mulching and Solarization

For these IES control techniques, materials are placed on the land surface, covering both soil and plants, blocking light and thereby preventing successful IES germination. Chipped wood mulch can be used to cover small areas, but would be impractical for larger areas. Solarization uses dark plastic sheeting to cover low-growing IES plants. The sheeting can block out sunlight, preventing germination, but it can also trap solar energy to heat the soil and air beneath the sheet, further suppressing vegetation. This method is useful as a first treatment of small areas where herbicides cannot be used (Miller et al. 2013).

Summary

An effective IES control plan for legacy-mine reforestation will prepare an area for the release and growth of native plant species. The goal is control of IES, not necessarily eradication, to allow forests to regenerate successfully. Once native species become established, there will be less maintenance, greater diversity, and greater soil building potential for that site. Successful establishment and growth of native trees will cause shading of the land surface and suppress growth of sun-loving IES.

Before enacting control practices, the IES present on the site, as well as appropriate control methods for the given IES, must be identified. Developing an IES control plan as part of the reforestation plan will ensure that suitable native species are planted (and IES are not introduced to the site) and that IES control practices are matched to the IES of concern.

Finally, when implementing IES control practices, safety should always be a top priority (See Box 1). Appropriate personal protective equipment for the given activity must be worn, and directions for use of tools and chemicals must be carefully read before beginning work. A proper understanding not only protects workers from harm, but also reduces the risk of environmental damage and improves the chance of successful IES control and mine-site reforestation.

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Acknowledgements

Scientists from the following universities and organizations contributed to this Forest Reclamation Advisory: American Bird Conservancy, Berea College, Green Forests Work, Indiana University of Pennsylvania, Ohio State University, Purdue University, Southern Illinois University, Stephen F. Austin University, The American Chestnut Foundation, US Forest Service, US Geological Survey, US Office of Surface Mining Reclamation and Enforcement, University of Kentucky, University of Maryland, University of Tennessee, Virginia Tech, West Virginia University and Wilkes University.

Photo credits: Figure 1: USDA Forest Service. Figures 2, 3, 4 and 5: Green Forests Work. Figure 6: University of Kentucky, Agricultural Communications Service.

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All chemical pesticides have the potential for environmental and health impacts. Recent statements of concern (e.g. Myers et al. 2016 for glyphosate based herbicides) should be consulted when deciding whether to use chemicals.

Appendix:
Profiles of selected invasive exotic plants of concern to reforestation of Appalachian mine sites

Trees

Silktree or mimosa (*Albizia julibrissin*)

- Deciduous legume, 10-50 ft tall. Introduced in late 1700s as an ornamental and still planted today.

Spreads:

- Abundant seeds are dispersed by animals, water, gravity and wind. The papery seed will easily float and blow up to 300 ft in the wind. Very young trees can produce seed and seeds will remain viable for 5 years to decades. Thick colonies can also form via root sprouts.

Control:

- Make stem injections of herbicide (Pathway, Arsenal) in midsummer. Saplings and seedlings can either be sprayed on the basal bark or leaves before seed formation. Cutting or pulling seedlings can result in sprouting, so apply herbicide along with cutting or pulling methods. Fire is ineffective.

Comments:

- Particularly common in oak/hickory forests and in floodplains and along waterways. It establishes quickly and vigorously. Fixes nitrogen.

Additional Information:

- <http://www.fs.fed.us/database/feis/plants/tree/albjul/all.html>

Tree of heaven (*Ailanthus altissima*)

- Deciduous, up to 80 ft tall. First introduced in late 1700s as an ornamental and continued to be sold in nurseries until the 1900s.

Spreads:

- Prolific large winged seeds dispersed by wind up to 350 ft from tree. It will produce seed within 3 years of growth. Commonly root suckers, especially in response to breakage or damage to the main stem. Early growth is vigorous.

Control:

- Target female, seed producing plants first. Make stem injections of herbicide (Pathway, Arsenal) in midsummer. Saplings and seedlings can either be sprayed on the basal bark or leaves before seed formation. Cutting or pulling seedlings leaves surface roots that will sprout, so apply herbicide along with cutting or pulling methods. Fire is ineffective, but will kill young saplings.

Comments:

- Leaves look similar to sumac and walnut but have a strong unpleasant odor described as cat urine or rotting peanuts. Its prolific seeding can create dense stands that will push out native vegetation. It has been found to be allelopathic and affects the growth of other plants.
- Drought tolerant.
- Sap may cause irritation through contact with the skin, and sap in the bloodstream is a danger to those with a cardiac condition.

Additional Information:

- <http://www.nps.gov/plants/alien/pubs/midatlantic/aial.htm>

Princess tree or Paulownia (*Paulownia tomentosa*)

- Deciduous, 30-60 ft tall. Introduced in the mid- 1800s for ornamental and timber. It is highly prized for wood carving.

Spreads:

- Abundant winged seed transported long distances by wind, water, and gravity. Seeds germinate easily and tree grows quickly to produce flowers within 5-10 years. Also colonizes by root sprouts.

Control:

- Young trees can be pulled by hand. Larger trees can be cut to a stump before seed formation (late spring) to prevent distribution and herbicide (Arsenal, Garlon, glyphosate) can be directly applied to the stump immediately following the cut. Basal spray and stem injections of herbicide are also effective. Sprouts and seedlings can be treated with a foliar spray of herbicide.

Comments:

- It is fire tolerant and will invade widely after a fire and other disturbances. It forms colonies from prolific sprouts that can quickly shade out native plants.

Additional Information:

- <http://www.nps.gov/plants/alien/pubs/midatlantic/pato.htm>

Sawtooth oak (*Quercus acutissima*)

- Deciduous tree, up to 50 ft tall. Native to Asia, it has been widely planted in the United States as an ornamental and as food for wildlife, and for land reclamation.

Spreads:

- It spreads by abundant seed, and it readily seeds into woodland edges, meadow habitats, and open areas. Sawtooth oak successfully establishes in edge habitats that are not managed by mowing or other woody plant control.

Control:

- With regular, annual, and semiannual mowing, it does not seem to persist. If not mowed, however, it is fast growing, tolerant of a wide range of moisture and temperature conditions, and can become a troublesome invasive.

Additional Information:

- <https://www.invasiveplantatlas.org/subject.html?sub=10086>

Shrubs

Autumn olive (*Elaeagnus umbellata*)

- Bushy, 3-20 ft tall. Introduced in 1830 as an ornamental, for wildlife habitat and forage, as windbreaks, and for land reclamation. Is still widely used today for mine reclamation.

Spreads:

- Berries are produced in the fall and dispersed by birds and mammals in droppings. Basal sprouts can produce a small dense thicket.

Control:

- Thorny sprouts and stems make it difficult to cut or pull. Top cutting and spraying is most effective and can be done with a mulcher, chainsaw, or handsaw depending on the size of the stand. Coat stumps with herbicide (Garlon, Pathfinder, Arsenal, Tordon, glyphosate) immediately following cutting. Foliar spray with herbicide (Arsenal, Vanquish, Garlon) from April to October if plants are not too big.

Comments:

- It puts leaves on early in the season and keeps them into late fall. This gives it the ability to shade out shrubs and tree saplings. Its dense thickets reduce available sunlight and nutrients for native vegetation.
- Drought tolerant.

Additional Information:

- <http://www.nps.gov/plants/alien/pubs/midatlantic/elum.htm>

Shrubby lespedeza (*Lespedeza bicolor*)

- Bushy, 3-10 ft tall. Introduced in mid- 1800s as an ornamental and later used widely for erosion control and wildlife forage and habitat.

Spreads:

- Prolific seeder that can produce seed by 3 years of age. Seed dispersal occurs mostly by gravity, but seeds remain viable for up to 20 years. Monitoring and control is required for many years after removal. It can also sprout from roots when top stems are disturbed.

Control:

- Foliar spray with herbicide (Milestone, Garlon, Escort, glyphosate) is best and should be done before seed production. Mowing or mulching months before herbicide application can help control. Do not mow or mulch during seed production as it will spread seed. Burn treatments have been known to worsen infestations.

Comments:

- It forms dense stands that can prevent native plant growth. It spreads very quickly and may continue to return due to seed remaining viable for up to 20 years.
- Fixes nitrogen.

Additional Information:

- <http://www.fs.fed.us/database/feis/plants/shrub/lesbic/all.html>

Amur (bush) honeysuckle (*Lonicera maackii*)

- Branching and bushy, 6-15 ft tall. Used as an ornamental and for wildlife habitat and erosion control.

Spreads:

- Produces many low-nutrition berries, which are dispersed widely by birds and some mammals in droppings. The seed remains viable for a long time. Root sprouts are very aggressive even following herbicide treatment.

Control:

- Foliar spray with herbicide (glyphosate, Garlon) from spring to fall. Cutting or mulching helps remove the heavy cover of woody stems. Immediately coat stumps with herbicide (glyphosate, Pathfinder). Basal sprouting will likely still occur following treatment. Continued maintenance in the future will be necessary to completely control.

Comments:

- It can rapidly invade and overtake areas, forming dense thickets. It greatly reduces light availability and has allelopathic activity. Together these characteristics prevent any vegetation from growing beneath its canopy and surface erosion is likely. It closely resembles native honeysuckle, so take care to properly identify.

Additional Information:

- http://www.na.fs.fed.us/fhp/invasive_plants/weeds/bush_honeysuckle.pdf

Multiflora rose (*Rosa multiflora*)

- Thorny sprawling shrub, up to 15 ft tall. Used as an ornamental and for erosion control and as a living fence for livestock.

Spreads:

- Wildlife, especially birds, eats the fruit and disperse the abundant seeds in droppings. Seed remains viable for up to 20 years. Vine tips can root into the ground and create a new plant.

Control:

- Manual cutting or mowing several times a season for a few years. Digging or tilling and fire can also suppress it. Cutting should be done when fruit is not present. Foliar spray with herbicide (Escort, Arsenal, glyphosate) from May to October with repeated applications. It can also be cut to a stump and treated with herbicide.

Comments:

- It is an aggressive grower that can sometimes climb other vegetation, overtaking it. It inhibits native trees, shrubs, and groundcover and can make animal movement difficult by forming dense thickets. It can tolerate most environmental conditions and grow in dense thickets.

Additional Information:

- <http://www.nps.gov/plants/alien/pubs/midatlantic/romu.htm>
<http://na.fs.fed.us/spfo/invasiveplants/factsheets/pdf/multiflora-rose.pdf>

Forbs

Japanese knotweed (*Fallopia japonica*)

- Cane-like shrub, 3-12 ft tall. Introduced for ornamental plantings and erosion control

Spreads:

- Along streams by stem and root fragments and seeds remain in waterway habitat.

Control:

- Foliar spray with herbicide (Garlon 3A, glyphosate, Arsenal, Tordon) after July 1st. A fall application is most effective, but spraying before seed production is recommended. For taller stems, cutting back to 2 inches tall, or to a stump, and coating the stump tops with herbicide (glyphosate, Garlon, Enforcer Brush Killer and Vine-X) is best.
- A combination of spring cutting, followed by foliar application of herbicide in the autumn, may also provide good control.

Comments:

- It is very tolerant of many environmental conditions and can form dense thickets that suppress native vegetation. The ground below its thickets usually does not support other vegetation. and the exposed soil is prone to erosion.
- It is important to protect water quality by using a herbicide labelled for use near waterways

Additional Information:

- http://www.nyis.info/index.php?action=invasive_detail&id=43
<http://www.dnr.state.mn.us/invasives/terrestrialplants/herbaceous/japaneseknotweed.html>

Sericea, or Chinese, lespedeza (*Lespedeza cuneata*)

- Upright legume, 6 ft tall. Planted for wildlife cover, forage, erosion control, and mine reclamation because it provides wildlife food and cover and fixes nitrogen

Spreads:

- Produces abundant seeds that are spread by birds, ants, rodents, and larger mammals. Humans disperse seed, especially by mowing. Seed can remain viable in the seedbank for up to 20 years.

Control:

- Manually pull when soil is moist to remove the roots. Foliar spray with herbicide (Garlon, Escort XP, Transline, glyphosate or Velpar L) from July to August. Mowing months before herbicide application can help.

Comments:

- It forms dense stands that prevent native growth, and contributes to reduced diversity, which is less attractive to wildlife. It has also been found to limit the growth of existing vegetation and may be allelopathic. Once established it is persistent and hard to eradicate. Prescribed burning can spread the seed. Nitrogen fixer.

Additional Information:

- <https://www.se-eppc.org/manual/LECU.html>

White sweet clover (*Melilotus alba*)

- Reason for original introduction is unclear. It was promoted by beekeepers as a honey plant, was embraced as a soil building crop and erosion reducer, and planted for livestock and wildlife forage.

Spreads:

- Produces abundant seeds that remain viable in the soil for up to 80 years. Seeds are dispersed by gravity, water, and animals. The seed must be scarified to germinate best, so burning and grazing are not effective control methods. Freely resprouts following a cutting or grazing.

Control:

- Results of control methods have been mixed. Mowing can control the spread, but several treatments will be necessary each year until the seedbank is exhausted. Burning provided similar results, and both methods have the potential to spread more seed depending on intensity of treatment and the time of year. All treatments should occur in spring before flower development. Foliar spray of herbicide is most effective on new sprouts and several treatments each year will also be necessary for control. A mixture of control methods is recommended.

Comments:

- Degrades grassland and streamside communities by overshadowing native species and forming large single-species patches. This creates the potential for lower animal and plant species diversity.

Additional Information:

- <http://www.fs.fed.us/database/feis/plants/forb/melspp/all.html>

Grasses

Japanese stiltgrass (*Microstegium vimineum*)

- Annual, mat-forming grass, up to 3 ft tall. Introduced in early 20th century packing material, and the seeds likely escaped

Spreads:

- Found mainly along floodplains and streamsides because seed is distributed by water. Seeds remain viable for at least three years and thrive following disturbance. Can also spread by hitchhiking and by rooting at joints along the stem

Control:

- Foliar spray with herbicide in early summer. Spray for up to several years to control for seeds in the seedbank. Mowing or weeding before seed set and herbicide treatment can help control an abundant seedbank. Fire is ineffective because of the seedbank. Not preferred by grazers such as deer, goats and horses. It has a shallow root and can be pulled easily.

Comments:

- Grows in full sun to deep shade. It threatens native vegetation, outcompeting via dense patches in both full sun and shaded environments.

Additional Information:

- http://www.nyis.info/index.php?action=invasive_detail&id=32

Chinese silvergrass (*Miscanthus sinensis*)

- Dense grass, 5-10 ft tall. Introduced as an ornamental plant.

Spreads:

- Primarily through underground roots with sprouts in mid spring.

Control:

- Foliar or soil spray with herbicide (Arsenal, glyphosate) while plant is actively growing. Applications may need repeated when new growth reaches approximately 2 feet. Mowing or tilling will likely spread root sprouts further.

Comments:

- It is typically found in large tufts from one central clump and displaces native vegetation. Heavy seed heads cause it to droop. It is very flammable and a fire hazard.

Additional Information:

- <https://dnr.state.il.us/Stewardship/cd/eppc/MISI.html>

Tall fescue (*Schendonorus arundinaceus*)

- Cool-season grass, 2-4 ft tall. Introduced for soil stabilization and forage.

Spreads:

- Expanding root crowns and somewhat by dropped seeds.
- Not all cultivars are invasive.

Control:

- Foliar spray with herbicide (e.g. glyphosate, Arsenal, Plateau, Journey) in spring when plants are young to prevent seed formation. Can be burned in early spring to promote native warm-season grasses.

Comments:

- Poor habitat for wildlife, especially ground nesting birds. Known to diminish biological diversity of soil organisms, insects, plants, birds, and mammals. Does not supply proper food and cover for many species because seeds are inadequate and dense root mats formed at the soil surface reduce birds' ability to scratch for food. It has also been known to reduce reproduction rates in livestock.

Additional Information

- <https://www.invasiveplantatlas.org/subject.html?sub=3037http>

Johnsongrass (*Sorghum halepense*)

- Warm-season grass, 3-8 ft tall. Introduced for ornamental purposes and as forage.

Spreads:

- Abundant, tiny, blackish seeds in the fall and can colonize by root sprouts. It spreads along roadsides and fence lines by mowing and weed eating and strong winds. Seed 'explodes' when disturbed and distributes readily and remains viable for several years.

Control:

- Foliar spray with herbicide (Outrider, Plateau, Journey, glyphosate) from June to October, applying multiple times to regrowth. Treat first when plants are young (~June) before seed formation. Can be burned to prevent root growth and sprouts.

Comments:

- Grass grows in patches and flowers in late July. It has caused millions of dollars in lost agricultural production by reducing yields and outcompeting desirable plants. Known to be a host to many crop-damaging insects and microorganisms and produces allelopathic toxins. Can be toxic to grazing animals after drought or frost.

Additional Information:

- <http://www.fs.fed.us/database/feis/plants/graminoid/sorhal/all.html>

Vines

Mile-a-minute vine (*Polygonum perfoliatum*)

- Annual, herbaceous spined vine. Accidentally introduced in 1930 via contaminated holly seed.

Spreads

- Wildlife, especially birds, eat the fruit and disperse the abundantly produced seeds in droppings. The seeds can float for over a week and travel long distances in water. It can produce seeds from June to October which can remain viable for up to 6 years.

Control

- Hand pulling and mowing can be done in the spring before fruit formation and can be repeated for greater affect. Foliar spray with herbicide before fruit appears.

Comments

- It can choke out, or girdle, stems and trunks of trees, and sometimes it can be so heavy it uproots the plant it is covering. It can grow up to 6 inches per day.
- Biocontrol releases have been partly successful.

Additional Information:

- http://www.nyis.info/index.php?action=invasive_detail&id=31
http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_010249.pdf

Kudzu (*Pueraria montana*)

- Trailing, mat-forming legume vine, 35-100 ft tall. Introduced in late 1800s as a forage crop. Mid-1900s prescribed to reduce soil erosion and planted widely by the Civilian Conservation Corps.

Spreads:

- Vines take root at the leaf and stem junction forming new plants. The seed is spread by wind, animal browsing and water, but is not as effective as stems rooting at the nodes.

Control:

- Thorough foliar spray with herbicide (Tordon, Escort, Milestone, Transline, Garlon, glyphosate) from June to October. Spraying may take place multiple times per year and is most effective on young vines. Larger vines can be controlled with basal spray or stem injections of herbicides. Prescribed grazing can reduce its spread. For large infestations, all treatments will need to be repeated for many years and vines must be cut back often.

Comments:

- It creates a solid blanket of leaves that can climb and cover native vegetation. It can choke out, or girdle, stems and trunks of trees and sometimes it can be so heavy it uproots the plant it is covering. Its large mats can extend up to 60 ft per season.
- Spread is somewhat limited by cold winter temperatures

Additional Information:

- <http://www.nps.gov/plants/alien/fact/pumo1.htm>

Japanese honeysuckle (*Lonicera japonica*)

- Semi-evergreen woody vine, trailing to 80 ft. Introduced in early to mid- 1800s as an ornamental, for erosion control, wildlife forage and cover.

Spreads:

- Creates a large woody root that branches out. Vines take root at the leaf and stem junction when under leaf litter and moist conditions. Animals eat the seeds and disperse seeds in droppings, but this method is less effective than spreading by stolons. Seedbank survival is less than 2 years.

Control:

- Foliar spray with herbicide (Escort, glyphosate, Garlon) from June to October. Vines can also be girdled or cut at the stump during the growing season and coated with herbicide.

Comments:

- It grows up trees, wrapping itself around the trunk and spreading across branches, competing for sunlight and water. Smothering other plants causes it to be hard to compete with. Its semi-evergreen nature gives it an early advantage on other species.

Additional Information:

- http://www.fcps.edu/islandcreekes/ecology/japanese_honeysuckle.htm
<http://www.nps.gov/plants/alien/fact/loja1.htm>

Oriental bittersweet (*Celastrus orbiculatus*)

- Deciduous woody vine, height up to 60 ft. Introduced in the 1860s as an ornamental and for erosion control .

Spreads:

- A serious threat to plant communities due to its high reproductive rate, long range dispersal ability to spread by woody stolons which can root at the nodes. Birds and other wildlife eat the fruit and distribute the seeds.

Control:

- Mechanical control is possible, but requires frequent repetition (several times a year).
- The cut-stump treatment (with glyphosate and triclopyr) is most successful, but repeat applications may be needed. Foliar spraying of large infestations may be the most economical means of control.

Comments:

- Oriental bittersweet is shade tolerant, surviving well under a closed forest canopy.
- Climbing vines severely damage native vegetation by constricting and girdling stems. Vines can shade, suppress, and ultimately kill native vegetation.

Additional Information:

- <https://www.invasiveplantatlas.org/subject.html?sub=3012>
- <https://www.invasive.org/eastern/srs/OAB.html>