Strategies for Controlling Invasive Plants in the Finger Lakes

A Project Guide for Problematic Plants of the Region

Terrestrial Edition

HOBART AND WILLIAM SMITH COLLEGES

FINGER LAKES INSTITUTE

FINGER LAKES PRISM
Partnership for Regional Invasive Species Management

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

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Authored by

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as a project under the direction of the Finger Lakes Partnership for Regional Invasive Species Management

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Finger Lakes PRISM

The Finger Lakes Partnership for Regional Invasive Species Management (Finger Lakes PRISM) is a collaborative program designed to address the threat of invasive species. Housed within Hobart and William Smith Colleges' Finger Lakes Institute (FLI), the program is one of eight across New York that focuses on managing invasive species, developing detection programs, employing response efforts, providing education programs and outreach, and working with communities. PRISM programs are administered through the New York State Department of Environmental Conservation.

Hobart and William Smith are nationally recognized liberal arts colleges defined by a longstanding focus on educating across academic disciplines and an intellectual environment that cultivates faculty and student connections. With a strong commitment to inclusive excellence, the Colleges have a distinguished history of interdisciplinary teaching and scholarship, curricular innovation and exceptional outcomes. Hobart and William Smith provide robust programs in career development, study abroad, service, leadership and athletics. There are 45 majors and 68 minors. With an enrollment of 2,241, more than 60 percent of students study abroad through the No. 1 global education program in the country and all participate in community service. Located in the heart of the Finger Lakes region, Hobart and William Smith enjoy a lakeside campus on the shore of Seneca Lake. Originally founded as two separate colleges (Hobart for men in 1822 and William Smith for women in 1908), Hobart and William Smith students share the same campus, faculty, administration and curriculum.

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Quick Notes

Using this Guide

Species are grouped by organism type (herbaceous plants, trees & shrubs, and vines & lianas) and arranged alphabetically by common name. A short description of the organism and its habitat is provided, as well as why it is a threat and how it may be managed.

Reporting an Invasive Species

Users of this guide are encouraged to survey and monitor their surroundings and scout for invasive species. Users of this guide are also urged to document their observations using photos and descriptions and to upload them to **iMapInvasives.org.** Photographed specimens are best examined when placed on a white background, such as a piece of paper.

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Introduction

Invasive species pose new and ever greater challenges to the native plant and animal communities that form the rich, diverse ecosystems of our bioregion. For a species to be considered invasive it must be non-native and also capable of causing serious economic or environmental harm, or harm to human health. Specifically, invasive species lead to declines in diversity and abundance of native species, reduce suitable food and habitat for wildlife and lead to de-clines in forestry-based and agricultural productivity. Dense stands of invasive species can also impair recreational activities, and some species such as giant hogweed cause serious burns to hu-man skin and threaten our ability to safely enjoy the natural world. In the 21st century, global trade and climate change are increasing the number of invasive species present in our region and exacerbating the magnitude of their impacts.

The plants featured in this guide were chosen using two criteria: 1) they have been designated by New York State's Invasive Species Council as being "very highly" or "highly" invasive, and 2) they are already present in our region. Invasive species are "very highly" or "highly" invasive due to their tendency to grow, spread, and reproduce rapidly; to form dense monotypic stands; to alter soil chemistry/nutrient cycles to which native communities are physiologically adapted; to grow very early in the spring or remain active for longer into fall; and to produce allelopathic chemicals that inhibit the growth of other plants and/or harm foraging insects.

This guide provides information necessary to create species-specific management plans. Knowing how a species spreads, how long its seeds remain viable in the soil, and how its seeds and propagules disperse is essential to creating a successful management plan that utilizes time, labor, and monetary resources effectively while minimizing the amount of herbicidal chemicals released into the environment. Therefore, we have included a brief description of the major distinguishing characteristics of each species, its phenology (when plants emerge, bloom, fruit, disperse seed, and senesce), preferred habitat, and native look-alikes.

Management strategies or "Integrated Management Options" that have been shown in controlled studies to be effective are included in this guide. These strategies are subdivided into mechanical options, chemical applications, and biological controls. The use of the word "integrated" is prescriptive: successful management plans will involve the use of multiple treatment options. Simply spraying stands with herbicide or mowing plants is rarely enough to control populations of invasives. Treatments should be combined into a robust management plan that looks at life cycle, phenology, characteristics of the treatment site and landscape matrix.

A successful management plan takes into account the size of the invasion; the characteristics of the treatment site (topography, hydrology, soil structure, etc); and the vulnerability of the site to subsequent invasion (e.g., Are propagules from neighboring sites likely to disperse into the treatment area?). It may be that long-term treatment and monitoring are the only options, or, in some rare cases, no effective management strategy exists (i.e., your treatment area is a stand of knotweed growing downstream from an extensive invasion). Being realistic about your remediation endeavors will help you avoid frustration and maximize your effectiveness by targeting areas that might substantially benefit from such efforts.

Finally, each profile concludes with a seasonal treatment planning table that provides effective options available per season. On the last page you will find an additional monthly planning table which is a good starting point for planning projects that involve multiple species of invasives at the same site, or for those planning a specific type of volunteer project (i.e., a mechanical treatment in April).

As a professional in invasive species management, I have witnessed the incredible ecological devastation wrought by unchecked growth and proliferation of terrestrial invasive plant species. Mapping invasive plants across nearly 40 miles of trails in the Finger Lakes National Forest allowed me to appreciate the enormous role humans play in their spread. Be mindful of the potential to transport invasive seeds and propagules on your shoes, clothing, and equipment, and be sure to dispose of invasive plant material responsibly. This might mean burning or landfilling cut plants, especially if they are fruiting. Our imperiled ecosystems truly need all the help they can get; thank you for taking the first step in addressing this important issue. In these future efforts, I wish you the best of luck.

Brittany L. Lagaly
Ithaca, NY
February 17, 2019

I. Herbaceous Plants

Canada Thistle

Cirsium arvense

Origin: Europe & northern Asia

Introduction: 1600s

Propagation: Through seed & vegetatively. Plants produce >5000 seeds per year. Shoots arise from spreading root systems.

Dispersal: Seeds are dispersed by wind, water, and animals, including birds.

Persistence: Short; only 1% of seeds in soil viable after 3 years.

Life Cycle: Perennial

Description: An erect branching forb growing 1-4' tall after spending its first year as a basal rosette; branching stems are slender, green, and mostly smooth, without spiny wings; leaves alternate, spiny, deeply lobed, with clasping bases; tubular, pink-purple flowers borne in dense heads, 1-5 heads per branch, up to 100 heads per shoot; fruits are brown seeds equipped with a feathery pappus to aid in wind dispersal.

Phenology: Shoots erupt from shallow horizontal roots in April; seedlings emerge in April and May. Plants flower from May through September. Fruits mature from July through September. Plants senesce in November and December.

Habitat: Abandoned fields, pastures, roadsides & right-of-ways, grasslands, and forest edges & openings. It is highly shade- intolerant and not likely to be found in mature, undisturbed forests.

Look-alikes: Several native thistle species and invasive bull thistle *(Cirsium vulgare).*

ECOLOGICAL IMPACTS

Canada thistle's aggressive root system and ability to produce numerous seeds allow it to outcompete native grassland species, reducing biodiversity and eliminating important sources of food & habitat for wildlife.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Frequent **mowing** combined with the **propagation** of native perennial grasses has been shown to virtually eliminate Canada thistle. In the case of cultivated land, sowing a **cover crop** as soon as possible after harvest drastically reduces the number and density of shoots that emerge the following year. **Fertilizing** fields with nitrogen also reduces shoot density. Treatments must be repeated for several years to exhaust this species' extensive root system and deplete the seed bank.

Chemical: Apply a **broad-spectrum systematic herbicide** as a **foliar spray,** preferably in early spring or late fall when most native plants are dormant. Herbicides are most effective when plants and seedlings are in the rosette stage. Note that broad-spectrum herbicides are non-selective and will kill desirable plant species as well. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as needed.

Biological: Managed **grazing** using **goats, sheep,** or **cattle** has shown some promise, with goats being most effective, followed by sheep and cattle. Insect and nematode species that feed on Canada thistle also attack native thistle, and their use is not recommended. Fungi, viruses, and bacteria that infect Canada thistle also infect crops and should not be used.

WINTER	SPRING
Broadcast sow colonized sites with native perennial grasses and forbs.	Mow or graze. Increase soil nitrogen. Apply herbicide in early spring while native plants are still dormant.
SUMMER	**FALL**
Mow or graze.	Mow or graze. If cropland, sow cover crops immediately after harvest. Apply herbicide in late fall after native plants have gone dormant.

Common Reed

Phragmites australis

Origin: Europe

Introduction: Late 1700s

Propagation: Primarily vegetatively through spreading rhizomes and root & stem fragments, but also through seed.

Dispersal: Rhizome & stem fragments are transported by water & human activities. Seeds dispersed by water, wind, and birds.

Persistence: Seeds very short-lived.

Life Cycle: Perennial

Description: A very tall riparian grass reaching heights of up to 20' at maturity (5-8 yrs); stout, vertical, hollow **stems** in dense clonal stands; narrow, flat, pointed, blue-green **leaves** up to 20" long and 1" wide growing along only one side of stem, with silky white hairs where the leaf and stem meet; feathery **inflorescences** are 7-15" long and purple to brown in color, composed of spikelets of 3-7 flowers that are surrounded by silky white hairs; **fruits** are very small, light seeds equipped with feathery "hairs."

Phenology: Shoots erupt from rhizomes and buried stems in late March or early April.
Plants begin to flower in late June. Seeds begin maturing in August and are dispersed Nov- ember through January. Plant stalks turn brown as they senesce in November and December.

Habitat: Roadside ditches, wetlands, and riparian areas. Disturbed areas are especially susceptible to invasion.

Look-alikes: Native *Phragmites* species.

ECOLOGICAL IMPACTS

An aggressive rhizome network allows Common reed to form dense stands that alter hydrology patterns and soil nutrient ratios and increase the risk of fire. Stands reduce wetland biodiversity and productivity by outcompeting native plants that cleanse water and provide valuable food and habitat for wildlife.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Pull isolated plants and small stands. **Mow** or **cut** in late July after plants have flowered but before seeds are produced. Stems must be severed below the lowest leaf, leaving a stump less than 6" in height. Mowing the edges of large patches can prevent vegetative spread. Cutting stands during winter months can improve the efficacy of subsequent chemical treatments. Clean equipment thoroughly and burn or landfill all harvested plant matter. Cover treated sites with a thick black tarp and leave in place for at least one full growing season to kill roots and seeds. **Burning** and **flooding** are effective under certain conditions, but should only be attempted by professional land managers. Treatments must be repeated each year until rhizome networks and seed banks have been exhausted.

Chemical: Apply a broad-spectrum systemic herbicide to **cut stems** after mowing or cutting, or use as a **foliar spray.** Herbicides should be applied in July after plants have begun flowering but before seeds begin to develop. Note that broad-spectrum herbicides are non-selective and will kill desirable plant species as well. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as necessary.

Biological: Managed **grazing** using **goats** may be effective at controlling common reed.

WINTER	SPRING
Cut & remove dead stalks to improve efficacy of herbicide treatments. Sow native seed on successfully treated sites.	Pull small stands and lingering plants at previously treated sites. Mow or cut stands. Graze with goats.
SUMMER	**FALL**
Continue grazing. Mow/ cut near in late July. Apply herbicide after cutting or as a foliar spray. Cover site with a thick, dark tarp.	Herbicide can be applied in early fall if not used in late summer. Careful not to transport seeds on shoes, equipment, or clothing.

Garlic Mustard

Alliaria petiolata

Origin: Europe

Introduction: 1868 (Long Island, NY)

Propagation: Through seed only. Each plant is capable of producing hundreds of seeds.

Dispersal: Seeds are carried by water, wind, and animals, including humans.

Persistence: Seeds remain viable in soil for up to 10 years.

Life Cycle: Biennial

Description: A biennial herb growing as a basal rosette its 1st year and as an upright flowering forb (1-4' tall) the 2nd year; alternate **leaves** are coarsely toothed, kidney-shaped, & smell of garlic when crushed; second year plants produce small white **flowers** in racemes; seeds are borne in silique **fruit** pods characteristic of the mustard family (Brassicaceae); the distinctive **taproot** is white and S-shaped.

Phenology: Seeds germinate in February & March. Plants emerge from late March to early April. Flowering occurs from April to June. Green fruit pods develop in mid-May and ripen by mid-June; plants then die but remain upright, dropping seed through November.

Habitat: Abandoned fields, pastures, roadsides & right-of-ways, disturbed sites, grasslands, forest edges & openings, and riparian areas.

Look-alikes: Saxifrage *(Saxifraga virginiensis)*, sweet cicely *(Osmorhiza claytonia)*, toothworts *(Dentaria)*, ginger *(Asarum canadense)*, wild anise *(Osmorhiza longistylis)*, & gill-over-the ground *(Glechoma hederacea)*.

ECOLOGICAL IMPACTS

Garlic mustard forms dense stands that suppress the growth of native plants, particularly spring wildflowers. Roots exude a biochemical compound, sinigrin, that inhibits the growth of soil fungi and native plants, especially tree seedlings. It is toxic to butterfly larvae and unpalatable to deer, reducing insect populations and increasing grazing pressure on native plants.

INTEGRATED MANAGEMENT OPTIONS

Research shows that, over several decades, garlic mustard populations produce less sinigrin (a toxic root exudate that prohibits other plants and soil fungi from growing), becoming less invasive over time. For large scale invasions, limiting soil and site disturbance and cutting plants to limit seed development may be the best management options. Small patches should be managed quickly and aggressively using the options below.

Mechanical: Garlic mustard is **easy to pull** and a good target species for projects involving children. Grip the stem of the plant near the soil and gently wriggle until entire root comes up (plants can re-sprout from taproots). The best time to pull garlic mustard is after plants have begun developing green seed pods but before seeds mature and plants turn brown. Pulled plants should be removed from the site and either burned or landfilled. **Mowing** or **cutting** stands close to the soil before seeds mature will prevent seed development; repeated cutting will exhaust taproots. **Burning** is also effective, but timing is crucial to prevent additional seedlings from sprouting; burn when seed pods are present but still green. Treatments must be repeated each year until seed bank has been exhausted.

Chemical: Garlic mustard can be treated with a **broad-spectrum systemic herbicide** applied as a **foliar spray.** Herbicide is most effective after plants have developed green seed pods but before pods begin to turn brown. Note that broad-spectrum herbicides are non-selective and will also kill desirable plants. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Repeat treatments annually as necessary.

Biological: Graze using **goats** when soil is dry and plants have not yet gone to seed.

WINTER	SPRING
Sow native seed at successfully treated sites.	Mow regularly to exhaust roots & seed bank. Cut large patches once as soon as green seed pods form to prevent seed development.
SUMMER	**FALL**
Pull stands in early summer when seed pods are green, or treat with herbicide. Continue mowing if applicable.	If treating aggressively with herbicide, spray green first year rosettes when weather is dry.

Giant Hogweed

Heracleum mantegazzianum

Origin: Caucasus mountains & SW Asia

Introduction: Early 1900s

Propagation: Through seeds; each plant can produce up to 50,000 seeds.

Dispersal: Seeds are dispersed primarily by moving water & human activity, and to a lesser extent by wind and animals.

Persistence: Seeds remain viable in soil for 3-7 years.

Life Cycle: Short-lived perennial

SAP ON STEMS & LEAVES CAUSES SERIOUS BURNS TO SKIN WHEN EXPOSED TO LIGHT.

Description: A very large, imposing plant of the carrot family (Apiaceae) often found growing in wet areas, measuring up to 20' tall when flowering; **stems** are stout, hollow and rigid, with hairy bristles and purple-to-reddish splotches, 2-4" in diameter; **leaves** are alternate, coarsely toothed, and pinnately compound, measuring 10' long and 5' wide; small white **flowers** in flat-topped, compound umbels about 2.5' in diameter; **fruits** are dry schizocarps.

Phenology: Plants typically emerge in March, growing rapidly from mid-May to mid-June. Flowering occurs in June and July. Fruits have typically ripened and dispersed by late August. Plants senesce in September and October.

Habitat: Roadsides & right-of-ways, grasslands, forest edges & openings, and riparian areas.

Look-alikes: Poison hemlock *(Conium maculatum),* Angelica *(Angelica archangelica),* Queen Anne's lace *(Daucus carota),* and cow parsnip *(Heracleum lanatum).*

ECOLOGICAL IMPACTS

Giant hogweed emerges very early in the spring, grows rapidly, and is a prolific seed producer, characteristics that allow it to form dense stands that choke out the native plant communities upon which wildlife depends. Monotypic stands that occur along banks and shorelines can cause erosion when plants go dormant and expose bare soil to late-season rain.

INTEGRATED MANAGEMENT OPTIONS

DO NOT TOUCH THIS PLANT

COVER ALL SKIN WITH PROTECTIVE WATER-RESISTANT CLOTHING & WEAR GOGGLES TO PREVENT BURNS FROM SAP.

Mechanical: Cut roots 4-10" below soil early in growing season and repeat in mid-summer. Deep tilling also works to kill roots and prevent germination of seeds. **Mowing** in early spring while plants are still short and repeating 2-3 times during the growing season for several years will eventually kill plants. **Cut flower umbels** to prevent seed development; continue cutting umbels as they develop throughout the growing season. Place cut umbels in black plastic bags and leave in direct sunlight to destroy developing seeds. Do not burn or compost stems, leaves, or roots.

Chemical: Treat with a **broad-spectrum systemic herbicide** during prolonged periods of dry weather; use as a **foliar spray** on stems and leaves. Apply herbicide at the beginning of spring and follow-up with a second treatment at the end of spring to kill any plants that germinated in response to the death of established plants. Note that broad-spectrum herbicides are non-selective and will also kill desirable plants. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as necessary.

Biological: Managed grazing using **sheep** or **cattle** is an effective management tool if initiated early in the spring and continued throughout the growing season.

WINTER	SPRING
Broadcast sow colonized sites with native perennial grasses and forbs.	Cut roots of plants. Mow in early spring and continue through growing season. Graze with cattle or sheep. Cut umbels. Treat with herbicide.
SUMMER	**FALL**
Treat seedlings with herbicide. Continue mowing until growth ceases. Cut umbels until flowering ceases. Continue grazing.	Sow invaded cropland with a cover crop immediately after harvest.

Knotweed Species

Reynoutria spp.

Origin: Eastern Asia

Introduction: Late 1800s

Propagation: Most commonly spread via root and stem fragments; plants also produce millions of seeds each year.

Dispersal: Seeds, rhizomes, and stem fragments are spread by water, wind, animals, & human activity, particularly mowing.

Persistence: Unknown; at least 1 year.

Life Cycle: Perennial

Description: A tall, semi-woody plant growing 3-15' tall; stout, hollow, ridged **stems** with reddish splotches & raised nodes superficially resemble bamboo; alternate **leaves** are broad (3-6" wide) with pointed tips & flat or heart-shaped bases; creamy-white **flowers** are borne in racemes or panicles; **fruits** are tri-winged achenes.

Phenology: Plants break dormancy in late March or early April; sprouts continue to emerge through mid-summer. Flowering occurs from June through August. Fruits begin to develop in late August, ripening in September. Leaves continue to photosynthesize until physically destroyed by multiple frost events.

Habitat: Knotweed is most often found along waterways and roadsides, where it is spread by erosion and mowers, respectively. Knotweed also commonly appears where "fill dirt" has been dumped. It easily grows through concrete and is a serious threat to infrastructure.

Look-alikes: Pokeweed *(Phytolacca americana)*; native knotweed *(Persicaria virginiana)* does not bear much resemblance to its invasive cousin.

ECOLOGICAL IMPACTS

Knotweed grows rapidly along streams, river banks, roadsides, and disturbed sites, permanently displacing native plant species through an aggressive rhizome network that can extend 65' laterally and 25' in depth. Large, course rhizomes encourage flooding & erosion, events that aid the spread of knotweed by sending rhizome and stem fragments downstream.

INTEGRATED MANAGEMENT OPTIONS

THIS SPECIES SPREADS PRIMARILY THROUGH STEM AND RHIZOME FRAGMENTS. BURN ALL HARVESTED PLANT MATTER.

Mechanical: FREQUENT CUTTING DOES NOT DAMAGE THIS PLANT AND WILL LIKELY RESULT IN THE SPREAD OF KNOTWEED. **Removing below-ground growth** is effective but often not practical, as rhizomes can extend 65' laterally and up to 25' in depth, depending on soil type. Digging several test pits to asses actual rhizome depth is recommended. Minimum effective excavation depth is at least 10' below the soil surface. Excavated plants and soil will need to be landfilled at a licensed facility which can be quite costly. DO NOT ALLOW EXCAVATED MATERIAL TO BE USED AS FILL DIRT.

Chemical: Broad-spectrum systemic herbicides are effective against most populations of knotweed. Use as a **foliar spray** on leaves and stems, apply to **cut stems**, or **inject stems** (most effective). First, cut plants to the ground in July and allow to regrow to deplete some underground energy reserves; then, in September, use herbicide as a foliar spray, apply to cut stems, or use as a stem injection. Treating stands while plants are going dormant ensures that herbicide is taken down to the rhizome network. Be sure to clean equipment and burn all cut plant material. Note that broad spectrum herbicides are non-selective and will also kill desirable plants. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Repeat treatments annually until rhizome networks are exhausted.

WINTER	SPRING
If excavation is feasible, doing so in winter helps limit the possibility of spreading viable propagules.	If excavating a site, do so before above ground growth is substantial.
SUMMER	**FALL**
Cut plants in July; remove and burn all cut plant material and clean equipment thoroughly.	Apply herbicide as a foliar spray, cut stem treatment, or stem injection in the fall to ensure plants pull herbicide down to their rhizomes.

Japanese Stiltgrass

Microstegium vimineum

Origin: Caucasus mountains & E. Asia

Introduction: 1918 (Tennessee)

Propagation: Through seed; each plant is capable of producing 100-1000 seeds, though seed viability is low.

Dispersal: Seeds are spread by human activity, wind, water, & animals, particularly deer and earthworms.

Persistence: Seeds remain viable in soil for up to 10 years.

Life Cycle: Annual

Description: A prostrate, branching, sprawling grass; **stems** can be green, purple, brown, or red, and are wiry & thin with prominent nodes capable of forming adventitious roots; smooth, alternate **leaves** have distinctive silvery midveins, are relatively short & broad for a grass and superficially resemble those of bamboo; inflorescences are racemes with paired spikelets that take on a reddish color as **seeds** develop and ripen; the **roots** are stilted, shallow, branching, and come up easily when pulled.

Phenology: Seedlings emerge in late March and early April. Flowering occurs August to September. Seeds develop and mature September through October. Plants turn red and die as seeds ripen, leaving thick brown carpets of dead vegetation behind.

Habitat: Prefers the rich, moist soils of forest floors, floodplains, fields, and riparian areas. Proliferates quickly in anthropogenically disturbed sites, including lawns and roadsides. Grows well in deep shade and full sun.

Look-alikes: Whitegrass *(Leersia virginica)*.

ECOLOGICAL IMPACTS

Japanese stiltgrass is shade tolerant, a prolific seed producer, and unpalatable to deer, characteristics that allow it to form dense stands on forest floors and flood plains where it both chokes out native vegetation and causes native plants to become overgrazed. Plants also exude biochemical compounds that inhibit the growth of native plants & soil fungi and alter soil nutrient cycles.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Plants are extremely **easy to pull,** making stiltgrass a good target species for projects involving children. The best time to pull is in August when plants are tall but not yet dropping seed. Pulling earlier in the year may encourage the germination of dormant seeds. **Mowing** or **cutting** stiltgrass in August before seeds have developed is also an effective control strategy. Sow annual rye *(Lolium multiflorum)*, whitegrass *(Leersia virginica)*, and/or jewelweed *(Impatiens capensis)* over invaded sites to decrease stiltgrass stand density and seed production. Continue treating annually until seed bank is exhausted.

Chemical: Treat with a **broad-spectrum systemic** or **grass-specific systemic herbicide** applied as a **foliar spray.** The best time to apply herbicide is in late July or August before seeds have developed. Corn gluten meal (CGM) can be applied to soil before seeds germinate as a **pre-emergent herbicide:** note that pre-emergents will also kill the seeds of desirable species. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as necessary.

Biological: Sheep can be used to manage target populations. To avoid dispersing seeds in soil on hooves, do not allow grazers on infested sites when soil is wet.

WINTER	SPRING
If treating colonized sites with a preemergent herbicide like CGM, apply in mid-March.	Graze using sheep.
SUMMER	**FALL**
Pulling, mowing/ cutting, and treating with herbicide should all occur in early August before seeds develop. Continue grazing using sheep.	Sow annual rye, jewelweed, and/ or whitegrass over treated areas in early fall.

Knapweed Species

Centaurea spp.

Origin: Europe & western Asia

Introduction: Late 1800s

Propagation: Both through seeds and vegetatively via lateral root sprouts. Each plant produces 50 to 2,000 seeds.

Dispersal: Seeds are carried by water, wind, and animals, including humans.

Persistence: Seeds remain viable in soil for up to 5 years.

Life Cycle: Perennial

Description: A tall, erect, thistle-like forb that first appears as a basal rosette; older plants typically have 1 to 15 branching **stems** growing 1-4' tall; deeply lobed, grayish-white **leaves** are alternately arranged along stalks; terminal pinkish-purple **flowerheads** with prominent stiff bracts are solitary or borne in clusters of 2-3 heads, with 25-30 flowers per head; **fruits** are achenes equipped with a feathery pappus that aids in wind dispersal.

Phenology: Plants emerge in late March or early April. Flower buds appear in June and flowering occurs from July through September. Seeds ripen in August and fruits open to release seeds 2-3 weeks later, typically dispersing from mid-August through September.

Habitat: Knapweed prefers full sun; habitats susceptible to invasion include cropland and pastures, meadows, prairies, roadsides, open forests, and disturbed areas.

Look-alikes: New York ironweed *(Vernonia noveboracensis)*, chickory *(Cichorium intybus)*.

ECOLOGICAL IMPACTS

The deep, aggressive roots of knapweed plants form symbiotic relationships with soil fungi; some species also exude a biochemical compound that is toxic to native plants. These traits, combined with prolific seed production, allow knapweed to rapidly colonize grasslands, excluding native plant communities that birds and other animals rely on for food & habitat.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Plants can be **pulled** after bolting but before flowering, typically from May through June. Pulling is easiest when soil is wet. Rosettes can be **dug up** with a hand trowel. Mowing is ***not*** an effective form of control. In the case of cropland, **plow** fields and **plant cover crops** to eliminate knapweed colonies. To reduce the density of knapweed stands and plant vigor, **fertilize** fields and meadows and **sow** with seeds of native perennial grassland species. Continue treatments annually until the seed bank and root systems are exhausted.

Chemical: Knapweed can be controlled using a **selective broadleaf herbicide,** which will kill all broadleaved plants but leave established grasses unharmed. Apply in spring while native broadleaved plants are still dormant. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually until the seed bank has been exhausted.

Biological: Managed grazing using **goats** and/or **sheep** will greatly reduce knapweed density and seed production; turn grazers out when plants first appear as basal rosettes at the beginning of spring and again after plants have begun flowering. Several **insects** are available for biocontrol, but are highly species-specific: seedhead weevils *(Larinus minutus & L. obtusus)*, and the root boring weevil *(Cyphocleonus achates)*, can be released directly into knapweed stands. It will take several years before knapweed populations are visibly reduced.

WINTER	SPRING
Broadcast sow colonized grasslands with native perennial grasses & forbs.	Plow and/or fertilize fields. Graze with goats or sheep. Dig up or treat rosettes with herbicide. Pull plants May-June when soil is wet.
SUMMER	**FALL**
Continue grazing. Release weevils July through September.	Sow agricultural fields with a cover crop immediately after harvest.

Purple Loosestrife

Lythrum salicaria

Origin: Europe & Asia

Introduction: Early 1800s

Propagation: Through seed; 100,000 to more than 2.5 million per plant. Vegetative propagation through root or stem fragments is possible but uncommon.

Dispersal: Seeds are dispersed by water, wind, and by human & animal activity.

Persistence: Seeds remain viable for 5 to 20 years in soil.

Life Cycle: Perennial

Description: A branching, erect herb belonging to the mint family (Lamiaceae) growing 3 to 10 feet tall; multiple branching **stems** are square, rigid, and semi-woody, up to 50 per plant; lance-shaped, stemless **leaves** are opposite or whorled with smooth margins and round or heart-shaped bases; showy purple **flowers** with 5-7 petals are arranged in conspicuous spikes, 3-40" in length; **fruits** are capsules filled with extremely small seeds.

Phenology: Plants emerge from late March to mid-April. Flowering occurs from June to September. Seeds mature & disperse from September to December. Plants senesce in November; brown stems remain upright through winter.

Habitat: Wet habitats, such as swamps, marshes, bogs, fens, sedge meadows, wet prairies, streams, riverbanks, and roadside ditches.

Look-alikes: Fireweed *(Chamaenerion)*, blazing star *(Liatris spicata)*, purple fringed orchid *(Platanthera psycodes)*, blue vervain (Verbena hastata), winged loosestrife *(Lythrum alatum)*, & swamp loosestrife *(Decodon verticillatus)*.

ECOLOGICAL IMPACTS

Extremely prolific seed production combined with an aggressive root system allows purple loosestrife to rapidly form dense monotypic stands, excluding native wetland species that provide abundant food, habitat, & nesting sites for wildlife. Because wetlands are the most productive, biologically diverse components of any ecosystem, these effects are deleterious to overall ecosystem health and resiliency.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Plants less than 2 years old can be **pulled**, preferably before setting seed. Pull when soil is moist and be sure to remove entire root system. Burn or landfill harvested plant matter as purple loosestrife can sprout from root fragments & sometimes from stems. **Mow** or **cut** larger populations until root systems are exhausted and before plants develop seeds. Continue treatments annually until seed bank & root systems are exhausted.

Chemical: Broad-spectrum systemic herbicides can be used to control purple loosestrife. Apply as a **foliar spray** when plants begin flowering in June. Note that broad-spectrum herbicides will also kill desirable plant species. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Note that chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually until the seed bank has been exhausted.

Biological: Sheep and **cattle** will graze purple loosestrife and can substantially reduce stand density and seed production. **Insect biocontrol** options include the black-margined loosestrife beetle *(Galerucella calmariensis*), the golden loosestrife beetle (*Galerucella pusilla),* the loosestrife root weevil *(Hylobius transversovittatus)* and the flower weevil (Nanophyes marmoratus); biocontrol is the best option for large invasions.

WINTER	SPRING
Broadcast sow seeds of native wetland species.	Graze with sheep or cattle. Mow or cut stands. Release biocontrol insects.
SUMMER	**FALL**
Pull plants or treat with herbicide after flowering begins. Continue grazing, mowing, or cutting.	Broadcast sow seeds of native wetland species.

Slender False Brome

Brachypodium sylvaticum

Origin: Northern Africa & Eurasia

Introduction: 1930s (Oregon)

Propagation: Through seed; each plant produces 10-200 seeds.

Dispersal: Seeds spread by attaching to the feet and fur of animals and on shoes and vehicles.

Persistence: Unknown. For eradication efforts, assume several years.

Life Cycle: Perennial

Description: A dense perennial bunchgrass typically growing 1-3' tall; **stems** are upright and feature hairy nodes; **leaves** are lime green, sometimes with a yellowish tint, arching, often hairy, up to 12" long and 0.5" wide; flowering stalks are branchless and hollow, 2-3' long; **flower spikes** conspicuously drooping with 4-12 flower clusters per spike; **fruits** are caryopses with distinctive hairy tips.

Phenology: Plants break dormancy in late March; seedling emerge in late March to early April. Slender false brome flowers and sets seed from June through September. Plants often remain green through the winter.

Habitat: Slender false brome can occur in a wide range of habitats, from wet to dry, full shade to full sun. This includes marshy areas, streams, riverbanks, forest floors, open fields and pastures, roadsides and right-of-ways, and along foot and deer trails.

Look-alikes: Grass species in the genus *Bromus*.

ECOLOGICAL IMPACTS

Slender false brome forms dense monotypic stands that both physically smother other plants and monopolize soil resources, reducing plant biodiversity, hampering forest regeneration, and causing trophic cascades that harm native wildlife species. The enormous amount of leaf litter these plants produce may also increase the risk of fire.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Pull or **dig out** small patches in April or early May when soil is moist; be sure to remove all roots to prevent re-sprouting. If the site has been colonized for one or more growing seasons, subsequent treatments will be required to exhaust the seed bank. For larger invasions, **mowing** is an effective way to prevent seed development and will eventually exhaust the seed bank, but will not kill established plants and should be combined with an herbicide treatment. Mow frequently from April through July to prevent seeds from developing.

Chemical: Apply a **broad spectrum systemic herbicide** as a **foliar spray**. Apply to seedlings in spring and/or to established plants in June to prevent seed development; alternatively, mow patches several times in June and July and apply herbicide in late August or early September. Use a **pre-emergent herbicide** to prevent the germination of banked seeds; note that pre-emergent herbicides will kill all seeds in the seed bank and should only be used on large monotypic stands. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually until the seed bank has been exhausted.

Biological: Slender false brome leaves often contain an alkaloid produced by a fungal symbiont that is toxic to mammals, so grazing is not recommended.

WINTER	SPRING
Broadcast sow seeds of native perennial forbs at invaded sites. Mulch treated sites to give native plants an advantage.	Hand pull or dig out small patches. Treat seedlings with herbicide. Mow established plants April-July to prevent seed development.
SUMMER	**FALL**
Apply herbicide to established plants in June to prevent seed development, OR continue mowing & treat with herbicide in August or September.	Large monotypic stands can be treated with a pre-emergent herbicide to kill dormant seeds.

Wild Parsnip

Pastinaca sativa

Origin: Europe & Asia

Introduction: 1600s

Propagation: Through seed; each plant is capable of producing hundreds of seeds, but few (~1%) are viable.

Dispersal: Seeds spread by wind, water, animals (including humans), & on vehicles, particularly mowing equipment.

Persistence: Seeds remain viable for up to 5 years in soil.

Life Cycle: Biennial/perennial

SAP ON STEMS & LEAVES CAUSES SERIOUS BURNS TO SKIN WHEN EXPOSED TO LIGHT.

Description: A tall (2-5'), rangy forb of the carrot family (Apiaceae) that grows as a basal rosette its 1st year; its single **stem** is smooth, deeply grooved, hollow, and often streaked with purple; alternate **leaves** are finely toothed, pinnately divided, and composed of several leaflets; small yellow **flowers** in large, flat-topped, compound umbels, 2-6" across; **fruits** are dry schizocarps; taproot is funnel-shaped.

Phenology: Plants emerge from late March to early April. Flowering occurs June to October. Seeds mature & disperse from August through November. Plants senesce after flowering.

Habitat: Primarily found in disturbed sites and abandoned agricultural fields. Also colonizes roadsides, forest edges, meadows, & river banks. It can tolerate dry, mesic, and wet soils; prefers full sun but can grow in partial shade.

Look-alikes: Poison hemlock *(Conium maculatum)*, Queen Anne's lace *(Daucus carota)*, cow parsnip *(Heracleum lanatum)*, & golden alexanders *(Zizia aurea)*.

ECOLOGICAL IMPACTS

Wild parsnip grows and reproduces rapidly in open areas and forest edges, creating dense monotypic stands that choke out native plants, drastically reducing the quantity and diversity of food and habitat available to wildlife. Its deep taproot allows it to monopolize soil nutrients and moisture, and persist even under drought conditions.

INTEGRATED MANAGEMENT OPTIONS

DO NOT TOUCH THIS PLANT

TO PREVENT BURNS FROM SAP, WEAR GOGGLES & COVER ALL SKIN WITH PROTECTIVE, WATER-RESISTANT CLOTHING.

Mechanical: To reduce stand density and seed production, begin **mowing** colonized sites in early spring before plants have bolted. Increase mowing frequency as plants start to produce flower umbels in May. Continue cutting until seed bank and taproots have been exhausted. Never mow plants that have already begun producing seeds. **Till soil** to kill plants in agricultural fields. **Dig out** or **sever the taproots** of isolated plants and small patches using a shovel to cut the taproot at least 1-2" below the soil surface. **Cover** cut stems with a thick black tarp for at least one full growing season to kill germinating seeds and taproots. Allow cut plants to decay on-site. Do not burn or compost harvested plant material.

Chemical: A broad-spectrum systemic herbicide can be used to kill wild parsnip and should be applied as a **foliar spray** in early spring to basal rosettes and plants that have bolted but not yet flowered, or, alternately to 1st year basal rosettes in the fall. Herbicide should not be used on plants that have already flowered, as they will likely still go to seed if treated. Note that broad-spectrum herbicides will also kill desirable plant species. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually until the seed bank has been exhausted.

WINTER	SPRING
Broadcast sow seeds of native perennials over treated sites. Mulch deeply to give native plants a competitive advantage.	Dig out /sever plants & small patches. Mow large patches. Apply herbicide as a foliar spray. Tarp or mulch treated sites.
SUMMER	**FALL**
Continue mowing large patches.	Apply herbicide to 1st year basal rosettes. Mulch treated sites to give native plants a competitive advantage & restore soil properties.

Yellow Iris

Iris pseudacorus

Origin: Northern Africa & Eurasia

Introduction: 1700s

Propagation: Through rhizome fragments & seeds. Each plant is capable of producing hundreds of seeds.

Dispersal: Rhizome fragments & seeds are primarily dispersed by water; seeds can remain buoyant for >1 year.

Persistence: Unknown, but viability of banked seeds is low.

Life Cycle: Perennial

Description: A robust monocot with large, showy flowers, found growing in moist and inundated areas; brightly colored **leaves** are long, stiff, and narrow, 1-3' long; one or many flower stalks, usually slightly shorter than surrounding leaves; **flowers** are cream to bright yellow in color, 3-4" wide; **fruits** are 2-4" long 6-angled capsules; thick, tuberous **rhizomes** are often visible and form dense floating mats.

Phenology: Most vegetative regeneration and seed germination takes place from late March through early April, though some regeneration and germination also occurs in the summer and autumn months. Flowering occurs from late May through early July; fruits are produced from August through October. Plants senesce after seeds have ripened.

Habitat: Growth is restricted to wetlands and riparian areas such as shorelines, swamps, marshes, and floodplains.

Look-alikes: Northern blue flag iris *(Iris versicolor)*.

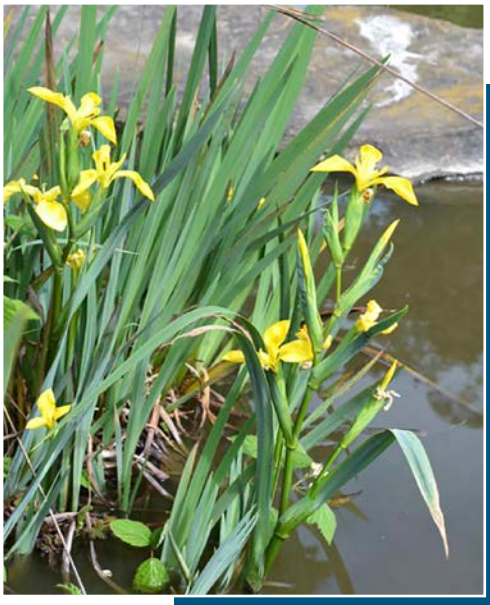
ECOLOGICAL IMPACTS

Yellow iris dominates wetlands & riparian areas, forming dense floating mats of rhizomes that prevent the germination and growth of native species, reducing biodiversity and damaging the ability of wetlands to provide food and habitat for wildlife. In time, rhizomatous mats build and collect enough organic matter to alter topography and hydrology patterns, reducing the size and effectiveness of wetlands.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: In the case of small patches, **pull** young plants and **dig out** established plants, taking care to remove the entire rhizome. There is some evidence that plants growing in standing water can be drowned by **cutting** all leaves and stems below the water level, preferably before flowering. Revisit treated sites to check for lingering rhizomes, which will reveal themselves in time by putting out new leaves. Small patches can also be killed by covering with a tarp for several years. Frequent **mowing** or **cutting** will eventually kill plants by exhausting rhizomes. Continue treatments until seed bank and rhizomes have been exhausted.

Chemical: Broad-spectrum systemic herbicides are effective in controlling large stands of yellow iris. Apply as a **foliar spray** in late spring or early summer when plants are growing most vigorously. A second application is usually necessary 3-4 weeks after the initial treatment. Monitor sites for several years to pull, dig, or treat surviving rhizomes and seedlings. Note that broad-spectrum herbicides are non-selective and will also kill desirable plants. **Stem injection** has shown some promise and limits damage to neighboring plants and aquatic ecosystems. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as necessary.



WINTER	SPRING
Broadcast sow seeds of native wetland species over successfully controlled sites.	Pull, dig, or mow/cut stands before flowering. Apply 1st herbicide treatment in late spring. Cover small sites with a thick tarp.
SUMMER	**FALL**
Monitor treated sites; if necessary, dig out lingering plants or apply 2nd herbicide treatment 3-4 weeks after the first. Continue to mow.	Mulch any sites left bare by treatment to give native plants a competitive advantage the following spring.









II. Trees & Shrubs

Autumn Olive

Elaeagnus umbellata

Origin: Eastern Asia

Introduction: 1830s

Propagation: Primarily through seed; plants produce around 66,000 seeds per year. Root fragments can also sprout.

Dispersal: Seeds are dispersed by frugivorous birds and, to a lesser extant, by small mammals.

Persistence: Unknown, likely < 3 years

Life Cycle: Perennial

Description: A medium-to-large sized, sprawling, deciduous shrub; woody **stems** are gray or silver in color; small twigs feature orange or brown scales and sometimes thorns; **leaves** are alternate and ovate, with pointed tips and smooth, wavy margins, green or grayish-green in color, with undersides covered in conspicuous silver scales; small, tubular, 4-petaled, cream-to-yellow colored **flowers** are borne in clusters along twigs; small, round, single-seeded **fruits** are orange or red and dotted with silver scales.

Phenology: Shrubs break dormancy in late March or early April. Flowering occurs May through June. Fruits develop July through August and ripen September through October. Plants senesce in November or December, after several frosts.

Habitat: Abandoned fields, pastures, grasslands, forest edges and openings, roadsides and right-of-ways, and other disturbed areas.

Look-alikes: American silverberry *(Elaeagnus commutata).*

ECOLOGICAL IMPACTS

Autumn olive quickly forms dense, impenetrable thickets that shade out and aggressively displace natural communities. By altering the structure and species composition of forests and meadows, autumn olive deprives native wildlife of valuable food and habitat resources, such as high-fat fruits and safe nesting sites. Roots exude nitrogen and allelopathic chemicals, conditional soil to favor invasives and leaching nitrates into waterways.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Small plants can be **pulled** when soil is moist and fruits are not present; plants with deeper roots can be **dug out** using a shovel or removed with a **weed wrench.** Be sure to remove the entire root crown to prevent resprouting. Cover with a thick layer of **mulch** to restore
proper soil nutrient balance & suppress seed germination. Mowing, cutting, burning, and girdling can suppress the growth of seedlings, but will not kill shrubs & may stimulate growth.

Chemical: Broad-spectrum systemic herbicides are effective in controlling autumn olive. Apply in late summer or early autumn using the **cut-stem** or **basal bark method.** Cut stems as short as possible and paint or spray with herbicide immediately, or, for younger shrubs with thin bark, apply herbicide as a basal bark spray during dry conditions. For best results, make a deep cut before applying herbicide to stems. Herbicides can also be used as a **foliar spray** in spring when native plants are dormant. Chose a **broadleaf-specific systemic herbicide** for grass-dominated ecosystems and a broad-spectrum systemic herbicide for wooded sites. Do not apply as a foliar spray when fruits are present, or May through September when birds are nesting. Note that broad-spectrum herbicides are non-selective and will also kill desirable plant species. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Repeat treatments annually as necessary.

WINTER	SPRING
Broadcast sow treated sites with native seeds.	Manually remove shrubs and seedlings. Apply herbicide as a foliar spray in early spring. Mulch treated sites deeply.
SUMMER	**FALL**
Manually remove shrubs and seedlings. Apply herbicide to cut stems or basal bark in late summer. Mulch deeply.	Apply herbicide to cut stems or basal bark. Cover treated sites with a deep layer of mulch.

Burning Bush

Euonymus alatus

Origin: Northern & eastern Asia

Introduction: 1860s

Propagation: Through seed as well as vegetatively via root suckering. Shrubs self-fertilize to produce a tremendous number of seeds.

Dispersal: Frugivorous birds spread seeds far and wide.

Persistence: Limited, likely < 1 year.

Life Cycle: Perennial

Description: A medium-to-large sized, dense, rounded, spreading shrub with brilliant autumn foliage; **stems** are greenishbrown with distinctive "wings" or flat ridges on small twigs; **leaves** oppositely arranged along stem, elliptic to ovate with pointed tips and finely toothed margins, turning bright red in the fall; small, yellow-green, 4-petaled **flowers** borne in cymes; **fruits** are small, fleshy, red capsules, each containing 4 seeds.

Phenology: Shrubs break dormancy and seedlings emerge from late March to early April. Flowering occurs from late April through June. Fruits develop and ripen in September and October. Shrubs senesce in October.

Habitat: Abandoned fields, pastures, grasslands, roadsides and right-of-ways, disturbed sites, forest edges, openings, and interiors. Forests with moist soils are most at risk.

Look-alikes: Native Blueberry *(Vaccinum).*

ECOLOGICAL IMPACTS

The aggressive root systems of burning bush monopolize soil moisture and nutrients. Shrubs grow in extremely dense stands that shade out native plants and reduce important sources of food and habitat for wildlife, fundamentally altering ecosystem structure and function and sharply reducing biodiversity.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Seedlings & small plants can be **pulled**; larger shrubs can be removed using a **weed wench** or **dug out** using a shovel. The best time to pull, pop, or dig up shrubs is when soil is moist and shrubs are not fruiting; be sure to remove the entire root crown. **Mowing, cutting, or girdling** may be effective, but will need to be repeated for 3-5 years to exhaust roots. Ironically, fire may be effective at controlling populations of burning bush, but more research is needed. Cover with a deep layer of **mulch** to reduce seedling germination the following spring.

Chemical: Apply a **broad-spectrum systemic herbicid**e in late summer or early autumn using the **cut-stem** or **basal bark** method. Cut stems as short as possible and paint or spray with herbicide *immediately*, or, for younger shrubs with thin bark, apply herbicide as a basal bark spray during dry conditions. For best results, make a deep cut before applying herbicide to stems. Herbicides can also be used as a **foliar spray** in spring when native plants are dormant. Chose a broadleaf-specific systemic herbicide for grass dominated ecosystems and a **broad spectrum systemic herbicide** for wooded areas. Do not apply as a foliar spray when fruits are present, or May through September when birds are nesting. Note that broad-spectrum herbicides are non-selective and will kill desirable plant species as well. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Repeat treatments annually as necessary.

Biological: Grazing may be an effective management tool, but research is lacking.

WINTER	SPRING
Broadcast sow treated sites with native seeds.	Mow or cut. Manually remove shrubs and seedlings. Apply herbicide as a foliar spray in early spring. Mulch sites deeply.
SUMMER	**FALL**
Continue mowing. Manually remove shrubs and seedlings. Apply herbicide to cut stems, or basal bark in late summer. Mulch sites deeply.	Apply herbicide to cut stems or basal bark. Mulch sites deeply.

Bush Honeysuckle

Lonicera spp.

Origin: Asia & Europe

Introduction: Late 1800s

Propagation: Through seed & vegetatively via root suckering and stem layering. Shrubs can produce up to 20,000 seeds each year.

Dispersal: Seeds are dispersed by frugivorous birds and, to a lesser extent, by deer.

Persistence: Limited/unknown.

Life Cycle: Perennial

Description: A medium-to-large sized shrub with arching branches & a spreading growth form, often found growing in dense stands; **stems** are sometimes shaggy, blonde in color, and feature a hollow pith; oppositely arranged **leaves** are ovate with pointed tips and smooth margins; distinctive showy **flowers** are bilaterally symmetrical and borne in pairs at leaf nodes; red, orange, or yellow **fruits** are paired round berries with multiple seeds.

Phenology: Plants break dormancy in early March. Shrubs begin flowering relatively early, April or May through June. Fruits develop and ripen June through August. Shrubs typically senesce in late October.

Habitat: Abandoned fields, pastures, grasslands, roadsides and right-of-ways, forest edges and openings, second-growth forests, wetlands, and riparian areas.

Look-alikes: Native bush honeysuckles *(Diervilla Lonicera, Lonicera canadensis),* which feature solid piths and toothed leaf margins, & common snowberry *(Symphoricarpos alba).*

ECOLOGICAL IMPACTS

Bush honeysuckle forms dense stands that choke out native plants. Honeysuckle fruits are high in carbohydrates and low in fats compared to those of native shrubs. This is an issue for migrating birds who need high-fat fruits to successfully complete their journeys. Bird nests also suffer higher rates of predation in honeysuckle stands, as the sprawling growth form allows ground predators access to nests.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Seedlings & small plants can be **pulled**; larger shrubs can be removed using a **weed wench** or **dug out** using a shovel. The best time to pull, pop, or dig up shrubs is when soil is moist and plants aren't fruiting. Be sure to remove entire root crown. Mowing, cutting, burning, and girdling are all effective strategies but will need to be repeated for 3-5 years to exhaust roots. Cover treated sites with a deep layer of **mulch** to reduce seed germination the following spring.

Chemical: Apply **a broad-spectrum systemic herbicide** or **broadleaf-specific systemic herbicide** in late summer or early autumn using the **cut-stem** or **basal bark method** (chose a broad leaf specific systemic herbicide for grass dominated ecosystems and a broad-spectrum systemic herbicide for wooded areas). Cut stem as short as possible and paint or spray with herbicide *immediately*, or, for younger shrubs with thin bark, apply herbicide as a basal bark spray during dry conditions. For best results, make a deep cut before applying herbicide to stems. Herbicides can also be used as a foliar spray in spring when native plants are dormant. Do not apply as a **foliar spray** when fruits are present or May-Sept when birds are nesting. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Repeat treatments annually as necessary.

Biological: Goats will graze honeysuckle but should be used in combination with other treatments. The European honeysuckle aphid *(Hyadaphis tatarica)* is an approved insect biocontrol.

WINTER	SPRING
Broadcast sow treated sites with native seeds.	Graze or mow. Manually remove shrubs and mulch. Apply herbicide as a foliar spray in early spring **or** release aphids.
SUMMER	**FALL**
Graze or mow. Manually remove shrubs and seedlings. Apply herbicide to cut stems, or basal bark in late summer. Mulch deeply.	Apply herbicide to cut stems or basal bark. Cover treated sites with a deep layer of mulch.

Common Buckthorn

Rhamnus cathartica

Origin: Europe, NW Africa, & W Asia

Introduction: Late 1700s

Propagation: Trees produce 1000-2000 seeds per year after 5 years of age. Cut trees sprout from roots.

Dispersal: Seeds dispersed by frugivorous birds & mammals. Fruits are buoyant and can also be dispersed by water.

Persistence: About 2 to 6 years in soil.

Life Cycle: Perennial

Description: A shrubby, medium-sized tree, often with multiple trunks; trunks & **stems** are dark gray with warty lenticels, while new growth is reddish-green with white lenticels; twigs have thorn-like tips; **leaves** dark, curved, & strongly ovate with finely toothed margins, pointed tips, & strongly curved veins; small, 5-petaled, greenish-yellow **flowers** in clusters; **fruits** are dark purple berries with 2-3 seeds.

Phenology: Plants break dormancy from late March to early April. Flowering occurs May through June. Fruits begin to develop in late June and have ripened by September. Plants retain green leaves into November, senescing much later than native trees.

Habitat: Fields, pastures, grasslands, roadsides, and right-of-ways, forest edges and openings, young forests, wetlands, and riparian areas.

Look-alikes: Native Alderleaf Buckthorn *(Rhamnus alnifolia)*, black cherry *(Prunus serotina),* choke cherry *(Prunus virginiana),* and hawthorn species *(Crataegus).* Leaf veins can resemble native dogwood species *(Cornus).*

ECOLOGICAL IMPACTS

Common buckthorn quickly forms deep, aggressive root systems that rapidly break down and consume nutrients, alter soil nitrogen cycles, eliminate leaf litter, and encourage both erosion and the growth of other invasive plant species. Fruits are strongly laxative and have poor nutritional value compared to fruits of native shrubs. Low lying branches allow ground predators easy access to bird nests.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Small plants can be **pulled** when soil is moist; large shrubs and those growing in clay soils can be **dug out** using a shovel or removed with a **weed wench**. Large trees can be ripped out using a tractor. Be sure to remove the entire root crown and all lateral roots to prevent re-sprouting. Bag any branches with fruits and burn or landfill. Cover treated sites with a thick layer of mulch to restore proper soil nutrient balance and suppress seed germination. **Mowing** and **girdling** (band > 3") will kill seedlings, weaken root systems, & kill plants after 2-3 consecutive years of treatment. **Burning** is effective, but will require 5-6 annual treatments to kill plants. **Flooding** is a viable control option for sites where water levels can be manipulated.

Chemical: Herbicides are effective against common buckthorn. Apply a **broad-spectrum systemic herbicide** in late summer or early autumn using the **cut-stem** or **basal bark** method. Cut stem as short as possible and paint or spray with herbicide *immediately*, or, for younger shrubs with thin bark, apply herbicide as a basal bark spray during dry conditions. For best results, make a deep cut before applying herbicide to stems. Note that broad-spectrum herbicides are non-selective and will also kill desirable plant species. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Repeat treatments annually as necessary.

Biological: Livestock find buckthorn palatable, and **grazing** can be used in conjunction with other methods to control populations.

WINTER	SPRING
Girdle shrubs. Mulch sites. Broadcast sow treated sites with native seeds.	Graze or mow. Manually remove shrubs and seedlings. Mulch deeply.
SUMMER	**FALL**
Graze or mow. Manually remove shrubs and seedlings. Apply herbicide to cut stems or basal bark in late summer. Mulch deeply.	Apply herbicide to cut stems or basal bark. Mulch deeply.

Japanese Barberry

Berberis thunbergii

Origin: Japan

Introduction: 1800s

Propagation: Shrubs produce 100s to 1000s of seeds each year & also regenerate through suckering & stem layering.

Dispersal: Seeds are dispersed primarily by frugivorous birds, especially wild turkeys and ruffed grouse.

Persistence: Limited, < 2 years

Life Cycle: Perennial

Description: A small, dense shrub with arching branches, growing 2-6' tall; deeply grooved **stems** feature a single spine at each node; small **leaves** with smooth margins are spatulate or ovate, in whorled clusters, turning red-purple in autumn; small, pale yellow, 6-petaled **flowers** dangle in clusters of 2-4 at leaf nodes; **fruits** are dry, small, bright red, egg-shaped berries.

Phenology: Plants break dormancy in late March. Flowers bloom in April and May. Fruits begin developing in June and ripen from July through October. Plants retain their leaves well into the autumn, senescing in November after several frosts.

Habitat: Abandoned fields, pastures, grasslands, roadsides and right-of-ways, disturbed sites, forest edges and openings, second growth forests, wetlands and riparian areas. Japanese barberry grows well in full shade and full sun and tolerates wet, dry, and mesic soils.

Look-alikes: American barberry *(Berberis canadensis)* can be distinguished from its invasive cousin by its toothed leaf margins.

ECOLOGICAL IMPACTS

Barberry forms dense stands that reduce biodiversity by choking out native plants. It is a threat to virtually all natural communities, as it can tolerate wet soils and dense shade. Mice are the primary vector of Lyme disease and take shelter under the thick canopies of barberry stands, under which both mouse & tick populations reliably explode.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Shrubs have shallow root systems that are relatively easy to uproot; **pull** small plants and seedlings by hand. **Dig out** larger shrubs or remove using a **weed wench.** The best time to remove plants is when soil is moist and shrubs are not fruiting. Be sure to remove all roots to avoid re-sprouting. **Mowing/cutting** and **flame-weeding** are effective control strategies, but will need to be repeated frequently for several years to exhaust root systems. Cover treated sites with a deep layer of **mulch** to reduce seed germination the following spring.

Chemical: Apply a **broad-spectrum systemic herbicide** in late summer or early autumn using the **cut-stem** or **basal bark** method. Cut stem as short as possible and paint or spray with herbicide *immediately*, or, for younger shrubs with thin bark, apply herbicide as a basal bark spray during dry conditions. For best results, make a deep cut before applying herbicide to stems. Herbicides can also be used as a **foliar spray** in early spring when native plants are dormant. Chose a broadleaf-specific systemic herbicide for grass dominated ecosystems and a **broad-spectrum systemic herbicide** for wooded areas. Do not apply as a foliar spray when fruits are present, or May through September when birds are nesting. Note that broad spectrum herbicides are non-selective and will also kill desirable plant species. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as necessary.

Biological: Cattle graze barberry, but studies on the efficacy of this treatment are lacking.

WINTER	SPRING
Broadcast sow treated sites with native seeds.	Manually remove shrubs and seedlings. Mow or cut. Apply herbicide as a foliar spray before native plants emerge. Mulch deeply.
SUMMER	**FALL**
Manually remove shrubs and seedlings. Continue mowing. Apply herbicide to cut stems or basal bark in late summer. Mulch deeply.	Apply herbicide to cut stems or basal bark. Cover treated sites with a deep layer of mulch.

Multiflora Rose

Rosa multiflora

Origin: Eastern Asia

Introduction: 1866

Propagation: Shrubs are capable of producing up to 500,000 seeds per year and also regenerate vegetatively through root suckering and stem layering.

Dispersal: Seeds are dispersed by frugivorous birds and small mammals.

Persistence: Seeds remain viable in soil for 10 to 20 years.

Life Cycle: Perennial

Description: A large, sprawling, climbing shrub with an arching, spreading growth form, often reaching heights of 15' of more; branched **stems** are red or green in color, spread out from the base of shrubs, and are well-armed with thick, recurved prickles; alternate compound **leaves** are pinnately divided into 5-11 oval leaflets with finely toothed margins and distinctively **fringed stipules** subtending leaf stems; numerous clusters of showy, fragrant, 5-petaled, white or pink **flowers** borne in panicles; **fruits** are small, dry, red rose hips.

Phenology: Plants break dormancy in late March or early April. Flowering occurs from May through June. Fruits begin developing in July and ripen by mid-September. Shrubs senesce in October.

Habitat: Abandoned fields, pastures, grasslands, roadsides and right-of-ways, forest edges and openings, young forest interiors, wetlands and riparian areas.

Look-alikes: Native roses can be distinguished by their un-fringed stipules.

ECOLOGICAL IMPACTS

Multiflora rose is a prolific seed producer and forms dense stands that aggressively choke out native plant species, reducing biodiversity and hampering the ability of invaded ecosystems to provide suitable food and habitat for wildlife. Bird nests suffer high rates of predation in multiflora stands, as the sprawling growth form allows ground predators access to nests.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Small plants can be **pulled** when soil is moist; large shrubs can be **dug out** using a shovel, removed with a **weed wench**, or pulled out using a **tractor**. Wear gloves to protect hands from prickles. Be sure to remove the entire root crown and lateral roots to prevent re-sprouting. Bag any branches with fruits & burn or landfill. Cover treated sites with a thick layer of **mulch** to suppress seed germination. **Mowing** 3-6 times per growing season will kill seedlings, weaken root systems, & kill plants after 2-4 consecutive years.

Chemical: Apply a **broad-spectrum systemic herbicide** in late summer or early autumn using the cut-stem method. Cut stem as short as possible and paint or spray with herbicide *immediately*, during dry conditions. Herbicides can also be used as a **foliar spray** in spring when native plants are dormant. Chose a **broadleaf-specific systemic herbicide** for grass dominated ecosystems and a broad-spectrum systemic herbicide for wooded areas. Do not apply as a foliar spray when fruits are present, or May through September when birds are nesting. Note that broad-spectrum herbicides will also kill desirable plants. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels & instructions thoroughly, follow all applicable laws & regulations, & wear protective gear when using herbicides. Repeat treatments annually as necessary.

Biological: Managed grazing using **goats** has shown some success as a control method. Rose rosette disease, a virus that kills shrubs within two years, is not recommended, as it also kills native rose and negatively impacts some agricultural crops. The European rose chalcid *(Megastigmus aculeatus)* is currently being evaluated for use as an insect biocontrol.

WINTER	SPRING
Broadcast sow treated sites with native seeds.	Graze or mow. Manually remove shrubs and seedlings. Apply herbicide as a foliar spray. Mulch deeply.
SUMMER	**FALL**
Graze or mow. Manually remove shrubs and seedlings. Apply herbicide to cut stems in late summer. Mulch deeply.	Apply herbicide to cut stems. Cover treated sites with a deep layer of mulch.

Norway Maple

Acer platanoides

Origin: Europe & western Asia

Introduction: Mid–1700s

Propagation: Trees begin producing seeds after 25 to 30 years of growth. Seeds are produced every year, with a bumper crop every 1 to 3 years.

Dispersal: Seeds are dispersed by wind.

Persistence: Unknown

Life Cycle: Perennial

Description: A stout, deciduous canopy tree, with purple, red, or yellow fall foliage; **trunks** are covered in gray-to-brown bark, shallowly textured with furrows and ridges; stems and twigs are reddish-brown and smooth; **leaves** are opposite and palmate with 5-7 pointed lobes, are noticeably broader than native maple leaves, and exude a latex sap from leaf stems when damaged; small, yellow, 5-petaled **flowers** borne in round, branching clusters; **fruits** are widely angled samaras.

Phenology: Trees break dormancy in late April, leafing out shortly after flowering begins. Flowering occurs from late April to June. Fruits mature and disperse in September and October. Trees senesce in late October after most trees have dropped their leaves.

Habitat: Prefers cool, shady forests with rich, moist soil. Beech-maple forests are especially prone to invasion by Norway maple.

Look-alikes: Native sugar maple (*Acer saccharum)* and red maple *(Acer rubrum).*

ECOLOGICAL IMPACTS

Norway maple invades forest communities where rapid growth allows it to dominate the forest understory, shading out the seedlings of native tree species. Trees eventually reach the canopy and form monotypic stands, drastically reducing tree species diversity and abundance and altering the structure of forests. It is a major threat to maple syrup producers.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Removing mature seed-bearing trees has been shown to be effective in restoring New Jersey forests dominated by Norway maple. Seedlings can be **pulled**, preferably when soil is moist. Saplings and large trees can be **girdled** or **felled** using a hand- or chainsaw. Be careful not to damage native saplings and canopy trees when felling Norway maple. Stumps of sub-canopy trees may successfully re-sprout; suckers from mature canopy trees usually die after a few years. Monitor treated sites and remove sprouts and seedlings when necessary. Be mindful of the fact that removing any amount of forest canopy will alter the site in ways that make it more vulnerable to colonization by other invasive plant species. Site restoration and long-term monitoring will likely be necessary until the canopy closes.

Chemical: Apply **a broad-spectrum systemic herbicide** in late summer or early autumn using the **cut-stem** or **basal bark** method. After felling trees, paint or spray with herbicide *immediately*, or, for younger shrubs with thin bark, apply herbicide as a basal bark spray during dry conditions. For best results, make a deep cut before applying herbicide to stems and trunks. Seedlings can be treated with herbicide applied as a **foliar spray.** Note that broad-spectrum herbicides are non-selective and will kill desirable plant species as well. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as necessary.

WINTER	SPRING
Fell or girdle trees. Broadcast sow treated sites with native seeds.	Pull seedlings. Fell or girdle trees. Plant native saplings.
SUMMER	**FALL**
Pull seedlings. Fell or girdle trees. Apply herbicide to cut stumps or basal bark in late summer.	Pull seedlings. Fell or girdle trees. Apply herbicide to cut stumps or basal bark. Plant native saplings.

Privet Species

Ligustrum spp.

Origin: Europe & eastern Asia

Introduction: 1950s

Propagation: Through seed and vegetatively via root suckering. Each shrub is capable of producing many hundreds of seeds.

Dispersal: Seeds are dispersed by frugivorous birds and small mammals.

Persistence: None

Life Cycle: Perennial

Description: Medium-to-large sized deciduous or semi-evergreen shrubs with arching branches and spreading growth forms, growing 10-16' tall; smooth, slender **stems** with raised lenticels are greenish-gray in color, new growth is reddish-brown; thick, glossy **leaves** are elliptic to ovate and paired along stem; conspicuous white tubular **flowers** are borne in terminal panicles; **fruits** are purple-to-black drupes containing 1-4 seeds, depending on species.

Phenology: Plants break dormancy in late March or early April. Flowers bloom in June and July. Fruits mature in September and often remain on plants throughout the winter. In the northeast, privet senesces in November after several frosts.

Habitat: Abandoned fields, pastures, grasslands, forest edges and openings, the interiors of both young and mature second-growth forests, wetlands, and riparian areas. Privet prefers full sun and mesic soils.

Look-alikes: Native coralberry *(Symphoricarpos orbiculatus).*

ECOLOGICAL IMPACTS

Privet forms extremely dense stands that prevent light from reaching the understory. Forests invaded by privet have fewer trees, decreased plant diversity, less leaf litter, and disrupted soil nutrient cycles. Privet also sharply reduces the abundance and diversity of native butterfly and bee species in affected communities.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Small plants can be **pulled** when soil is moist and fruits are not present; plants with deeper roots can be **dug out** using a shovel or removed with a **weed wench**. Be sure to remove the entire root crown to prevent re-sprouting. Cover treated sites with a thick layer of **mulch** to suppress seed germination. Mowing, cutting, and burning can suppress the growth of seedlings but will not kill shrubs and may stimulate growth.

Chemical: Apply a **broad-spectrum systemic herbicide** in late summer or early autumn using the **cut-stem method.** Cut stem as short as possible and paint or spray with herbicide *immediately*, during dry conditions. Herbicides can also be used as a **foliar spray** in spring when native plants are dormant. Chose a **broadleaf-specific systemic herbicide** for grass dominated ecosystems and a broad-spectrum systemic herbicide for wooded areas. Do not apply as a foliar spray when fruits are present, or May through September when birds are nesting. Note that broad-spectrum herbicides are non-selective and will also kill desirable plant species. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as necessary.

Biological: Managed **grazing** using **goats** has shown some success as a control method when combined with other treatment types.

WINTER	SPRING
Broadcast sow treated sites with native seeds.	Graze or mow. Manually remove shrubs and seedlings. Apply herbicide to cut stems or foliage. Mulch deeply.
SUMMER	**FALL**
Graze or mow. Manually remove shrubs and seedlings. Apply herbicide to cut stems in late summer. Mulch deeply.	Apply herbicide to cut stems. Cover treated sites with a thick layer of mulch.

Tree-of-Heaven

Ailanthus altissima

Origin: China & Taiwan

Introduction: 1784 (Philadelphia, PA)

Propagation: Through seed and via root sprouts; trees are capable of producing millions of seeds, and lateral roots can spread up to 90 ft from the parent trunk.

Dispersal: Seeds are dispersed by wind, water, and human activity.

Persistence: None

Life Cycle: Perennial

Description: A medium-to-large, deciduous, dioecious tree; stems and twigs are green-to-reddish brown and smooth where not covered in conspicuous lenticels; **trunks** feature thick, corky bark; **leaves**, which give off an offensive odor when crushed, are pinnately compound, with 10-40 lanceolate leaflets, each entire except for 2-4 distinctive rounded teeth near the base with 1-2 protruding glandular bumps; small, 5-petaled, yellow-to-red **flowers** borne in large panicles; **fruits** are samaras containing a single seed, turning an orange-to-pinkish color when mature.

Phenology: Plants generally break dormancy in April. Flowers bloom in June and July. Fruits mature from August to October; most seeds are dispersed in October and November, though some are retained and disperse through winter. Trees senesce in November.

Habitat: Urban areas, roadsides and right-of-ways, disturbed sites, grasslands, forest edges and openings, wetlands and riparian areas.

Look-alikes: Sumac species *(Rhus),* walnut and butternut *(Juglans),* and hickory species *(Carya).*

ECOLOGICAL IMPACTS

Tree-of-heaven grows and reproduces rapidly, forming dense root systems that choke out native plant species. These trees are extremely prolific seed producers and seeds are often dispersed in clumps, creating dense stands of seedlings. Tree-of-heaven also exudes allelopathic chemicals from its roots, which prohibits the growth of other plants. It is the preferred host tree of the spotted lanternfly, an emerging forest & agricultural pest that poses a serious threat to the wine & fruit industries.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Seedlings can be **pulled**, preferably when soil is moist; be sure to remove the entire root system. Cutting/mowing is not recommended, as doing so will stimulate roots to sprout, leading to a rapid & substantial increase in stem density. **Felling** large trees must always be combined with an herbicide treatment prior to cutting to kill root systems, which will otherwise undergo vigorous resprouting. Be mindful of the fact that removing any amount of forest canopy will alter the site in ways that make it more vulnerable to colonization by other invasive plant species. Long-term monitoring of such sites will likely be necessary until the canopy closes. Sweetgum *(Liquidambar styraciflua)* & sycamore *(Platanus occidentalis)* compete well with tree-of-heaven and can be grown to shade-out treatment sites.

Chemical: Apply a **broad-spectrum systemic herbicide** in mid-to-late summer as a foliar spray or using **basal bark method** (the cut-stem method is not recommended, as cutting triggers vigorous root sprouting in this species). Apply as a foliar spray on dense patches to kill off small plants, then apply herbicide to remaining trees and saplings as a basal bark spray during dry conditions from July through mid-October. For best results, make a deep cut before applying herbicide to stems. Wait at least 2 months after applying herbicide to fell trees. Note that broad-spectrum herbicides are nonselective and will also kill desirable plant species. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Monitor sites and repeat treatments annually until root systems have been exhausted.

Biological: A native vascular wilt fungus, *Verticillium nonalfalfae,* and a host-specific Asian weevil, *Eucryptorrhyncus brandti,* are currently being evaluated for use as biocontrol agents.

WINTER	SPRING
Broadcast sow treated sites with native seeds. Fell treated trees if necessary.	Pull seedlings when soil is moist. Plant sweetgum and sycamore saplings.
SUMMER	**FALL**
Apply herbicide as a foliar spray and/or using the basal bark method during active growth, from July through mid-October.	Apply herbicide no later than mid-October. Wait at least 2 months after treatment to fell trees. Plant sweetgum and sycamore saplings.

III. Vines & Lianas

Japanese Honeysuckle

Lonicera japonica

Origin: Japan

Introduction: Early 1800s

Propagation: Plants produce seeds after 3 to 5 years; production peaks between 4-6 years, then declines sharply. Shading dramatically reduces seeding.

Dispersal: Seeds are dispersed by frugivorous birds and small mammals.

Persistence: Limited, likely > 2 years.

Life Cycle: Perennial

Description: A woody, semi-evergreen, twining liana, usually found growing in dense mats overtopping other vegetation; **stems** are sometimes shaggy, blonde in color, and twisted, with twigs that feature a hollow pith; oppositely arranged **leaves** are ovate with smooth margins; distinctive showy white **flowers** are bilaterally symmetrical and borne in pairs at leaf nodes; **fruits** are paired, round, black berries with multiple seeds.

Phenology: Plants break dormancy in March. Flowers bloom from May to July. Fruits mature from September through November. Plants usually senesce in late November or December, sometimes retaining leaves into winter.

Habitat: Abandoned fields, grasslands, roadsides and right-of-ways, disturbed areas, forest edges and openings, second-growth forest interiors, wetlands, and riparian areas.

Look-alikes: Trumpet honeysuckle *(Lonicera sempervirens)* and wild honeysuckle *(Lonicera dioica).*

ECOLOGICAL IMPACTS

A woody vine (liana) that kills trees both by strangling their trunks, effectively girding them, and by overtopping and shading out their canopies. Japanese honeysuckle also smothers shrubs and herbaceous plants and monopolizes soil resources via an aggressive root system. This species grows and spreads rapidly, posing a serious threat to forest communities and riparian areas.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Plants less than 2 years old can be **pulled** when soil is moist. **Mowing** is effective when repeated several times over the growing season for many years; mow at least twice, once in mid-July and again in mid-September. Density of stems may initially increase as a response to mowing, but repeated treatments will thin and eventually kill stands. **Burning** stands annually may be effective, but must be continued for many years to achieve the desired result; stem density may initially increase as a response to burning.

Chemical: Apply a **broad-spectrum systemic herbicide** as a **foliar spray** just before the first autumn frost, or as a spot treatment after a prescribed burn. Do not apply as a foliar spray when fruits are present, or May through September when birds are nesting. Note that broad -spectrum herbicides are non-selective and will also kill desirable plant species. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as necessary.

Biological: Livestock find Japanese honeysuckle palatable and have a similar effect to mowing, though they will likely not be able to reach the tops of mature lianas. Grazing should be combined with other treatments.

WINTER	SPRING
Broadcast sow treated sites with seeds of native species.	Begin grazing. Pull small patches and isolated plants.
SUMMER	**FALL**
Continue grazing. Pull small patches and isolated plants. Mow or burn in mid-July.	Pull small patches or isolated plants. Mow or burn in mid-September. Apply herbicide as a foliar spray just before the first frost.

Mile-a-Minute Weed

Persicaria perfoliata

Origin: Eastern Asia

Introduction: Mid-1930s (Pennsylvania)

Propagation: Plants produce 10s to 1000s of seeds; shading decreases seed production.

Dispersal: Seeds are dispersed by frugivorous birds, mammals, ants, and by water, as fruits are quite buoyant.

Persistence: Seeds viable up to 7 years.

Life Cycle: Usually an annual.

Description: A glaucous, branching, herbaceous vine often found growing in thick mats; **stems** are green or reddish in color and covered in recurved spines, with conspicuous rounded leaf sheaths subtending each node; **leaves** are light green and decidedly triangular, with recurved spines on petioles and on the undersides of major leaf veins; small, white, inconspicuous **flowers** in terminal spikes; **fruits** are bright blue, iridescent, round, berrylike, and fleshy, each containing a single seed.

Phenology: Plants emerge in late March or April. Flowering occurs from early June through July. Fruits develop from mid-July through August and mature from September to November. Plants die in October after one or more frosts.

Habitat: Abandoned fields, grasslands, roadsides and right-of-ways, disturbed sites, forest edges & openings, wetlands, & riparian areas.

Look-alikes: Arrowhead tearthumb *(Persicaria sagittata),* halberd-leaf tearthumb *(Persicaria arifolia)*, and bindweed species *(Convolvulus).*

ECOLOGICAL IMPACTS

Mile-a-minute weed is an herbaceous vine that can grow up to 6 inches per day. It forms dense mats of tangled vines that overtop trees, shrubs, and herbaceous plants, smothering them with a dense, heavy carpet of foliage, reducing native plant diversity and abundance and degrading wildlife habitat. This vine is so aggressive that it is even capable of killing Japanese honeysuckle stands.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Mile-a-minute weed has a shallow root system; small populations can be destroyed with a **hoe** or **pulled** in early spring before spines harden (be sure to wear gloves). **Mowing** and **cutting** are very effective methods of controlling this species; cut multiple times over the growing season to prevent flowering and fruiting. Repeat treatments annually until the seed bank has been exhausted.

Chemical: A **broad-spectrum systemic herbicide** can be applied as a **foliar spray** in early spring when native plants are still dormant. Note that broad-spectrum herbicides are non-selective and will also kill desirable plant species. For extensive or long-term invasions, apply a **pre-emergent herbicide** to prevent seeds from germinating in the spring. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Chemical treatments are most effective when combined with mechanical methods. Repeat treatments annually as necessary.

Biological: Managed **grazing** using **goats** or **sheep** has a similar effect to mowing. The Asiatic stem-boring weevil *(Rhinocomimus latipes)* has been approved for use as an **insect biocontrol** and feeds exclusively on Mile-a-minute weed.

WINTER	SPRING
Broadcast sow treated sites with seeds of native species **or** treat with a pre-emergent herbicide.	Begin grazing or mowing. Pull small patches and isolated plants. Release weevils **or** apply herbicide as a foliar spray.
SUMMER	**FALL**
Continue grazing or mowing. Pull small patches and isolated plants. Release weevils.	Broadcast sow native seed over treated sites.

Oriental Bittersweet

Celastrus orbiculatus

Origin: Southeastern Asia

Introduction: 1860s

Propagation: Plants produce large numbers of seeds; shading decreases seed production. Vegetative regeneration from root fragments is common.

Dispersal: Seeds are dispersed by frugivorous birds and mammals. Seeds are also buoyant and can be transported by water.

Persistence: Limited, 1-3 years.

Life Cycle: Perennial

Description: A twining, woody, robust liana winding its way from the forest floor up to the canopy; **stems** are rough, woody, and twisted, up to 70' long and 4" in diameter; **leaves** are alternate, glossy, toothed, and strongly ovate, with pointed tips; small 5-petaled, greenish **flowers** in clusters at leaf axils; numerous round **fruits** are green-to-yellow capsules that split upon maturity to reveal fleshy red arils containing 1-2 seeds.

Phenology: Plants break dormancy in April or early May. Flowering occurs from May through June. Fruits develop and mature from July through October. Plants senesce in October or November after multiple frosts.

Habitat: Abandoned fields, pastures, grasslands, roadsides and right-of-ways, disturbed sites, riparian areas, and forest edges, openings, and interiors.

Look-alikes: American bittersweet *(Celastrus scandens).*

ECOLOGICAL IMPACTS

Oriental bittersweet kills trees, shrubs, and herbaceous plants by overtopping and smothering them with a thick layer of vegetation. This woody, twining vine can also girdle tree trunks. Stands can become so heavy that they cause even mature canopy trees to topple, bringing whole forests to the ground. This species spreads to rapidly that a plant can grow to a stand that covers an acre of forest in less than 15 years.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Small plants can be **pulled** when soil is moist; be sure to remove entire root crown to avoid re-sprouting. **Mowing** and **cutting** are effective when repeated every 2 weeks throughout the growing season; continue for many years to exhaust the root system. Cessation of mowing before root systems are killed will result in higher stem density. **Burning** stands annually may be effective, but must be continued for many years to achieve the desired result; stem density may initially increase as a response to burning. Mechanical methods are most effective when combined with chemical treatments.

Chemical: Apply a **broad-spectrum systemic herbicid**e using the **cut-stem method.** Cut stems 2" above the soil and paint or spray with herbicide *immediately*, during dry conditions. For best results, apply in early spring or mid-October. Use herbicide as a **foliar spray** in early spring when native plants are dormant. Sites treated in spring will likely need a follow-up treatment to kill re-sprouting stumps. Combining chemical treatments with frequent mowing has proven very effective in controlling oriental bittersweet. Note that broad-spectrum herbicides are non-selective and will also kill desirable plants. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Repeat treatments annually as necessary.

WINTER	SPRING
Broadcast sow treated sites with seeds of native species.	Begin mowing. Pull small patches and isolated plants. Apply herbicide as a foliar spray or using the cut-stem method.
SUMMER	**FALL**
Continue mowing or burn. Pull small patches and isolated plants.	Pull small patches and isolated plants. Apply herbicide using the cut-stem method.

Porcelain Berry

Ampelopsis brevipedunculata

Origin: Southeastern Asia

Introduction: Mid-1800s (New England)

Propagation: Plants are capable of producing a large number of seeds and regenerate vegetatively through root suckering and stem layering. Root fragments are also capable of sprouting.

Dispersal: Seeds are dispersed primarily by frugivorous birds and mammals, including deer. Fruits are buoyant and can also be transported by water.

Persistence: Unknown

Life Cycle: Perennial

Description: A woody, climbing liana; **stems** are dotted with lenticels, feature a white pith, and grow up to 20' long; alternate, coarsely toothed **leaves** with 3-5 pronounced lobes and heart-shaped bases; small, greenish-white **flowers** in flat-topped clusters at leaf axils; **fruits** are speckled round berries in colors ranging from blue to pink to purple, containing 1-4 seeds.

Phenology: Plants break dormancy in late April or May. Flowering occurs from May through August. Fruits develop and mature from August through October. Plants senesce in October after the first hard frost.

Habitat: Anthropogenically disturbed sites, roadways, abandoned fields, meadows, disturbed wetlands, riparian areas, and forest edges and openings. It is intolerant of deep shade and not likely to colonize mature, undisturbed forests.

Look-alikes: Native grape *(Vitis)* and peppervine species *(Ampelopsis).*

ECOLOGICAL IMPACTS

Porcelain berry lianas rapidly form dense mats of vegetation that overtop, weigh down, and shade out native plants. Porcelain berry alters forest structure, reduces plant abundance and diversity, and prevents natural ecological succession, permanently degrading wildlife habitat and eliminating important food resources.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Small plants can be **pulled** when soil is moist; be sure to remove entire root crown to avoid re-sprouting. Shading-out stands by **planting** fast-growing native trees has shown some success as a control method when combined with other treatments and when trees are kept free of lianas. **Mowing** and **cutting** can be effective control methods provided they are done frequently enough to prevent plants from flowering and fruiting; continue for many years to exhaust root systems. Cessation of mowing before root systems are killed will result in higher stem density.

Chemical: Apply a **broad-spectrum systemic herbicide** in autumn using the **cut-stem** or **basal bark** method. Cut stem as short as possible and paint or spray with herbicide *immediately*, or, for younger plants with thin bark, apply herbicide as a basal bark spray during dry conditions. For best results, make a deep cut before applying herbicide to stems. Herbicide can also be used as a **foliar spray** in early spring when native plants are dormant. Note that broad spectrum herbicides are non-selective and will also kill desirable plants. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Repeat treatments annually as necessary.

Biological: Goats will **graze** porcelain berry, and managed grazing has shown some success in controlling populations when combined with other treatment options.

WINTER	SPRING
Remove vines from trees. Broadcast sow treated sites with seeds of native species.	Pull small plants. Plant native trees. Mow, cut, or graze. Apply herbicide as a foliar spray before native plants emerge.
SUMMER	**FALL**
Pull small plants. Remove vines from native trees. Mow, cut, or graze.	Pull small plants. Plant native trees. Apply herbicide using the cut stem or basal bark method.

Swallow-wort Species

Vincetoxicum spp.

Origin: Europe & northern Asia

Introduction: Mid–1800s

Propagation: Each plant is capable of producing dozens of seeds. Seed production is highly variable, with shaded plants producing considerably fewer seeds.

Dispersal: Seeds are dispersed by wind.

Persistence: Limited, likely < 5 years.

Life Cycle: Perennial

Description: An herbaceous vine, upright or twining, up to 6.5' tall, often found growing in dense patches; slender, green **stems** with milky sap; **leaves** opposite or whorled, elliptic to ovate, with pointed tips; small, star-like, 5-petaled **flowers**, maroon or various shades of purple, borne in cymes at leaf axils; **fruits** are 2-3" long pods that split to release seeds with hairy apical tufts that aid in wind dispersal.

Phenology: Plants break dormancy in April. Flowering occurs from May to late July. Fruits develop and mature from June to September, with seeds dispersing from July through October. Plants senesce in October.

Habitat: Abandoned fields, pastures, grasslands, roadsides and right-of-ways, disturbed sites, wetlands, riparian areas, forest edges, and openings. Swallow-wort is shade tolerant and can invade mature forests from edges and openings.

Look-alikes: Native honeyvine *(Cynanchum laeve).*

ECOLOGICAL IMPACTS

Swallow-wort grows & spreads rapidly, forming extremely dense, expansive stands that choke out native plants including its close relative, native milkweed. In areas where milkweed is absent, monarch butterflies lay eggs on swallowwort, which is toxic to insect larvae. Research suggests swallow-wort suppresses both insect populations and soil microbial communities.

INTEGRATED MANAGEMENT OPTIONS

Mechanical: Digging up isolated plants and small patches is effective as long as the entire root crown is removed. **Plowing** followed by the immediate **planting** of an annual cover crop annually for 5 years is effective, but not feasible in natural communities. **Planting** of broadleaf species that break dormancy in early spring and/or **mulching** may help to thin stands, but will not control populations. **Covering** with a thick black tarp for two years is very effective, but may not be practical for large invasions. Mowing or cutting are not effective and may increase stand density, though mowing once in late June or early July may prevent most plants from successfully seeding. Mulch treated sites to reduce seed germination. Repeat treatments annually for 2 or more years.

Chemical: Applying a **broad-spectrum systemic herbicide** as a **foliar spray** can be effective at reducing swallow-wort density, cover, and biomass and may prevent plants from seeding. The best time to apply herbicide is when plants are flowering but have not yet produced seed, in late June or early July. Note that broad-spectrum herbicides are non-selective and will also kill desirable plants. A permit is usually required to apply herbicides in wetland and riparian areas. Read labels and instructions thoroughly, follow all applicable laws and regulations, and wear protective gear when using herbicides. Repeat treatments as necessary.

Biological: Cattle have been observed to graze swallow-wort, but do not effectively control populations. Horses avoid swallow-wort, and it appears to be toxic to goats.

WINTER	SPRING
Broadcast sow treated sites with seeds of native broadleaf species. Cover with a deep layer of mulch.	Dig out small patches and isolated plants. Cover with mulch or a thick black tarp. Plow cultivated land and sow an annual cover crop.
SUMMER	**FALL**
Dig out small patches and isolated plants. Mow or apply herbicide as a foliar spray in late June or early July. Cover with a tarp or mulch.	Broadcast sow treated sites with seeds of native broadleaf species. Cover with a thick tarp or mulch. Plow cultivated land & sow a cover crop.

Photo Credits

Canada Thistle *(Cirsium arvense)*
Stem and Leaves : Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Basal Rosette: Jan Samanek, Phytosanitary Administration, Bugwood.org
Flowers: Jan Samanek, Phytosanitary Administration, Bugwood.org
Seeds: Jan Samanek, Phytosanitary Administration, Bugwood.org
Infested field: Jan Samanek, Phytosanitary Administration, Bugwood.org
Flowering Plant: Bonsak Hammeraas, NIBIO - The Norwegian Institute of Bioeconomy Research, Bugwood.org

Common Reed *(Phragmites australis)*
Stem and Leaves: Ohio State Weed Lab, The Ohio State University, Bugwood.org
Leaves : Rebekah D. Wallace, University of Georgia, Bugwood.org
Inflorescence: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Seeds: D. Walters and C. Southwick, Table Grape Weed Disseminule ID, USDA APHIS PPQ, Bugwood.org
Lakeside infestation: John M. Randall, The Nature Conservancy, Bugwood.org
Plant Against Blue Sky: Steve Dewey, Utah State University, Bugwood.org

Garlic Mustard *(Alliaria petiolata)*
Basal Rosette: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Close-up of Flower : Chris Evans, University of Illinois, Bugwood.org
Green Seed Pods: Chris Evans, University of Illinois, Bugwood.org
Taproots: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Infested Forest: Steven Katovich, USDA Forest Service, Bugwood.org
Flowering Plant: Chris Evans, University of Illinois, Bugwood.org

Giant Hogweed *(Heracleum mantegazzianum)*
Stem: Rob Routledge, Sault College, Bugwood.org
Leaf: Donna R. Ellis, University of Connecticut, Bugwood.org
Flower Umbel: Terry English, USDA APHIS PPQ, Bugwood.org
Seeds: USDA APHIS PPQ, USDA APHIS PPQ, Bugwood.org
Infestation: Terry English, USDA APHIS PPQ, Bugwood.org
Flowering Plant: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Knotweed spp. (*Reynoutria spp.)*
Stem: Ansel Oommen, Bugwood.org
Leaves : David J. Moorhead, University of Georgia, Bu gwood.org
Flowering Branch: Jan Samanek, Phytosanitary Administration, Bugwood.org
Seeds: Chris Evans, University of Illinois, Bugwood.org
Infestation: Barbara Tokarska-Guzik, University of Silesia, Bugwood.org
Knotweed growing on Eroded Banks: Jenn Grieser, New York City Department of Environmental Protection, Bugwood.org

Japanese Stiltgrass *(Microstegium vimineum)*
Red Stem photo; Silvery Leaves photo; and Seed Stalk photo: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Roots: Brittany Lagaly, Finger Lakes Institute
Infestation: Chris Evans, University of Illinois, Bugwood.org
Patch of Stiltgrass: Brittany Lagaly, Finger Lakes Institute

Knapweed Species *(Centaurea spp.)*
Stem photo; Basal Rosette photo; and Flowerhead photo: Rob Routledge, Sault College, Bugwood.org
Seedhead: Ohio State Weed Lab, The Ohio State University, Bugwood.org
Infestation: John M. Randall, The Nature Conservancy, Bugwood.org
Blooming Plant: Catherine Herms, The Ohio State University, Bugwood.org

Purple Loosestrife *(Lythrum salicaria)*
Stem: Rob Routledge, Sault College, Bugwood.org
Leaves: Bruce Ackley, The Ohio State University, Bugwood.org
Flower: Linda Wilson, University of Idaho, Bugwood.org
Seed pod: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Infestation: Agriculture and Agri-Food Canada, Bugwood.org
Blooming Plant: Mark Schwarzlander, University of Idaho, Bugwood.org

Slender False Brome *(Brachypodium sylvaticum)*
Stem & Leaves: Bruce Newhouse, kingcounty.gov
Drooping Plant: WNY PRISM
Inflorescence: Bruce Newhouse, kingcounty .gov
Seeds: Steve Hurst. Provided by ARS Systematic Botany and Mycology Laboratory. Turkey, Samsun.
Infested Forest Floor: WNY PRISM
Infestation Along Trail: Audrey Bowe, Ithaca, NY

Wild Parsnip *(Pastinaca sativa)*
Stem: Ohio State Weed Lab, The Ohio State University, Bugwood.org
Leaf photo and Flower Umbel photo: John Cardina, The Ohio State University, Bugwood.org
Seed Umbel: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Infestation: John M. Randall, The Nature Conservancy, Bugwood.org
Blooming Plant: Linda Haugen, USDA Forest Service, Bugwood.org

Yellow Iris *(Iris pseudacorus)*
Leaves: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Flower: Shaun Winterton, Aquarium and Pond Plants of the World, Edition 3, USDA APHIS PPQ, Bugwood.org
Seed Pod photo; Root photo; and Infestation photo: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
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Autumn Olive *(Elaeagnus umbellata)*
Stem: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Leaves: James H. Miller, USDA Forest Service, Bugwood.org
Flowers: Nancy Loewenstein, Auburn University, Bugwood.org
Fruiting Stem: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Infestation photo and Shrub photo: Chris Evans, University of Illinois, Bugwood.org

Burning Bush *(Euonymous alatus)*
Stem: Chris Evans, University of Illinois, Bugwood.org.jpg
Leaves: Richard Gardner, Bugwood.org
Flower photo and Fruit photo: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg
Infestation: Richard Webb, Bugwood.org
Foliage: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg

Bush Honeysuckle *(Lonicera spp.)*
Stems: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Leaves: Ryan Armbrust, Kansas Forest Service, Bugwood.org
Flowering Stem photo and Fruiting Stem photo: John M. Randall, The Nature Conservancy, Bugwood.org
Infestation photo and Flowering Shrub photo: Richard Gardner, Bugwood.org

Common Buckthorn *(Rhamnus cathartica)*
Trunk: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Leaves: Chris Evans, University of Illinois, Bugwood.org
Flowers: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg
Fruits: Jan Samanek, Phytosanitary Administration, Bugwood.org
Infestation: Chris Evans, University of Illinois, Bugwood.org
Fruiting Branches: John M. Randall, The Nature Conservancy, Bugwood.org

Japanese Barberry *(Berberis thunbergii)*
Stems: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg
Leaves: Richard Gardner, Bugwood.org
Flower: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg
Fruits: Barry Rice, sarracenia.com, Bugwood.org
Infestation photo and Green Shrub with Red Shrubs photo: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg

Rosa multiflora *(Multiflora rose)*
Stem and Stipules: James H. Miller, USDA Forest Service, Bugwood.org
Leaves: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg
Flowers: Rob Routledge, Sault College, Bugwood.org
Fruits: James H. Miller, USDA Forest Service, Bugwood.org
Infestation: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg
Climbing Flowering Shrub: James H. Miller, USDA Forest Service, Bugwood.org

Norway Maple *(Acer plantanoides)*
Trunk: Rob Routledge, Sault College, Bugwood.org
Leaves: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg
Flower photo and Samara Fruits photo: Robert Vidéki, Doronicum Kft., Bugwood.org
Infestation: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.jpg
Tree: Dow Gardens, Dow Gardens, Bugwood.org

Privet spp. *(Ligustrum spp.)*
Stem: Karan A. Rawlins, University of Georgia, Bugwood.org
Leaves: Chris Evans, University of Illinois, Bugwood.org
Flower photo; Fruit photo; Infestation photo; and Shrub photo: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Tree-of-Heaven *(Ailanthus altissima)*
Trunk: Annemarie Smith, ODNR Division of Forestry, Bugwood.org
Leaves: Chuck Bargeron, University of Georgia, Bugwood.org
Flowers: Jan Samanek, Phytosanitary Administration, Bugwood.org
Samara Fruits: Annemarie Smith, ODNR Division of Forestry, Bugwood.org
Infestation: Chris Evans, University of Illinois, Bugwood.org
Fruiting Branches: Jan Samanek, Phytosanitary Administration, Bugwood.org

Japanese Honeysuckle *(Lonicera japonica)*
Liana: James H. Miller, USDA Forest Service, Bugwood.org
Leaves: Bruce Ackley, The Ohio State University, Bugwood.org
Flowers: Chuck Bargeron, University of Georgia, Bugwood.org
Fruit photo and Infestation photo: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Flowering Liana: Chris Evans, University of Illinois, Bugwood.org

Mile-a-Minute Weed *(Persicaria perfoliata)*
Vine: Bruce Ackley, The Ohio State University, Bugwood.org
Leaf photo; Flower photo; Fruit photo; Infestation photo: and Fruiting Vine photo: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Oriental Bittersweet *(Celastrus orbiculatus)*
Liana photo and Leaves photo: Chris Evans, University of Illinois, Bugwood.org
Flower photo; Fruit photo; and Infestation photo: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Lianas: Chris Evans, University of Illinois, Bugwood.org

Porcelain Berry *(Ampelopsis brevipedunculata)*
All photos: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Swallow-wort spp. *(Vincetoxicum spp.)*
All photos: Rob Routledge, Sault College, Bugwood.org

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Glossary

Alternate leaves: leaves are arranged singly with one leaf per node along stem.

Axil: referring to the area where the petiole meets the stem.

Basal bark method: the application of herbicide to the base of a shrub or tree trunk.

Basal rosette: a low, unbranched, whorled cluster of leaves; many perennial and biennial plants spend their first year as basal rosettes.

Bolting: referring to the rapid growth of a plant, usually followed by flowering.

Bract: modified leaf tissue that subtends a flower or flowerhead.

Broad-spectrum herbicide: a non-selective herbicidal chemical that will kill any plant it reaches; as opposed to a selective herbicide.

Cut-stem method: the immediate application of herbicide to a low-cut stump; typically herbicide is painted on with a brush or applied as a spray.

Dioecious: referring to a plant species where male and female reproductive organs are located on different individuals.

Dispersal: the process by which a seed or propagule is carried away from its parent plant.

Ecosystem: a complex, interdependent system that arises from the evolution of a community of organisms interacting with abiotic elements of the environment over time.

Evolution: the genetic process through which populations of species change over time.

Foliar spray: herbicide that is applied to the leaves and stems of a plant.

Glaucous: waxy or powdery in appearance.

Liana: a woody vine.

Lenticel: a raised pore on a stem or trunk that aids the plant in respiration.

Opposite leaves: leaves are arranged in pairs at leaf nodes along stem.

Palmate: leaf lobes or leaflets radiate from a central point, like fingers from a palm.

Persistence: the ability of seeds and propagules to remain viable under normal circumstances.

Phenology: referring to the timing of developmental and reproductive events in relation to seasonal changes.

Pinnate: leaf lobes or leaflets are arranged opposite of one another along a central axis, like a feather.

Propagation: the mechanisms through which plants regenerate; can be vegetative or reproductive.

Propagule: referring to seeds or vegetative matter that is capable of dispersing from its parent plant and growing into another plant (i.e., a root or stem fragment).

Recurved: curved back toward the stem.

Rhizome: modified stems that act as roots.

Root crown: the roots that arise from the base of a plant.

Seed Bank: referring to all viable seeds in the soil of a given area.

Senescence: the process through which plants relocate resources to storage organs, usually in preparation for winter.

Simple leaf: leaves that are not subdivided in smaller leaflets.

Stem layering: the process by which part of a stem becomes buried and develops adventitious roots.

Stipule: a leafy growth subtending the base of a leaf petiole.

Suckering: the process by which plants activate dormant buds in root or stem tissue to create new shoots.

Systemic herbicide: an herbicidal chemical that is taken up by the plant and moved through stems, leaves, and roots, negatively affecting all plant organs.

Terminal: referring to a position at the end of a leaf or stem.

Weed wrench: a simple fulcrum and lever device used to uproot trees and shrubs.

Whorled leaves: leaves are arranged with three or more leaves per node

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Seasonal Planning Table

M= Mechanical; **C**=Chemical, **B**=Biological

		January	February	March	April	May	June
Herbaceous Plants	Canada Thistle			M	M,C,B	M, B	M, B
	Common Reed			M	B	M, B	M, B
	Garlic Mustard			B	B	M, C, B	M, C, B
	Giant Hogweed			M	M, C, B	M, B	M, C, B
	Knotweed	M	M	M			
	J. Stiltgrass			C	B	B	B
	Knapweed				M, C, B	M, B	M, B
	P. Loosestrife				M, B	M, B	M, C, B
	S. Falsebrome			C	M	M, C	M
	Wild Parsnip			M	M	M, C	M
	Yellow Iris			M	M	M	M, C
Trees & Shrubs	Autumn Olive			M	M, C	M	M
	Burning Bush			M	M, C	M	M
	Honeysuckle			M	M, C, B	M, B	M, B
	C. Buckthorn				M, B	M, B	M, B
	J. Barberry			M	M, C, B	M, B	M, B
	Multiflora Rose			M	M, C, B	M, B	M, B
	Norway Maple	M	M	M	M	M	M
	Privet Species			M	M, C, B	M, B	M, B
	Tree-of-Heaven			M	M	M	
Vines & Lianas	J. Honeysuckle			M	M, B	M, B	M, B
	Mile-a-Minute			M, C, B	M, C, B	M, B	M, B
	O. Bittersweet			M	M, C	M	M
	Porcelain Berry			M	M, C, B	M, B	M, B
	Swallow-wort			M	M	M	M, C

Seasonal Planning Table

M= Mechanical; **C**=Chemical, **B**=Biological

		July	August	September	October	November	December
Herbaceous Plants	Canada Thistle	M, B	M, B	M, B	M, C		
	Common Reed	M, C, B	B	B			
	Garlic Mustard						
	Giant Hogweed	M, B	M, B	B			
	Knotweed	M		C			
	J. Stiltgrass	B	M, C, B				
	Knapweed	B	B	B	M		
	P. Loosestrife	M, B	M, B				
	S. Falsebrome	C			C		
	Wild Parsnip	M	M	M	M, C		
	Yellow Iris	M, C					
Trees & Shrubs	Autumn Olive			C	C		
	Burning Bush	M	M	C	C		
	Honeysuckle	B	B	B, C	C		
	C. Buckthorn	M, B	M, B	C	C		
	J. Barberry	M, B	M, B	M, C, B	C		
	Multiflora Rose	M, B	M, B	M, C, B	C		
	Norway Maple	M	M	M, C	M, C	M	M
	Privet Species	M, B	M, B	C	C		
	Tree-of-Heaven	C	C	C	C		
Vines & Lianas	J. Honeysuckle	M, B	M, B	M, B	C		
	Mile-a-Minute	M, B	M, B	M, B			
	O. Bittersweet	M	M	M	C		
	Porcelain Berry	M, B	M, B	M, B	M, C		
	Swallow-wort						

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