WEED RISK ASSESSMENT

INTRODUCTION

Risk assessment is a process of managing hazards by identifying critical control points and best management practices to mitigate the hazard. In this document, we discuss weed risk assessment, where weeds and/or invasive plants are the identified hazard that could potentially cause harm to plants being grown or offered for sale. The weed risk assessment will identify **critical control points (CCP)**, the opportunities or points in the growing process where control measures, called **best management practices (BMP),** can be applied to prevent, eliminate, or reduce the risk of a crop becoming contaminated with weeds or invasive plants.

WHY DOES IT MATTER?

Weeds and invasive plants compete with crops for water, nutrients, and sunlight. They may directly reduce profits by hindering harvest operations, lowering nursery stock quality, and producing chemicals that are harmful to other plants (allelopathy). Conducting a risk assessment specifically targeted to weed and invasive plant management strategies can help you to:

- grow healthier plants,
- evaluate whether your current weed management efforts are effectively targeting and controlling weeds that are present in or around the nursery,
- document and organize your weed management program so it can be clearly communicated to staff and customers,
- reduce the potential spread of invasive plants that may be hitchhiking with plants that are for sale,
- reduce complaints from customers by preventing the introduction of weeds and invasive plants to their property via nursery stock,
- better understand invasive plant pressure in and around the nursery and where nursery stock could become infested,
- increase awareness of plants in your inventory to prevent invasive plants on the do-not-sell list from being grown or sold.

HOW TO USE THIS DOCUMENT

You can find information here whether you are ready to conduct a full risk assessment to document your weed management practices or just looking for ideas to improve your weed management strategies.

- First, dive into risk assessment! Identify critical control points and apply best management practices to develop a weed and invasive plant management plan.
- Next, we discuss general best management practices for weed control. Explore potential cultural, mechanical, chemical, and biological control options for weeds and invasive plants and the best strategies for annuals, perennials, and woody plants.
- Last, we've included information on strategies to control specific invasive plant species growing in or around your nursery and help prevent their spread by keeping them out of your crop!

GLOSSARY

Best Management Practice (BMP): Measures implemented at a critical control point to prevent, eliminate, or reduce the risk associated with a particular hazard.

Critical Control Point (CCP): Any point, step, or procedure at which controls may be applied and the hazard prevented, eliminated, or reduced to an acceptable level.

Hazard: A threat that has the potential to cause harm to nursery stock by the introduction of plant pests. For the purposes of this document, weeds and invasive plants are the identified hazards.

Invasive Plant: A non-native species that has spread into native or minimally managed plant communities (habitats) in Maine that causes economic or environmental harm by developing self-sustaining populations that become dominant and/or disruptive to native species.

Nursery: All types of businesses that grow and sell plants. The concepts presented here can apply to businesses that produce plants in the ground or in containers, as well as garden centers, greenhouses, and other businesses that sell and grow plants.

Nursery Stock: Any plants (annual, perennial, tree, shrub, etc.) intended for sale at nurseries.

Risk Assessment: The process of identifying hazards, critical control points, and best management practices to improve pest management and grow healthier plants.

Weeds: Are any plant that grows where it is not wanted. They can be native or non-native plants. This document sometimes uses the term weeds interchangeably with invasive plants.

CONDUCTING A WEED RISK ASSESSMENT

A weed risk assessment will help your business proactively prevent weeds and invasive plants. The risk assessment involves:

- Identify the CCPs where the nursery crop may become contaminated with weeds and invasive plants in your growing processes,
- Document what BMPs you are using to prevent and control weeds and invasive plants,
- Add new BMPs that fit with your existing production process to improve your weed and invasive plant management, if necessary,
- Develop a weed management plan that includes the BMPs documented in the risk assessment and identifies which employee is responsible for implementing each BMP,
- Periodically review your weed management plan to ensure it continues to prevent weed and invasive plant infestation of nursery stock.

Figure 1: Follow these steps to develop a weed and invasive plant management plan by conducting a weed risk assessment

IDENTIFY CRITICAL CONTROL POINTS

The first step in risk assessment is to identify the critical control points (CCP) in your plant production process where weeds or invasive plants could be introduced and contaminate your crop. The CCPs for each business may vary, but some common CCPs apply to many plant growing and selling businesses. Below is a list of potential critical control points, but keep in mind that some of these may not apply to your production process, or you may have other CCPs not listed here.

1. **Inputs -** Invasive plants and weeds can be introduced via seeds, tissue culture, bare-root, and container stock. Inspecting imported materials prevents the introduction of unwanted plant material. Soil, media, mulch, and other inputs can harbor weeds and invasive plants. Obtain these inputs from reliable, clean suppliers.
2. **Site -** Weeds and invasive plants can move from the surrounding environment into growing and sales areas. Know the invasive plant pressure surrounding your nursery and keep growing and plant holding areas free of weeds and invasive plants.
3. **Water -** Water can carry weed fragments and seeds. A clean, filtered water source should be used. Consider water runoff. Where can plant propagules be carried?
4. **Production Practices -** Sanitize benches and equipment. Plant debris should be disposed of in off-site trash (an invasive plant or weed should not be disposed of in a compost pile). Isolate temporary on-site invasive plant and weed disposal areas from growing or display sites. Regularly scout for weeds and invasive plants and use appropriate best management practices to manage them.
5. **Shipping and Sales -** Ensure proper inspection and sanitation to prevent the movement of weed or invasive plant seeds or fragments with nursery stock as it leaves the nursery.
6. **Training and Recordkeeping -** Train employees to recognize invasive plants and other weeds and implement the nursery's weed and invasive plant management plan. Good recordkeeping will help compare issues between crops from year to year, which can highlight successes and weaknesses with your weed and invasive plant management program.

DOCUMENT BEST MANAGEMENT PRACTICES

Once the CCPs in your plant growing program are identified, it is time to start documenting the best management practices (BMPs) you use to prevent or control weeds and invasive plants. Chances are you are already using some BMPs. Start by compiling what you already do, then determine if additional BMPs are needed to enhance or improve your weed and invasive plant management program. Remember, the goal is to sell only healthy plants free of weeds and invasive plants, and this is best achieved by applying at least two BMPs at every CCP, but the more BMPs you use, the stronger your pest management system!

Best Management Practices Checklist: Below is a list of potential BMPs organized by CCP. You can use this as a checklist to identify the BMPs you use in your business but keep in mind that:

- Each business is unique; you don't need to implement all the BMPs listed here to adequately prevent and control weeds and invasive plants. Pick and choose the ones that make sense for your business.
- This list is not exhaustive; you may follow other potential BMPs not listed here. We've left space under each critical control point for you to add your own.

CRITICAL CONTROL POINT: INPUTS

Potential best management practices for reducing or preventing the introduction of weeds and invasive plants on plant material moved into the nursery include:

- ☐ Know the operations where you source plants. Ensure the sending nursery is aware of the need to exclude hitchhiking plants, especially those that are illegal to sell in the State of Maine.
- ☐ Quarantine imported plants.
- ☐ Thoroughly inspect all incoming plant material, including liners, pots, and rootballs for weed seedlings, more advanced weeds, and invasive plants.
- ☐ Carefully remove weeds or invasive plants that have gone to seed to prevent the seeds from spreading into pots and production or display areas.
- ☐ Before ordering or purchasing plants, check the most current invasive plant do-not-sell list, and do not order plants that are no longer legal to import or sell in Maine.
- ☐ Upon arrival, double-check the list of plants in the shipment for any species on Maine's invasive plant do-not-sell list. Send back or refuse shipment of any plants on the list.
- ☐ Keep detailed records to allow for tracing back to the nursery of origin and provide feedback when weeds or invasive plants are discovered after the initial inspection.
- ☐ Use certified, weed-free seed sources.
- ☐ Store potting media under a cover and away from production areas.
- ☐ _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____

CRITICAL CONTROL POINT: SITE

Potential best management practices to follow when considering the site where you grow, hold, or sell plants include:

- ☐ Select planting and display sites not near established invasive plants.
- ☐ Survey the areas around fields and display areas regularly for invasive plants and weeds. Identify which weeds are present and what BMPs are needed to manage each species.
- ☐ Map out areas where weeds have been found to help guide future management efforts.
- ☐ Manage weeds growing along the perimeter of the nursery and around irrigation ponds.
- ☐ Mechanical cultivation may prevent annual weeds from going to seed.
- ☐ Train and license someone on staff as a pesticide handler or private pesticide applicator.
- ☐ Use registered pre-emergent herbicides labeled for nursery or greenhouse sites to help prevent weed infestations.
- ☐ Treat recently disturbed sites with pre-emergent herbicides or landscape fabric to suppress weeds.

- ☐ Spot apply post-emergent herbicides to help manage larger weed infestations not controlled by other means.
- ☐ Keep the area around and under containers weed-free.
- ☐ Consider flame weeders to clean up weeds not controlled by herbicides or mechanical cultivation.
- ☐ Hand-weed regularly to clean up weeds not controlled by other methods.
- ☐ Consider permeable disk-type or loose-fill mulches to prevent weed establishment in pots.
- ☐ Under greenhouse benches and outdoor plant display areas, use landscape fabric or other covers over dirt floors.
- ☐ Consider living mulches or cover crops between plant rows to help exclude weeds.
- ☐ Use mulch as a weed barrier around field-grown trees and shrubs. Maintain and renew mulches as needed.
- ☐ _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____

CRITICAL CONTROL POINT: WATER

Potential best management practices to follow when considering watering and your water source:

- ☐ Filter irrigation water.
- ☐ Drip irrigation is preferable to overhead irrigation.
- ☐ Limit excess water use as it encourages weed growth and causes runoff.
- ☐ Target fertilizer applications to nursery plants and avoid applying fertilizers through runoff to weedy or non-managed areas.
- ☐ Set the planting sites up so that excess water drains away from other planting areas, directing it into areas vegetated with non-invasive plants.
- ☐ Prevent or contain water and fertilizer runoff on-site.
- ☐ _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____

CRITICAL CONTROL POINT: PRODUCTION PRACTICES

Potential best management practices to follow when considering your plant production or growing practices include:

- ☐ Clean footwear, tools, equipment, tires, and treads regularly to prevent the spread of weed and invasive plant seeds.
- ☐ Use containers, potting media, and fertilizers not contaminated with weed seeds.
- ☐ Plant dense evergreens around field borders to prevent weed seeds from drifting into production areas and to reduce the potential for pesticide drift.
- ☐ Before using tillage equipment, control perennial weeds that may spread through tillage, such as yellow nutsedge, quackgrass, knotweed, or other plants that can root from plant fragments.
- ☐ Thoroughly clean all tillage implements before using them in another production area.
- ☐ Avoid broadcast fertilizer application; apply it in bands or spots to reduce excess fertilizer away from crop plants. Excess fertilizer encourages more weed growth.
- ☐ Consider applying pre-emergence herbicides to prevent early weed competition.
- ☐ All unlicensed pesticide applicators must be trained as Pesticide Handlers and indirectly supervised by a licensed Private Pesticide Applicator.
- ☐ Use spot application of post-emergence herbicides to clean up escaped weeds.
- ☐ Before using an herbicide, read the label thoroughly, follow all label directions, and use application equipment dedicated to herbicide use.
- ☐ Use clean equipment.
- ☐ Only use herbicides labeled for nursery or greenhouse use, and ensure products are registered for use in Maine.
- ☐ Consult the linked publication for guidance on maximizing herbicide efficacy and choosing herbicides for ornamental plant production. https://agsci.oregonstate.edu/sites/agscid7/files/em8899.pdf
- ☐ _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____
  _____

CRITICAL CONTROL POINT: SHIPPING AND SALES

Potential best management practices to follow when considering shipping and sales:

- ☐ Remove any weeds or invasive plants before moving plants into sales areas.
- ☐ Remove any weeds or invasive plants before loading purchased plants for shipping.
- ☐ Keep detailed records of all shipments and sales to help respond to customer complaints about weeds or invasive plants found hitchhiking with crop plants.
- ☐ Keep trucks and other conveyances clean to reduce the potential for contaminating plants in transit.
- ☐ _____

CRITICAL CONTROL POINT: TRAINING AND RECORDKEEPING

Potential best management practices to follow when considering training and record keeping:

- ☐ Develop an employee training program that includes weed and invasive plant identification.
- ☐ Provide updated weed and invasive plant training regularly.
- ☐ Train all employees as Pesticide Handlers or Workers according to the EPA Worker Protection Standard.
- ☐ License all key employees as Private Pesticide Applicators.
- ☐ Keep detailed records of weed scouting efforts.
- ☐ Map out weed populations, noting areas that need additional attention.
- ☐ Record all methods used to manage specific weeds or invasive plants in a management plan.
- ☐ Review records regularly to evaluate progress and results.
- ☐ Keep detailed records of all herbicide applications as the Maine Board of Pesticides Control requires.
- ☐ Evaluate the efficacy of all methods and only repeat those that have worked well.
- ☐ _____

COMPLETING THE RISK ASSESSMENT

Once you have identified and documented your best management practices, it is time to review and evaluate if the weed and invasive plant management plan you have in place is adequate. Ask yourself these questions:

1. Have I observed weeds or invasive plants in the pots or rootballs in my nursery stock?
2. Have I received feedback from employees, customers, or my state inspector that they observed weeds or invasive plants in the pots or rootballs of my nursery stock?
3. Has a customer or another state rejected or refused to accept any shipment of plants due to the presence of weeds or invasive plants?
4. Have I documented at least two best management practices for every critical control point?
5. Are the best management practices I've identified reducing or minimizing the presence of weeds and invasive plants?
6. Does my weed and invasive plant management plan include best management practices to control the invasive plant species identified in or around the nursery?

If you answered yes to questions 1-3 or no to questions 4-6, your weed and invasive plant management plan may not be adequate to prevent crop contamination. Consider implementing additional BMPs in your plant production process.

The list of critical control points and best management practices you assembled during the risk assessment process is the backbone of your weed and invasive plant management plan. The final steps in the risk assessment process and implementing your weed and invasive plant management plan include:

- Identify the personnel responsible for implementing each BMP,
- Train all personnel on their roles and responsibilities within the weed management plan and any other training identified in the risk assessment process,
- Periodically review the weed and invasive plant management program, document any changes or tweaks, and communicate them to the appropriate personnel.

GENERAL STRATEGIES FOR MANAGING WEEDS & INVASIVE PLANTS

Early detection is essential. Start managing an infestation before it becomes a severe problem. A combination of different practices is typically the best solution. When choosing an area to control, prioritize the least infested areas.

Timing matters. Before choosing a method of control, understand the weed you are working with and its biology. Knowing the biology will help determine the best management practices to implement to achieve control. For example, prevent the spread of annual or biennial plants by controlling them before they set seed. Perennial plants are often easiest to control in the early stages of growth or sometimes after flowering.

Be persistent. Management is a long-term process. Weed seeds can last in the soil for 5-50 years, and just an ½ inch of root fragment or a cutting could grow an entirely new plant.

Establish new plants. Maintaining vegetative cover will help prevent weeds and invasive plants from regaining a foothold. Establish new plantings with a diversity of non-invasive plant species. Grasses and low-growing legumes like Dutch white clover can be good options for weed-suppressing ground covers between nursery crop rows because they allow the directed use of some broadleaf herbicides with minimal effects on the ground cover plants.

Combine multiple strategies. Management options for weeds and invasive plants include cultural, mechanical, chemical, and biological controls. A single control method does not always guarantee success when preventing or managing weeds. Combining several best management practices will usually lead to the most effective outcomes.

TYPES OF CONTROLS FOR MANAGING WEEDS AND INVASIVE PEST

CULTURAL CONTROLS

Cultural control practices influence how weeds or invasive plants spread throughout the nursery. Consider how you grow your plants. What are you already doing, or what changes to your cultural practices can you make to minimize the establishment and spread of weeds in your growing and plant holding areas?

Watering/Fertilizing

- Over or under-watering can encourage weeds or invasive plants.
- Use a clean and filtered water source.
- Match fertility to crop plant needs.
- Direct water and nutrients onto crop plant root zones.

Site Maintenance

- Once open, quickly use growing media packages to reduce the time for weed seeds to intrude.
- Keep bagged products sealed until use.
- Keep fabric and mats weed-free.
- Travel corridors around the nursery should be weed-free; seeds can hitchhike on shoes, equipment, and tires.

Sanitation

- Use new or sanitized pots. Completely clean growing media out of any re-used pots before applying a sanitizer.
- Keep areas under benches swept and free of media, bare soil, and weeds.
- Clean boots, tires, and equipment regularly.

Exclusion

- Plant traffic-tolerant grasses or other densely growing non-invasive plants between crop plant rows.
- Use landscape fabric or weed mats between crop plant rows and under benches.
- Cover pots with weed barriers.

MECHANICAL CONTROLS

Mechanical controls for weeds and invasive plants can be labor-intensive and are not always feasible. These practices are often most effective in preventing weed and invasive plant establishment or when infestations are small.

Mulching

- Mulching can suppress weeds and weed seeds.
- Mulching works best when proper depths (4 to 6 inches) are maintained and it does not mix with soil or media.

Hand-Pulling

- Pull out the entire plant, including its root system.
- Dispose of pulled weeds away from growing or plant holding areas or off-site.

Mowing

- Mowing can reduce seed production in some annuals.
- Use a mulching mower that does not direct clippings into plant pots or crop areas.

Solarization

- Applying a clear plastic covering to damp ground and leaving it for several weeks can suppress some seeds, roots, and pathogens up to 3 inches deep.
- Solarization may also harm beneficial organisms; use caution.

Flaming & Burning

- Flaming must be very hot to prevent weed seed germination; surface burning can aid germination.
- The heat must barely boil the plant and not char it to control annual and perennial seedlings.
- Burning established perennials can help reduce top growth but leaves behind a viable root system.

CHEMICAL CONTROLS

Chemical control or herbicides may be applied as a spray, with a brush, or injected into weed plants. They are especially effective because they are easy to use and fast-acting and, depending on the product, may kill the roots as well as the upper portion of the plant. An Agricultural Basic or Private Pesticide Applicator License may be required to apply herbicides at the nursery.

Foliar Spray

- Herbicides are sprayed onto the foliage to slow down or kill vegetative growth by reducing/eliminating photosynthesis rates.
- Glyphosate and triclopyr are probably the most familiar foliar herbicides and are often used for weed and invasive plant management. Each is a systemic herbicide absorbed by the foliage and translocated into the root system.

Cut Surface Treatment

- A concentrated herbicide is applied to a freshly cut stem's cambium (outer ring). Cut surface treatment is ineffective in early spring when the sap is rising.

Basal Bark Application

- A systemic herbicide and penetrating oil mixture is thoroughly sprayed around the trunk of a woody plant under 5 inches in diameter.

Pre-Emergent Vs. Post-Emergent Herbicides

- Pre-emergent herbicides are applied in the spring or fall to target seed germination. These herbicides can effectively prevent summer or winter annual weed seeds from growing and continuing the infestation cycle.
- Post-emergent herbicides are applied during the growing season and target roots and vegetation. These herbicides can effectively control infestations of annual, perennial, and woody weeds and invasive plants and can interrupt the annual weed cycle when used to control plants before they set seed.

BIOLOGICAL CONTROLS

Biological control involves using another organism (insect, livestock, or pathogen) to combat invasive plants or weeds. There are limited options for controlling plants using biological controls. This method takes time to see results because the biocontrol agent often needs to be established before it provides adequate control. The release of biological control organisms can be inundative or inoculative:

- Inundative release involves releasing many biocontrol agent individuals at once. It is used to build biological control populations quickly and may be used once a pest is detected or is already established.
- Inoculative release involves releasing a small number of biocontrol organisms over time. Usually, inoculative releases are used preventatively to establish a biological control population when the pest population is low or before the pest is detected.

Augmentative

Augmentative biocontrol involves increasing the number of native natural enemies or pathogens, for example, by releasing bacteria or predators that may already be established in an area but not in high enough numbers to offer sufficient control.

Classical

Classical biocontrol involves introducing an exotic biocontrol agent, a natural enemy, or sometimes a pathogen. This method usually relies on scientists who study the agents and on governments that approve their release.

Conservation

Conservation biocontrol practices seek to preserve and enhance the number or activity of existing natural enemies. They mainly focus on managing the environment.

Any of the following factors may be enhanced or preserved to improve natural enemy populations: food sources, alternative hosts, shelter and refuge habitat, and appropriate microclimates.

Livestock

Grazing can either promote or reduce weed abundance at a particular site.

By itself, grazing will rarely, if ever, completely eradicate invasive plants. However, when grazing treatments are combined with other control techniques, such as herbicides or biocontrol, severe infestations can be reduced, and small infestations may be eliminated.

Grazing animals may be beneficial in areas where herbicides cannot be applied (e.g., near water) or are prohibitively expensive (e.g., large infestations). Animals can also be used as part of a restoration program by breaking up the soil and incorporating seeds of non-invasive plants.

APPROACHES TO MANAGING GROUPS OF WEEDS AND INVASIVE PLANTS

The strategies that best manage a species are often determined based on whether it is an annual/biennial, perennial, or woody plant and how it reproduces. Below are some best management practices that apply generally to these different groups of plants.

ANNUALS AND BIENNIALS

Annuals are herbaceous plants that live for only one growing season and do not survive the winter.
Biennials- are herbaceous plants that live for only two growing seasons, often in a vegetative form the first year, and then progress to flowering and producing seed the second year. Annual and biennial plants only naturally proliferate by producing seeds that overwinter and germinate once soil, water, light, and temperature conditions are favorable.

Seeds are the product of sexual reproduction in plants. Seeds of invasive plants are often viable for several years, depending on the species. Even if every growing plant of the species being managed is removed before it sets seed during the growing season, seeds previously left in the soil may be able to germinate for several years to come. Therefore, continually preventing the production and dispersal of seeds for many years is critical for managing invasive species.

Best Management Practices for Annuals and Biennials:

- Identify what time of year seeds are produced and how long seeds survive for the species you are managing.
- Prevent seed production by pulling, mowing, flaming, or covering before seed production
- Apply pre-emergent herbicides before seeds germinate, remembering that this method can also affect non-target plant seeds.
- Prevent seed spread by inspecting and cleaning shoes, clothes, vehicles, and equipment before leaving an infested area
- Pets, birds, and other animals can move seeds on their bodies or through their digestive systems when eaten. Therefore, pets and other animals should be prevented from moving through infested areas when possible.
- Do not compost plant material containing seeds.

PERENNIALS AND WOODY PLANTS

Perennials are herbaceous plants that survive the winter and live for more than two years. While their unprotected foliage dies back, perennials survive the winter via an underground energy storage structure (such as a root, rhizome, tuber, or bulb), which then produces foliage again each growing season. Some perennial root systems can be extensive, such as Japanese knotweed, which has roots that can be 18' in length. Others can be brittle and easily broken when plants are pulled, making digging out the root system necessary. Above-ground portions of perennial plants can also reproduce vegetatively by creating roots at nodes that have the potential to start new plants.

Woody Plants are a type of perennial that, in addition to having a hardy root system, also produce stiff stems that survive winters and provide the base for above-ground growth that compounds yearly. These include deciduous and evergreen trees, shrubs, and some vines. Due to the strength of the woody stems, manual control tends to need more rugged equipment, such as loppers, handsaws, pole saws, bush hogs, chain saws, and weed wrenches.

The following lists different ways perennial and woody plants can vegetatively reproduce.

Root Fragments: Many species can produce new plants from root fragments when broken, divided, cut, or eroded from the soil. For example, common mugwort can generate a new plant from root fragments as small as ¾" long.

Layering: Layering occurs when a plant produces roots at a node that can start a new plant. Tip layering occurs when arching stem tips touch the soil surface, grow roots, and send new shoots. This often creates impenetrable rolling thickets, commonly occurring with plants such as multiflora rose and stiltgrass.

Stolons/runners: Stolons and runners are stems that grow horizontally along the ground and produce roots at nodes that touch the soil surface, resulting in new plants. This can create low, interwoven mats of plants, as displayed by creeping Charlie.

Stem fragments: Stem fragments are pieces of stems that have been cut or mowed and left on the soil surface that are capable of rooting and starting new plants.

Suckers: Suckers are additional shoots that grow from underground roots. Woody plants that produce suckers can form large clonal stands of genetically identical plants, or if the root is separated from the

main plant, create new plants. Some plants, such as black locusts, are stimulated to produce abundant and vigorous new growth from suckers after being cut back.

Best Management Practices for Perennial Plants:

- Control seed production and germination using BMPs for Annual and Biennial Plants.
- Choose BMPs based on the vegetative reproduction methods of specific species.
- When removing perennials, include as much of the root system as possible to prevent root fragmentation.
- Mowing, pulling, cutting back, or using livestock to graze perennials can reduce the amount of energy that could be stored but will usually not kill the plant unless done repeatedly until stored energy has been exhausted.
- Bag and dispose of any plant material that can resprout.
- Post-emergence chemical control options for perennials depend on the species but may include foliar spray, stem injection, or cut-drip applications.
- Use established biological controls, if available.

Best Management Practices for Woody Plants:

- Control seed production and germination using BMPs for Annual and Biennial Plants.
- Choose BMPs based on the vegetative reproduction methods of specific species.
- Hand pull or mow seedlings during their first growing season before roots have time to develop.
- Control saplings and small infestations manually by digging and removing the root crowns.
- Cut, mow, or pull woody plants repeatedly for several years until energy resources have been exhausted.
- Root docking can damage the crown to prevent resprouting without disturbing soil.
- Larger woody plants may need to be cut down and, depending on the species, monitored for resprouts.
- Girdle trees by removing the bark layer, including the cambium, around the entire trunk circumference. Cut surface treatments pr
- Post-emergence chemical control options, such as glyphosate and triclopyr, must be determined based on the woody species to be controlled.
    - Basal bark spray on many species can be effective on stems less than 6" in diameter.
    - Cut surface treatment applied immediately following cutting can be effective, but not in early spring when the sap is rising.
    - Foliar Spray on many invasive woody shrubs and vines can often be applied in early spring or late fall when native species don't have leaves, thus reducing effects on non-target species.
    - Stem injection is an option for woody plants with a hollow pith but is often time-consuming.

STRATEGIES FOR CONTROLLING SPECIFIC PLANTS

Each invasive plant species may require a different approach to prevent or eradicate an infestation. On the following pages, you will find information on preventing and controlling certain invasive plant species and other weeds that you may encounter. For any invasive plant species that is particularly problematic in your nursery and requires control measures or implementation of specific BMPs, document those BMPs in your risk assessment to include them in your weed management plan.

AEGOPODIUM PODAGRARIA (BISHOP'S WEED, GOUTWEED)

Biology and Spread: Bishop's weed is an herbaceous perennial that primarily spreads through rhizomes, forming dense, impenetrable patches. Small root fragments easily create new plants. Variegated leaves may revert to solid green outside of cultivation, hindering identification.

Prevention and Management:

- ☐ Diligently hand-pull or dig plants, removing as much of the rhizomes as possible. Bag and dispose of all plant debris as plant fragments readily resprout.
- ☐ Apply glyphosate or triclopyr as a foliar spray during the growing season. The best results will be achieved if the infestation is mowed first and herbicide is applied to the leafy regrowth.

ACER GINNALA (AMUR MAPLE)

Biology and Spread: *Acer ginnala is a deciduous tree that produces allelopathic chemicals and prolific winged seeds. The seeds typically land within 100 meters of the parent tree and* can be moved by water.

Prevention and Management:

- ☐ Control infestations within 100 yards of production areas.
- ☐ Seedlings are easily pulled by hand or controlled by mowing.
- ☐ Small infestations can be controlled manually by digging and removing the root crowns.
- ☐ Infestations can be controlled by cutting and treating the cut surface with herbicide or through basal bark spray treatments.

ACER PLATANOIDES (NORWAY MAPLE)

Biology and Spread: Norway maple is a large deciduous tree that produces winged seeds readily dispersed in the wind and germinate quickly. Seedlings can be pulled from moist soil before they get too large. Other types of manual removal include digging out saplings and root systems or cutting down large trees.

Prevention and Management:

- ☐ Hand pull or mow seedlings.
- ☐ Dig saplings to remove root crowns.
- ☐ Girdling the trees by removing the bark layer (including the cambium) is most effective in the spring.
- ☐ Use a cut surface treatment of glyphosate or triclopyr, but not in early spring.
- ☐ Apply a foliar spray of glyphosate or triclopyr to seedlings, short saplings, or resprouts.
- ☐ Basal bark treatments are effective on stems up to 6" using triclopyr in penetrating bark oil.

ALLIARIA PETIOLATA (GARLIC MUSTARD)

Biology and Spread: Garlic mustard is an allelopathic biennial plant that can dominate the forest floor. Seeds germinate and grow into a short rosette by mid-summer. Flowers form in the second year, producing seeds, and die back in June. Seeds may remain viable for up to 6 years in the soil.

Prevention and Management:

- Hand-pull small populations and remove at least the upper half of the taproot to prevent a new flower stalk from forming and producing seed.
- Second-year plants that have begun to flower should be bagged for disposal, as seeds can still mature after being pulled.
- Mowing in late spring for 3-5 years can deplete the seed bank.
- Flaming
- Foliar spray with triclopyr ester or glyphosate solution on first-year rosettes and second-year plants well before seed set.
- Minimize disturbances in the forest understory that could allow for rapid invasion if seeds are present.

ARTEMISIA VULGARIS (COMMON MUGWORT)

Biology and Spread: Mugwort is a perennial that spreads primarily through its extensive yet shallow rhizome system. Plants can regenerate from rhizome fragments as small as ¾ inch, which can easily contaminate nursery stock. While a single plant can produce prolific seed, this does not seem to be a significant factor in the spread of mugwort populations.

Prevention and Management:

- Dig whole plants with all roots. Pulling is ineffective and may even promote growth by leaving residual rhizome fragments in the soil.
- Continued mowing can reduce stored energy but will not eradicate infestations.
- Cultivate soil repeatedly to disturb shallow roots, taking care not to spread root propagules on equipment.
- Control is best achieved using foliar applications of glyphosate or dicamba, though the rates required for adequate suppression are rarely economical.

BERBERIS THUNBERGIA (JAPANESE BARBERRY) & *B. VULGARIS* (COMMON BARBERRY)

Biology and Spread: Japanese and common barberry are spined deciduous woody shrubs. They spread through seed dispersed by wildlife, suckering, and tip layering. These shrubs leaf out earlier in the spring than native species and resprout vigorously when damaged by cutting or fire.

Prevention and Management:

- Pull or dig small infestations.
- Cut or mow several times each growing season for several years.
- Mow to prevent seedling establishment.
- Flame in spring and then again in summer to catch any survivors.
- Apply foliar treatment of glyphosate or triclopyr while leaves are present. Early spring application is best before native plants leaf out.
- Apply cut surface treatment of glyphosate or triclopyr immediately after cutting, but not in early spring. This is more effective for common barberry.
- Extra large plants can be cut one year, followed by a foliar herbicide treatment the next year.

CELASTRUS ORBICULATUS (ASIATIC/ORIENTAL BITTERSWEET)

Biology and Spread: Bittersweet is a deciduous woody vine that reproduces by seed that is often spread by wildlife and spreading underground roots that form new stems.

Prevention and Management:

- Do not use fruits in wreaths or decorations to prevent the spread of seeds.
- Hand pull or dig plants when they are small.
- Mow to prevent seedling establishment.
- Cut vines will readily resprout and must be kept off the ground. Cutting must be done at least six times a year for at least 3 years and then monitored to reduce the population.
- Basal bark treatments of triclopyr in bark oil work well for stems under 6" in diameter.
- Remove a section of larger vines between ankle and chest height to prevent new sprouts from reclimbing. Treat the lower cut surface immediately with triclopyr, except in early spring.
- Foliar applications of triclopyr are effective on foliage that can be safely reached.

CYANCHUM LOUISEAE (BLACK SWALLOW-WORT)

Biology and Spread: Black swallow-wort is an herbaceous perennial vine with allelopathic properties. Its seeds have fluffy filaments that allow it to move long distances in the wind. Spread is also achieved by rooting of stoloniferous stems.

Prevention and Management:

- Remove small infestations by digging and removing the root crowns before seed pod development.
- To control larger infestations, apply a foliar application of triclopyr when the foliage has developed before flowering or glyphosate after flowering has started.
- Several species have been identified as potential biological controls for swallow-wort. Two leaf-eating moth species (*Hypena opulenta* and *Abrostola asclepiadis*) show promise against swallow-worts but are not commercially available.
- Avoid cutting and mowing that stimulate sprouting from the root crown, resulting in denser infestations the following season.

EUONYMUS ALATUS (BURNING BUSH, WINGED EUONYMUS)

Biology and Spread: Euonymus alatus is a deciduous woody shrub that spreads through seeds often dispersed by birds and root suckering.

Prevention and Management:

- Pull small plants and seedlings by the roots.
- A weed wrench can be effective in removing roots on larger plants.
- Mow to prevent seedling establishment
- Cut larger plants several times a year for several years.
- This species leaves out early and drops its foliage late compared to most native woody species. Therefore, foliar glyphosate treatments should be applied early in spring or later in fall to prevent damage to nearby native plants.
- Apply glyphosate or triclopyr to the cut surface immediately after cutting, except in early spring.

EUONYMUS FORTUNEI (WINTERCREEPER, CLIMBING SPINDLE TREE)

Biology and Spread: Wintercreeper is an evergreen woody vine. It spreads vegetatively along vines in contact with the ground by producing rootlets that can develop into new plants. Aerial rootlets allow wintercreeper to climb rocks and trees, reaching heights of 40 to 70 feet. Wildlife and water also disperse wintercreeper seeds.

Prevention and Management:

- For small infestations, pull up individual vines by the roots.
- Apply cut surface treatment of glyphosate or triclopyr.
- A glyphosate or triclopyr foliar treatment with surfactant is best applied to heavy infestations after the last killing frost and before spring wildflower emergence to prevent harm to non-target species.

FALLOPIA JAPONICA (JAPANESE KNOTWEED)

Biology and Spread: Japanese knotweed is an herbaceous perennial often found in moist habitats. It mainly reproduces through fragmentation of its extensive root system that can reach lengths of 15-18 feet and be transported via water, especially during flooding. It can also sprout at stem nodes and from stem fragments. Some seeds are viable and can also be carried long distances on water.

Prevention and Management:

- Repeatedly cut or mow new patches of fewer than 20 stems once a week for several years until root reserves are exhausted.
- Digging roots is not recommended as they will fragment, creating new plants.
- Smothering with mulch or plastic sheets covering the infestation plus an additional 5' buffer can sometimes be effective with continual maintenance and scouting for escapees. This method can take up to 10 years.
- Glyphosate and triclopyr are effective against Japanese knotweed.
- Use a stem injection or cut-drip application of glyphosate for small patches.
- Cut or mow large patches when plants are 3' tall, then apply glyphosate as a foliar spray when plants have regrown 3-5' tall later in the same growing season. Avoid herbicide applications when flowering to prevent injury to pollinators.
- Apply foliar application of glyphosate to uncut, mature stems just before flowering.
- Herbicide use in or within 25 feet of wetlands may require a special permit from the Maine Department of Environmental Protection and/or a variance from the Maine Board of Pesticides Control.

FRANGULA ALNUS (GLOSSY BUCKTHORN)

Biology and Spread: Glossy buckthorn is a deciduous woody shrub or a small tree that spreads primarily through seed dispersal within fruits eaten by wildlife.

Prevention and Management:

- Pull or dig small plants with roots.
- Mow seedlings to prevent establishment.
- Cut or mow larger plants at least three times a year for three years, followed by monitoring for resprouts.
- Apply foliar treatment of glyphosate or triclopyr or a cut surface treatment immediately after cutting but not in early spring.
- Apply basal bark application of triclopyr ester in bark oil to stems less than 6" in diameter.
- Early-spring controlled burns in fire-adapted natural areas can help control glossy buckthorn seedlings in forests and woodlots with dense populations.

GLECHOMA HEDERACEA (CREEPING CHARLIE, GROUND IVY)

Biology and Spread: Creeping Charlie is an herbaceous perennial plant that spreads by seeds and stolons that grow along the ground. Variegated leaves may revert to solid green outside of cultivation, hindering identification.

Prevention and Management:

- Dig small patches of plants to remove all root fragments.
- Mowing and tilling are not recommended on large infestations due to their ability to regrow from plant fragments.
- Apply a post-emergence broadleaf herbicide such as triclopyr.

HESPERIS MATRONALIS (DAME'S ROCKET)

Biology and Spread: Dame's rocket is a short-lived perennial with a 3-month flowering season and produces seeds that remain viable for many years. It has been sold in garden centers as a perennial and is sometimes included in "wildflower" seed mixes.

Prevention and Management:

- Check any wildflower seed mixes to ensure they do not contain Dame's rocket seeds.
- Hand pull small infestations repeatedly until tap roots are exhausted.
- Dispose of plant material in trash or burn if flowers or seeds are present.
- Apply foliar herbicide applications based on timing: triclopyr in spring/early summer before flowering or glyphosate in late summer/early fall after flowering.

IMPATIENS GLANDULIFERA (ORNAMENTAL JEWELWEED)

Biology and Spread: Ornamental Jewelweed is an annual plant typically growing in wet areas. Its seeds are viable for at least 18 months and can float and germinate underwater.

Prevention and Management:

- Small populations can be hand-pulled or dug up.
- Mowing is very effective and causes less erosion than hand-pulling, but mowed or cut plants may resprout later in the season.
- Sheep and cattle will eat this plant.
- Apply a foliar spray of glyphosate or triclopyr if located in a grassy area.
- Herbicide use in or within 25 feet of wetlands may require a special permit from the Maine Department of Environmental Protection and/or a variance from the Maine Board of Pesticides Control.

LONICERA JAPONICA (JAPANESE HONEYSUCKLE), *L. MAACKII* (AMUR HONEYSUCKLE), *L. MORROWII* (MORROW'S HONEYSUCKLE), *L. TATARICA* (TATARIAN HONEYSUCKLE), *L. XYLOSTEUM* (DWARF HONEYSUCKLE)

Biology and Spread: Most of the honeysuckles in this group are large deciduous woody shrubs, except for Japanese honeysuckle, which is a woody vine. Spread to new sites mainly occurs through seed dispersal by birds and mammals. Honeysuckles also reproduce vegetatively by stem layering and suckering.

Prevention and Management:

- Hand pull seedlings and small plants by the roots, especially when the soil is moist.
- Mow twice yearly to prevent seedling establishment and slow the vegetative spread; however, stem density may increase.
- Dig or pull larger plants from the base using a weed wrench, rope, or chain.
- Root docking can be used. A bladed hoe is used to chop the root crown, leaving the soil undisturbed and helping prevent resprouting.
- Prescribed burning is best accomplished in spring but can also be done in fall. This method dramatically decreases abundance within a habitat by killing the seedlings and tops of mature plants. Since burning will not kill plant roots, spread is only limited to one to two growing seasons and is best used in combination with other control methods.
- Since honeysuckle leaves stay green and senesce later than other plants, apply glyphosate to foliage late in autumn when other plants are dormant.
- Cut large shrubs near the ground and treat the cut surface with glyphosate or triclopyr.

LYTHRUM SALICARIA (PURPLE LOOSESTRIFE)

Biology and Spread: Purple loosestrife is a perennial plant with dense root systems typically growing in wet areas. Its seeds are easily transported on water, clothing, equipment, soil, and wildlife and are viable for many years.

Prevention and Management:

- Dig, cut, or pull plants 3 times a year for at least 3 years.
- Cut and bag flower heads to prevent seed dispersal.
- Apply aquatic glyphosate or aquatic triclopyr (which avoids harm to grasses and sedges). Aquatic glyphosate can also be used as a cut-drip application but has shown less success.
- Herbicide use in or within 25 feet of wetlands may require a special permit from the Maine Department of Environmental Protection and/or a variance from the Maine Board of Pesticides Control.
- There are several biocontrol options, including *Gallerucella* beetles, but they may not be commercially available.
- A guide to rearing the beetles can be found on the York County Soil & Water Conservation District website at https://www.yorkswcd.org/photogallery/Invasives%20Files/Beetle%20Rearing%20Protocol.pdf

MICROSTEGIUM VIMINEUM (STILTGRASS)

Biology and Spread: Stiltgrass is an annual grass with very few populations in Maine, but seeds are known to hitchhike on nursery stock. Seeds are produced in September and are viable for 3-5 years.

Prevention and Management:

- Report all stiltgrass finds to the Maine Department of Agriculture, Conservation & Forestry.
- Hand-pull small populations before seed sets in September.
- Mow infestations between late July and early August, just before seed set so plants do not have time to develop new shoots that could produce seed.
- Pre-emergent and grass-specific herbicides can be used as interim control of larger infestations.
- Cover stiltgrass with 6" of mulch (chips, leaf litter) to help prevent seed germination.
- Flaming is not recommended for controlling established stiltgrass populations as dried stems from previous years are highly flammable and a forest fire risk.
- Minimize disturbances in the forest understory that could allow for rapid invasion if seeds are present.

PERSICARIA PERFOLIATA (MILE-A-MINUTE)

Biology and Spread: Mile-a-minute weed is a fast-growing, barbed herbaceous annual vine. There are no known established populations of mile-a-minute in Maine, but seeds are known to hitchhike on nursery stock. Seeds can be viable for up to 6 years and can be carried long distances via wildlife and water as they can float for 7-9 days.

Prevention and Management:

- Report all mile-a-minute finds to the Maine Department of Agriculture, Conservation & Forestry.
- Hand-pull vines in late spring to early summer before fruit formation. Wear thick gloves to prevent injury from barbed stems.
- Repeated mowing, weed whacking, or cutting can exhaust resources and reduce flower and fruit production.
- Use foliar applications of glyphosate or triclopyr before flowering. Use caution to prevent herbicide damage to plants the mile-a-minute vine is climbing over.
- Herbicide use in or within 25 feet of wetlands may require a special permit from the Maine Department of Environmental Protection and/or a variance from the Maine Board of Pesticides Control.
- *Rhinocominus latipes* Korotyaev weevil is a host-specific biological control of mile-a-minute weed, though it may not be commercially available.
- Avoid creating disturbances, openings, or gaps in existing vegetation.

PHRAGMITES AUSTRALIS (COMMON REED)

Biology and Spread: Common reed is an herbaceous perennial that primarily spreads from rhizome fragments in fill or by water. Seeds are viable for up to 5 years and are spread by wind and birds, but the germination rate is low.

Prevention and Management:

- Where equipment access and soil conditions allow, cut or mow plants repeatedly (as often as every 2 weeks for 5-10 years) before flowering.
- Flood with either fresh or salt water in settings where water levels can be controlled.
- Apply cut-drip or foliar application of aquatic glyphosate late in the season.
- Herbicide use in or within 25 feet of wetlands may require a special permit from the Maine Department of Environmental Protection and/or a variance from the Maine Board of Pesticides Control.
- Prescribed burning during the spring following an herbicide treatment can remove old thatch and encourage native plant regeneration.

RANUNCULUS REPENS (CREEPING BUTTERCUP)

Biology and Spread: Creeping buttercup is a perennial herb that reproduces by seed, root fragments, and stolons that root at stem nodes. It is toxic to most grazing livestock.

Prevention and Management:

- Dig plants, including roots, using gloves to prevent skin irritation from toxic sap.
- Many broadleaf herbicides are recommended for the control of buttercups.
- Plants can be weakened by mowing or cultivation but regenerate from the root and stem fragments, increasing the population.
- Plowing provides ideal conditions for seed germination and is therefore not recommended.
- Restore disturbed areas with desirable plants to prevent seed germination.

ROBINIA PSEUDOACACIA (BLACK LOCUST)

Biology and Spread: Black locust is a deciduous tree that reproduces by seeds that survive long periods and suckers that can establish large clones. Livestock should not be used for control as inner bark, roots, and twigs are poisonous.

Prevention and Management:

- Hand pull small seedlings.
- Pulling, mowing, cutting, or burning trees is only temporarily effective because black locusts can resprout and spread vegetatively. Such damage to stems can stimulate vigorous resprouting.
- Apply cut surface treatment of glyphosate or triclopyr except in spring. Continue to watch for resprouting.
- Apply a foliar spray of glyphosate or triclopyr to control seedlings, short saplings, or resprouts.
- Apply basal bark treatments of triclopyr in penetrating oil to lower 18-24" of the trunk on trees less than 6" in diameter.

ROSA MULTIFLORA (MULTIFLORA ROSE)

Biology and Spread: Multiflora rose is a thorned deciduous woody shrub that spreads primarily through seed dispersed by wildlife and layering of arching stem tips that reach the ground and take root. Seeds are viable in the soil for up to 20 years.

Prevention and Management:

- Hand pull individual small plants.
- Mow or cut large populations 3-6 times per growing season for 2- 4 years.
- Grazing by goats after flowering can reduce foliage growth and prevent seed set.
- Early-spring controlled burns can reduce above-ground plant material, making other controls more successful.
- Apply glyphosate or triclopyr herbicides as foliar, basal bark, or cut surface treatments during the growing season. Cut surface treatments should be applied immediately after cutting, except in early spring.

TUSSILAGO FARFARA (COLTSFOOT)

Biology and Spread: Coltsfoot is a rhizomatous perennial that is spread by seed and has a brittle root system that easily fragments. Seeds can be dispersed by water and wind as far as 8 miles.

Prevention and Management:

- Carefully dig plants and all roots for very small infestations.
- Minimize soil disturbance and establish competitive native perennial plants to reduce populations.
- Coltsfoot exhibits characteristics that may allow it to survive or establish after fire.
- Apply a foliar spray of glyphosate or triclopyr in the summer when leaves are fully expanded.