Vermont Landowner's Guide to Invasive Terrestrial Plant Management

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Top left going clockwise; Garlic mustard infestation, Emily Boedecker, The Nature Conservancy; Luna Moth, Warren Walker; Barberry infestation in Vermont sugarbush, Tim Wilmot; Lady's Slipper, The Nature Conservancy.

Introduction

Invasive species are a difficult and complicated problem. They change the places we love and the natural resources we depend upon for recreation, tourism, and income. They impact wildlife and disrupt natural succession, and can decrease biodiversity at an alarming rate.

The Vermont Chapter of The Nature Conservancy has trained thousands of Vermonters to recognize and remove invasives in their gardens and in natural areas. Our workshop instructors found that as peoples' awareness of the issue grew, so did their need for more comprehensive information than we could provide in a short workshop. We decided to create a manual to provide landowners with up-to-date and relevant prevention and management techniques.

We decided to create a new document because much of what is available is written for professional land managers of natural areas in faraway places. We combed through existing resources and websites to come up with a succinct set of guidelines for the Vermont land owner. We have brought you the most current management techniques for the most common species found in Vermont, as well as tips on how to prevent new invasions from occurring. There are suggestions on how to develop a management plan for controlling invasives on your land. The appendices direct you to additional resources for technical assistance, invasive species identification and information, and Vermont specific information and funding sources that may be useful for you.

We hope that this guide will help you take a step towards creating an informed management plan so that before you hire a contractor, or head to the shed for the clippers, you know what plants you want to remove, where you are going to begin your work, and how you are going to manage the plant populations in the future. A slow, methodic approach to invasive plant management will keep you from losing steam, and be more effective for long-term success.

This is not a field guide – you'll want to put your hands on some fact sheets (available at www.nature.org/vermonet/weeds, or call us at 802-229-4425 x 120), a good field guide, or take a workshop to help you learn to identify plants. It is also not a complete technical manual. The field of invasive plant management is experimental and changing, and there are more detailed resources out there that provide pages upon pages of information for each species.

Your efforts will have a positive impact on the long-term goals for your property. The work you do will help to maintain viable habitat for wildlife, productive sugarbushes and woodlots, and more resilient natural communities. Thank you for choosing to steward your land in an informed way.

Take care,

Sharon Plumb

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Facing the Challenge of Invasive Terrestrial Plants

A THREAT TO VERMONT'S ECOSYSTEMS AND WORKING FORESTS

Vermont supports a rich diversity of wildlife and plants that residents and visitors rely upon for forest and agricultural products, tourism, and pleasure. Our forests and fields may look lush and healthy, but in fact many are currently, or will become, threatened by invasive plants, insects and pathogens. In recent years, the number and abundance of species that have become invasive in Vermont has sharply risen. County foresters report that the quality of timber stands and sugarbushes throughout much of the state has been reduced. Tree regeneration is threatened by glossy buckthorn *Rhamnus frangula,* bush honeysuckle *Lonicera spp*., Oriental bittersweet *Celastrus orbiculatus*, garlic mustard *Alliara petiolata*, Japanese barberry *Berberis thunbergii*, burning bush *Euonymus alata,* and other invasives. Our major rivers are lined with Japanese knotweed *Polygonum cuspidatum*, and abandoned farm fields are invaded by honeysuckle, Autumn olive *Elaeagnus umbellate,* and wild chervil *Anthriscus sylvestris*.

Despite these widespread threats many people remain relatively unaware that invasive plants pose a very real environmental and economic threat. When weeds are mentioned, people may think of the weeds in the vegetable gardens or some of the more commonly known invasives, such as purple loosestrife *Lythrum salicaria*. It is critical that people learn to identify and manage these invasive plants on public and private lands. Early and consistent prevention and management will allow future Vermont generations to have access to healthy, viable ecosystems and productive working forests and farmlands.

WHAT IS AN INVASIVE SPECIES?

An invasive species is non-native to the ecosystem under consideration whose introduction causes or is likely to cause economic or environmental harm or harm to human health. [1] They impact natural processes and reduce the diversity and functionality of native plants. Most non-native plants that we intentionally or accidentally import do not become a problem. However, those that do become invasive share many characteristics. For example, they:

- ✓ ***Produce abundant viable seeds.*** Each purple loosestrife plant, for example, can produce up to 1 million seeds.
- ✓ ***Seeds germinate and plants leaf out earlier in the spring and keep their leaves late into the fall.*** Bush honeysuckle and Norway maple *(Acer platanoides),* hold their leaves into November, long past when native plants have stopped photosynthesizing and lost their leaves.
- ✓ ***Have few pests or diseases***. Native plants have pests and diseases that keep them in balance with other species. When non-native plants are introduced to a new ecosystem they do not come with the predators and diseases that kept them in check in their native lands.
- ✓ ***May produce toxic chemicals that make it difficult for other plants to grow***. Garlic mustard exudes a chemical compound from its roots that makes it difficult for native plants in close proximity to survive.

[1] As defined in Executive Order 13112. http://www.invasivespeciesinfo.gov/laws/execorder.shtml

- ✓ ***Invade a range of sites.*** Most invasive plants are generalists, and can live in a wide variety of soil types, moisture regimes, and light conditions. Oriental bittersweet is known to invade fields, forests, roadsides, designed landscapes and disturbed areas.
- ✓ ***May produce monocultures over large areas of land.*** Purple loosestrife and garlic mustard can grow such dense monocultures that few other species are able to reproduce and grow.
- ✓ ***Reproduce sexually and asexually (rhizomatous root system).*** Many invasive plants have multiple ways that they reproduce. Goutweed *(Aegopodium podgraria)*, and Japanese knotweed are just a few of the invasive plants that spread rapidly via rhizomes. One small root fragment from these plants can initiate new plants.

Many of these reproductive strategies are also frequently employed by native plant species. However, the combination of these characteristics with the lack of predators and diseases can make a seemingly harmless non-native plant become a problem plant.

WHERE DID THEY COME FROM?

Invasive terrestrial plants arrive through many vectors, or pathways, including ship ballast, wildlife plantings, agricultural plants, roadways and the horticultural industry. Eighty-five percent of the woody stemmed invasive plants found in our fields and forests, including Japanese knotweed, Oriental bittersweet, Japanese barberry, Burning bush and Norway maple, arrived as ornamentals (Reicherd and White, 2001). The bush honeysuckles, buckthorns, and Autumn olive were imported to the United States and ironically planted for wildlife value, though scientists later discovered that they have little wildlife value. In fact, the fruits of non-native invasive plants have been dubbed as "junk food" because they do not contain the proteins and lipids birds need for survival (Witmer, 1996). Scientists have also found that birds such as wood thrushes and American robins that nest in invasive buckthorn and honeysuckle suffer a greater risk of nest predation (Schmidt and Whelan 1999).

Be a Responsible Gardener

- ✓ **Use safe alternatives instead of invasives.** Go to www.beplantwise.org for a good list of alternatives for your region.
- ✓ **When possible, select native plants**. Vermont's native insects and birds evolved with our native plants. Native plants are far better suited for supporting wildlife, while at the same time providing attractive blooms, foliage, or fruits.
- ✓ **Tell your neighbors about invasive gardening plants.** The Nature Conservancy has free brochures that make good educational tools. You can find us at www.nature.org/vermont/weeds.
- ✓ **Ask your local nurseries and landscapers to stop using and selling invasives**. The more they hear that customers care about the issue, the more likely they will be to cease sale of invasive species..
- ✓ **Contact Vermont's professional horticultural association, GreenWorks**, and let them know that you support their efforts to promote safe alternatives.

Invasive species are especially problematic in areas with disturbed soils. Road building, grading and maintenance, residential development, forest clearing, logging operations, grazing, mining, ditching of marshes for mosquito control, mowing, and erosion control can all lead to new infestations. Recreationalists can escalate the spread of invasives by inadvertently carrying seeds in their clothing, bike wheels and other recreational equipment. Natural disturbances, such as floods and landslides provide other avenues for invasive species to establish themselves. The extent of human-caused alterations to the Vermont landscape over the past few hundred years has increased the opportunities for invasive plants to become further established.

Ecological Impacts

Numerous invasive species are now well established in many parts of Vermont. As time goes on, more will become a problem. Understanding the problems these plants create will help motivate land owners to take steps towards reducing their spread. Here are just a few examples of problems caused by invasive plants:

- ***Replace native species.*** Invasive plants are the second leading cause of loss of biodiversity. This is evident in our wetlands, where purple loosestrife and common reed, *Phragmites australis,* grow so dense that few native shrubs, sedges, or herbaceous plants can survive.
- ***Interrupt natural succession.*** In Vermont, most abandoned farm fields would typically revert to forests, with white pines and birch species initially present, followed by a mix of hardwood species. In some areas of the state, it is now common for honeysuckle or buckthorn to grow so thick that it is difficult for natural succession from field to forest to take place.
- ***Decrease forest regeneration:*** When dense populations of invasive plants are present, regeneration of native tree species is reduced. Mature trees produce seeds, but the seedlings cannot get enough light and frequently perish. Deer prefer to eat native plants over invasives. When there are fewer natives, deer browse them more heavily , to the point that there is little native tree regeneration (Knight, T.M. et. al, 2009).
- ***Disrupt the food chain.*** Native wildlife often will not feed on invasive plants. This is particularly true for insects, resulting in the loss of a critical food source for birds, fish and many other wildlife species (Tallamy, 2009).
- ***Degrade habitat.*** According to the Fish and Wildlife Service, invasive species have become the single greatest threat to the National Wildlife Refuge System, causing widespread habitat destruction and contributing to the decline of native wildlife and bird species. Forests invaded with barberry and garlic mustard offer poor quality habitat for ground and shrub layer nesting birds (National Fish & Wildlife Service, 2010).
- ***Hasten erosion.*** A healthy mix of native plants along a riverbank provides a combination of root structures that keep soil in place. Conversely, Japanese knotweed lacks a strong root structure and does a poor job of anchoring the riverbank. This can increase sedimentation and erosion, which increases phosphorus runoff into rivers.

- ✓ ***Increase risk of predation.*** Non-native plants do not always share the same form and structure as our native shrubs and trees. Honeysuckle stems are stronger, making it easier for raccoons and other predators to climb them and prey upon nestlings.
- ✓ ***Change soil chemistry.*** It may make sense to alter your garden's soil chemistry, but not natural ecosystems. For example, buckthorn can change nitrogen levels in the soil, and barberry7 can change profoundly impact microbial activity in the soil, resulting in a change in plant composition (Kourtev, P.S. 2002).

Economic Impacts

In 2005, David Pimentel of Cornell College of Agriculture and Life Sciences directed a study that found that nationally, estimated costs associated with a much wider group of invasive species to be around $143 billion per year based on damages and costs. In Vermont, landowners might spend up to $800 per acre to manage invasives, depending upon the degree of the infestation, the topography, methods used, and contractor fees. In addition to management costs, lost revenues need to be considered. A forest that has a high quality stand of saleable timber with a barberry or buckthorn understory will not be as valuable fifty years from now if there is minimal native regeneration.

Landowners and land managers of properties of any size must act quickly to remove invasives before they are fully established! Invasives in their early stages of development are relatively easy and inexpensive to remove. Once an infestation is fully established, it is far more difficult and costly to remove. Unfortunately, people do not typically recognize the invasive plants dominate the property People need to walk their land frequently, observe the vegetation and forest composition, and notice and remove plants when they first appear. Prevention of an infestation is by far the most effective and least costly approach.

Recreational and health impacts

A walk through a honeysuckle or barberry infestation is an adventure to wish only upon one's worst enemy. The annual trek to see spring wildflowers or hunt for mushrooms may be disappointing when few can be found because they have been outcompeted by garlic mustard. Trails overgrown with fast growing Autumn olive and honeysuckle are no fun to walk and costly to manage.

Invasive plants also pose health risks. For example, chervil, wild parsnip *Pastinaca sativa*, and giant hogweed *Heracleum mantegazzianum,* contain a phototoxic sap. When bare skin touches the plant and is then exposed to sunlight, the sap reacts and causes burns, blistering, and skin discoloration (Science Daily, 2007). Barberry infestations make particularly good hiding places for mice, causing an increase in mice populations. Mice are an alternate host for Lyme disease, and with greater sizes of mouse populations, there is a greater presence of Lyme disease in areas with dense barberry stands (Scott et al., 2009).

Vermont Initiatives on Invasive Species Management

Goutweed population found in Peru, Vermont. Photo: The Nature Conservancy.

Many of Vermont's ecologists, foresters, and gardeners are taking the invasive terrestrial plant issue seriously. In 2002 The Vermont Invasive Exotic Plant Committee (VIEPC) was formed. It is comprised of representatives from state and federal government, non-profit organizations, private industry, and concerned individuals. The goal of VIEPC is to provide coordination and guidance on invasive exotic plant issues so as to protect natural communities, native species, agricultural and forestry interests, and human use and enjoyment of Vermont's natural resources. Since its inception, it has introduced the state's first Quarantine Rule. It was approved by The Vermont Department of Agriculture, and currently limits the sale and movement of 32 plant species. Periodically, VIEPC members conduct research to determine which additional species need to be added to the watch list or Quarantine RUle. Unfortunately, there is a significant lag time between when a plant becomes a problem and when it is added to the rule, making it illegal for sale. In 2010, VIEPC plans to add another dozen or so plants, including Japanese barberry, Burning bush and Norway maple, among others. *However, Gardeners need to be aware that many nurseries still sell invasive plants, even when they are known to be a problem.* Go to www.vtinvasiveplants.org to find the most recent additions to the Quarantine Rule and the watch list.

Other statewide activities have focused on outreach, surveillance, technical assistance, and management. In 2007, The Vermont Chapter of The Nature Conservancy started Wise on Weeds! (www.nature.org/vermont/weeds), an outreach program that provides outreach and technical assistance to land owners, gardeners, road crews and land managers. In 2009, the Green Mountain National Forest developed a comprehensive weed management plan. That same year, the State of Vermont received American Recovery Act funding to monitor invasive plants and insects in southern Vermont. In 2010 the University of Vermont, Vermont Forests Parks & Recreation, and the Nature Conservancy started a citizen science monitoring program, training people to look for invasive insects and plants. These efforts contribute significantly to raising public awareness of the issue, and increase the likelihood that land managers will take the initiative to manage invasives.

Integrated Invasive Plant Management

Effective invasive plant removal and management includes early detection and rapid response and a combination of mechanical and chemical control techniques. This type of approach is an integrated weed management strategy. These steps are outlined in detail below. You'll find a step by step approach to using these techniques to develop a plan for your own land on page 17.

Early Detection and Rapid Response

The most cost-effective and effective approach to controlling invasive species is to prevent them from becoming established in the first place. As time goes by they are more costly and difficult to remove, and management options decrease. Table 1 includes the most common terrestrial plants found in Vermont and the habitats you are most likely to find them in. Landowners need to continue to learn new species each year, including those that are not known to be in Vermont yet, such as mile a minute vine *(Persicaria perfoliata)*, kudzu *(Pueraria lobata)*, Japanese stiltgrass *(Microstegium vimineum)* and Five leaved Akebia *(Akebia quinata)*. Refer to www.vtinvasiveplants.org for an updated list and identification tips.

Table 1: Vermont's most common terrestrial invasive plants

Species	*Likely Habitat*
Goutweed *(Aegopodium podagraria*	Rivershores, forests, gardens, roadsides.
Garlic mustard *(Alliaria petiolata)*	Rivershores, forests, gardens, roadsides.
Flowering Rush *(Butmous umbellatus),* Common reed *(Phragmites australis),* and Purple loosestrife *(Lythrum salicaria)*	Wetlands, stream edges, ditches.
Oriental bittersweet, *(Celastrus orbiculatus),* Honeysuckle *(Lonicera sp.),* Glossy and common buckthorn *(Rhamnus frangula and Rhamnus cathartica),* Norway maple *(Acer plataoides),* Amur maple *(Acer ginnala)* Autumn olive Elaeagnus umbellata), Russian Olive (Elaeagnus angustifolia) and Tree of heaven *(Ailanthus altissima)*	Forests, field edges, early succession fields.
Black swallow-wort *(Vincetoxicum nigrum)* and Pale Swallowwort *(Vincetoxicum hirundinaria)*	Field and forest edges.
Japanese knotweed *(Fallopia japonica) and* Giant knotweed (Polygonum sachalinense)	Rivershores, streambanks, ditches, roadsides.
Spotted knapweed *Centaurea stoebe,* Wild parsnip *(Pastinaca sativa L.),* wild chervil (*Anthriscus sylvestris),*	Roadsides, fields, right of ways, ditches and forests.
Giant hogweed *Heracleum mantegazzianum*	Riverbanks, ditches, right of ways

Mechanical Control Methods

Mechanical controls are one of the most common control techniques used to effectively eradicate invasives. A description of the most commonly used mechanical techniques is found below. Appendix 2 includes a summary of how and when these techniques can be applied to specific species found in Vermont.

Hand pulling: Hand pulling ensures that, with proper identification, only target plants are removed. Depending upon the species and the size of the plant, it may be helpful to use a weeder, trowel, or spade. Plants are easiest to remove after a rain, when the ground is soft. Grasp plants at the base near the soil and pull slowly to ensure that you remove the entire plant and root stem—many woody and herbaceous plants can resprout from underground roots, so getting the entire root is crucial. This is most easily done when the ground is moist.

Before you begin to hand pull, understand the plant's reproductive strategies. Does the plant produce abundant berries that are ready in the fall, or does it both resprout from root suckering and produce abundant seeds? This will inform when and how to remove the plant. For example, garlic mustard should only be pulled in the spring, before it has set seed, and the plants should be put in a garbage bag and hauled to the dump. This is because its flowers can still turn to seed even after it is pulled from the ground. Bittersweet should never be handpulled, because the roots resucker quickly. Other species have specific removal techniques that are appropriate for their reproductive biology. Weed wrenches are available to pull larger plants. The Brush Grubber, the Root Talon, and the Honeysuckle Popper are useful tools you can easily find by googling their name on the web.

Prevent the Spread of Invasive Terrestrial Plants

- After spending time in an area that has invasive plants, check clothing for seeds. Thoroughly remove soil from shoe soles.
- Clean equipment before transporting it between properties or habitats, especially when used in areas with known invasive species. For example, vacuum and dust inside vehicle, clean tires on bikes and cars, pressure wash large equipment.
- Be aware of precautions that are critically important for certain plants. For example, in areas that have garlic mustard, do not let dogs loose, clean shoes thoroughly and shake out all clothing, hair, and hats.
- Minimize soil disturbance by vehicles, machinery, irrigation ditches, and livestock.
- Require that any logging, mowing, or excavation equipment that comes on your property is weed free.
- Avoid driving in weed-infested areas.
- Use weed-free certified seed mixes.
- Use only clean fill for any construction projects.
- Monitor new plantings, whether within designed landscapes, farms, or elsewhere, for invasives that may have been present in soils.
- Work with your neighbors to encourage these practices on abutting or neighboring parcels.
- Monitor regularly for potential introductions

Cutting or Mowing: Sometimes, when invasive plants are found in large monocultures or their root systems are extensive, cutting or mowing may be a good option. Typically, the plants will have significant carbohydrate reserves stored in the root system and it will take multiple cuts over a season and/or years to fully deplete the plant's reserves. As with hand pulling, know the reproductive strategy of your plants well. For example, repeated mowing of wild chervil spreads

seeds and starts new infestations, so is not an effective control technique. Knotweed, however, responds well to repeated cuts every month during the growing season for five years.

Smothering: Some invasive plants have pernicious root systems. A small fragment of goutweed root, for example, can start a new plant any time in the growing season. For these species, removing all above-ground vegetation and then covering the entire site—including at least a 3 foot "buffer zone"— with several layers of black plastic will smother the plants' new growth. Secure the fabric with large stones, bricks or ground staples. The site should be monitored frequently to ensure that the cover remains securely in place and that roots or rhizomes are not growing outside the cover. Depending upon the species, leave the ground cover in place for at least 1 full growing season. For plants such as knotweed, goutweed, and wild chervil, 2 – 4 years is more effective.

Girdling: Girdling is an effective way to kill most trees and shrubs that have a single trunk. To girdle the plant, use a chainsaw or ax to make two to three circular cuts three inches or more apart around the circumference of the tree. This cut will kill the cambium layer, or the inner bark of the tree. This living tissue produces new wood and bark, and is critical for transporting carbohydrates and sugars between the roots and the leaves. Be sure not to make the cut too deep, or the tree will topple in high winds. To prevent resrpouting, you can use a chemical control as you would for cut stump treatment, described below.

Burning: Propane torches can be used to successfully reduce small populations of certain woody stemmed species, including barberry. Spot follow up treatments are likely necessary. *Follow instructions carefully and use torches only during a rainy wet period.*

Chemical Control Methods

PLEASE NOTE: Chemical control should be only one piece of your prevention and management plan. Chemicals should only be used when another approach will not be effective. Remember that the label on the chemical bottle is the law. Before you purchase or begin using herbicides, take a workshop and consult other resources. Appendix 2 includes a summary of application recommendations for invasives found in Vermont. Appendix 3 includes safety tips when using herbicides.

There are many ways to apply herbicides to a plant. The method you choose will depend upon the plant species, the size of the infestation, whether or not you have a license to use the recommended product, and the location. It is critically important to apply the correct formulation and concentration of herbicide with the appropriate method at the appropriate time of year. This will depend upon the invasive, the site, and the size of the infestation.

In order to ensure effective treatment and minimal damage to non-target species, it is recommended that a landowner contract a certified herbicide applicator who specializes in invasive plant management. This is especially true for medium to large infestations where it is easy to exceed the legal application limits. Even though herbicides are the most effective controls available, it is important to consider the negative impacts of applying large quantities of herbicides into natural systems.

Most of the common invasive plants can be treated using one of two herbicides: glyphosate (the active ingredient in Roundup™ and Rodeo™) and triclopyr (the active ingredient in Brush-B-Gone™ and Garlon™).

Glyphosate is non-selective, meaning it kills all plant material it contacts so choose the correct form of application to avoid damage to non-target plants. Glyphosate acts by interrupting the photosynthetic processes of plants. In low concentration, this chemical does not negatively impact insects, mammals or birds. It is considered to be safe for terrestrial and aquatic systems. However, the surfactant in RoundUp can be harmful to fish and amphibians so Rodeo is more appropriate to use near wetlands.

Triclopyr is selective and does not kill monocots (grasses, orchids, lilies, etc). It is, however, a much stronger herbicide and therefore is used on plants that are the most difficult to control, such as Oriental bittersweet. Most triclopyr formulations require a Pesticide Applicator's License to purchase or use these products.

Common chemical applications used to treat invasive terrestrial plants.

Cut Stem Treatments: The most effective treatment period is in the fall. Stems should be cut close to the ground, but not so close that you will not be able to see them. For woody stemmed species, apply herbicide directly to the cut surface immediately after cutting, before the stem starts to dry out. For larger stumps, you only need to apply the herbicide to the living tissue in the outer layer. The herbicide can be applied with a sponge, paintbrush, or spray bottle. For common reed and Japanese knotweed, drip a teaspoon of herbicide into the hollow stem. For both methods, it is helpful to mix a dye, such as food coloring, in with the herbicide solution to mark where you previously applied the chemical.

Foliar applications: This type of application refers to applying herbicides to the leaves or foliage. Foliage applications are frequently used on large infestations. This type of treatment is usually applied with a backpack sprayer or a boom spray for larger infestations. It is most effective when the plants are actually growing, ideally when they are flowering or beginning to form fruit. Apply well into the summer, after spring flowers are no longer present above ground. While some plants, such as barberry, are easily controlled with foliar spray, it has been shown that other plants are more susceptible to this type of treatment if the existing stems are cut off in the spring and regrowth is treated in early fall. The target plants should be thoroughly wetted on a day when there is no rain in the forecast. Refer to the label to determine what temperature range is best for application. The benefit of this method is that there is a wider window of time it can be used and the concentration of herbicide is less. It is also quicker to apply than the cut stem treatment. However, because it is a spray, it is more likely to hit non-target species.

Safe and effective use of herbicides

- ✓ **Develop an Integrated Plant Management approach.** Use chemical control as only ONE piece of your prevention and management strategy.
- ✓ **Hire a contractor to manage large infestations.** They will know the most useful concentrations and combinations of chemicals to use for the combination of species and density of plants that you have on site.
- ✓ **The label found on the pesticide container is the law.** Read this label in its entirety. It will teach you what concentrations to use, what protective clothing to wear, how to apply the product, and what environmental and human health hazards are associated with the chemical. Pesticide labels can also be found at http://www.msds.com/
- ✓ **Follow directions precisely for both environmental and personal safety.** Improperly used herbicides can cause both short- and long-term health and environmental problems. More is not better!
- ✓ **A pesticide applicators license is required to purchase certain chemicals.** Go to http://www.vermontagriculture.com/ARMES/am/pesticide.html for more information.
- ✓ **Do not use higher concentrations than are required by the label.** Using more herbicide does NOT make the formulation more effective.
- ✓ **Use aquatic formulations within ten feet of water.** Commonly available glyphosate formulations are not permitted to be used in wetland areas. Use of Class A restricted herbicides, which are designed for use in and near wetlands, requires a Vermont Pesticide Applicator's License.
- ✓ **You need to be certified to apply herbicides on land that you do not own.** Contact the VT Department of Agriculture at 802-828-3482 or go to http://www.vermontagriculture.com/ARMES for more information.
- ✓ **You can not apply herbicides within 100 feet of a wellhead.** Contact VT DEC at 802-241-3761 for more information.
- ✓ **You need a permit to apply herbicides in a wetland.** Contact VT DEC at 802-241-3761 for more information.

Biological control Methods

Biocontrol uses biocontrol agents - insects, pathogens, fungi, animals, or microbes - to feed on or otherwise disrupt an invasive species. Biocontrols are not expected to eliminate invasives completely and it often takes years or even decades after repeated releases before their effects are substantial.

When successful, biocontrol agents can provide long-term, widespread control with a very favorable cost-benefit ratio. For example, in 2001 the Massachusetts Office of Coastal Zone Management released purple loosestrife biocontrol beetles at the Diamond School in Lexington,

MA. The site was completely dominated with purple loosestrife, covering over 80% of the wetland complex. After three annual biocontrol releases, the purple loosestrife population had been reduced to less than 10% cover by the summer of 2008. As a result, native vegetation reestablished and the wetland is slowly being restored to healthier conditions. For many years the Vermont Department of Environmental Conservation Water Quality Division ran a purple loosestrife biocontrol program, but due to funding shortfalls has stopped the program.

Biocontrols are often viewed as a progressive and environmentally friendly way to control invasives because they leave behind no chemical residues that might have harmful impacts on humans or other organisms. There is controversy as to whether the biocontrol agent itself can or will eventually harm native vegetation or negatively impact ecosystems.

Grazing

In some parts of the country, goats, sheep, and even cows have become popular management "tools". Goats and sheep can feed on weeds in hard-to-reach places such as steep slopes or heavily overgrown areas where mechanical or chemical techniques are not the best option. While grazing can make a positive impact on invasive species populations, goats and sheep can also cause significant damage to a site and promote the spread of invasives through soil disturbance and native herbivory. Grazing animals should not be used in areas with an abundance of native plants, rare, threatened or endangered species, or important natural communities. However, when grazing treatments are combined with other control techniques, such as herbicides or other biocontrols, severe infestations can be reduced and small infestations can be eliminated. Before using this method, learn more about successes and failures with this practice in your area.

Organic Control Methods

If you are interested in using only organic controls for the invasive species on your property there are a few options available in the marketplace. Corn gluten is considered to be an excellent pre-emergent herbicide that inhibits seed germination by drying out the seed when it splits open to sprout. This control can be used in sites where you know there is a viable seed bed of invasive species. The main concern is to not use this control in a flower bed where you intend on growing plants from seed. Vinegar and clove based controls have also been proven to be effective in many situations. Burnout II is a new vinegar-based control on the market that could be an effective option for organic farmers and gardeners.

When to hire an Invasive Species Contractor

If your property has sensitive areas, or a large quantity or diversity of invasive plant species, it is highly recommended that you consult a professional invasive plant management expert. This can start with conversations with county or consulting foresters. At some point, you may want to hire an invasive species contractor. They can help you determine what species to tackle first, and where to focus the work.

How to Select an Invasive Plant Management Contractor

- **Determine management goals for the invasives on your property.** This will help you hire the appropriate contractor. For example, do you want your contractor to have a more environmentally sustainable approach to invasive species removal or is your only objective in mind to eradicate the multiflora rose in your back yard so your kids can play?
- **Communicate specific habitats or species for protection.** Some contractors may have very little knowledge about native plant species and habitats. Do your homework so you can communicate areas of special concern.
- **Check references!** Contractors will come with a different set of skills. Be sure you know something about who you hire.
- **Require at least a minimum of a bachelor's degree and that they are a certified commercial pesticide applicator** in a natural resource related field from the project manager/company owner or an equivalent amount of field experience and training
- **Require a written management plan** that outlines what species they will work on, what areas they will focus on, when they will do the work, what chemicals they will use, and a clear estimate of costs and fees. The plan should also include a guaranteed kill rate and what they will do for follow up the next year.
- **Require a safety plan.** Make sure that they know what will be done in the event that chemicals are spilled or someone is hurt on the job.
- **Contact Matthew Wood at the Vermont Department of Agriculture to obtain a current list of Vermont contractors**. 802-828-3482 or matthew.wood@state.vt.us

Developing an Invasive Plant Management Plan

It is easy to get overwhelmed with invasive species management. Having a plan in place will allow you to focus your resources on the species that are most threatening to your land, and the areas of highest importance. The following guidelines will help you get started.

1. ***Get to know your property***. Create a simple property map depicting the natural features and major vegetation cover types (e.g. mature hardwood forest, early successional forest, riparian area). Include areas where you have seen evidence of wildlife, as well as recreation trails, buildings, and roads. You can sketch it by hand or make a more sophisticated map. Google Earth is a useful tool that will allow you to create interactive aerial maps.
2. ***Create land management goals.*** Think about what natural features you want to protect, and what wildlife management, forestry activities or trail building you may do in the future. Determine what you want your land to be like 5, 10 or 20 years from now.

Close-up of glossy buckthorn. The Nature Conservancy.

3. ***Identify and map invasive species on your property and the surrounding area.*** Find out what plants are likely to be on your property and look for them along logging roads and trails, at old home sites, openings in the forest canopy (old patch cuts or tree blow-downs)as well as deeper into the woods. Map the species that you find, and try to convey a sense of the size and density of the populations.
4. ***Integrate invasive species management into all of your forestry or wildlife management activities***. Any land management activities you do have a chance of spreading invasive species. Predict what activities (such as logging, construction of trails, roads or buildings) will cause future problems, and do what you can to prevent a problem. If you currently do not have a land management plan, consult your county forester or a consulting forester to develop one. Vermont Coverts (http://www.vtcoverts.org/index.php) is another excellent source for information and workshops that can help you gain skills and knowledge about land management. Consider enrolling in Vermont's Current Use program.
5. ***Practice Early Detection and Rapid Response (EDRR).*** Each year walk your property to look for invasive species. Stay on top of what species are coming into your area. Remove new problem plants as soon as you see them. For more on EDRR go to page 10.
6. ***Consider available resources.*** Be realistic with the time and money you have and set goals accordingly.

7. ***Determine a weed or site led management approach.*** Determine whether you want to protect particular natural resources or whether you want to eradicate one particular species. *Site-led management* is designed for the landowner interested in protecting a particular resource or natural feature from encroachment. *Weed-led management* approaches the problem from a single-species perspective. It is beneficial when you are concerned with controlling or eradicating a particular problematic species rather than protecting the resource. Your approach may change from one part of your property to another.
8. ***Determine which methods you will use.*** A mix of approaches is usually the most successful. Hand pulling smaller woody stemmed species, girdling larger trees, and using selective chemicals in appropriate habitats can all be part of your plan.
9. ***Develop a reasonable timeline.*** A reasonable timeline should be based on size of infestation, species, time of season it is best to treat, and what suitable control methods exist. This will provide structure to your management plan. Prepare to treat established populations for 3 - 5 years, in addition to follow-up treatments and monitoring.
10. ***Be realistic.*** Invasive plant management can be a long term project. Because of the tenacity of certain species, it may be impossible to completely remove them from your land. You can, however, manage them at a level that allows you to wisely steward your land.

Funding Sources

- ✓ The USDA Natural Resource Conservation Service (NRCS) offers a number of programs, including WHIP and EQIP, that can help public land owners defray the costs of invasive plant control for qualified landowners. Talk to your county forester, or go to www.vt.nrcs.usda.gov/programs/ for more information.
- ✓ The USDA lists a number of sources for federal and private grants. www.invasivespeciesinfo.gov/. The National Fish and Wildlife Foundation, and the National Invasive Species Council are also possible sources.
- ✓ The Lake Champlain Basin Program and the Vermont Department of Fish and Wildlife have grants that may be used for invasive plant control on certain lands. For more information go to www.lcbp.org and http://www.vtwaterquality.org/lakes/htm/lp_watershedgrants.htm.

Appendix 1: Mechanical and Chemical Control Techniques

Mechanical Control Techniques and Disposal Methods

Hand pulling: This method insures that, with proper identification, only target plants are removed. When pulling, using tools like a weeder or spade may be helpful. Grasping plants at the base near the soil and pulling slowly will insure that you pull up the entire plant and root stem—many herbaceous plants can re-sprout from underground roots, so getting the entire tap root is crucial. Avoid trampling or injuring the native plants around the invasives you pull. Hand pulling can cause soil disturbance, especially if the area is heavily infested. In some cases, it may be helpful to replant an area after you remove the invasive population. No permits are necessary to hand pull plants in Vermont.

Cutting or Mowing: Sometimes, when invasive plants are found in large monocultures or their root systems are extensive, cutting or mowing is the best option. Typically, the energy stored in the root system will be great and it will take multiple cuts over a season and/or years to fully deplete the plant's energy reserve. Removing cut materials will prevent any nodes or flowers from spreading seed and encourage growth of non-invasive plants in the seed bank underneath. Mowing can be combined with smothering (see below) or with a foliar spray (See Herbicide Use Handout) to the re-sprouted plants.

Smothering: Some invasive plants are so pernicious and have such extensive root systems that you cannot cut it fast enough or dig it deep enough to control the growth. For these species, removie all above-ground vegetation and then coverthe entire site—with at least a 3 foot "buffer zone" extra—with ground tarps or black construction plastic. The edges of the material should be secured firmly by large stones, bricks or ground staples. The site should be monitored frequently to insure that the cover remains securely in place and that sneaky roots or rhizomes are not growing outside the cover. Depending upon the species, leave the ground cover in place for at least two growing seasons.

It's important to dispose of invasive plant species properly. Sometimes, the material left remaining at a site can re-root or produce fruit, even after it has been pulled from the soil. This section discusses the best ways to dispose of invasive plants to prevent re-infestations.

#1—Bagging: It is typically never a good idea to compost invasive plant material. Root fragments or seeds can persist in compost piles and, once transported to a new site, can re-infest that area. To insure that removed plants do not remain viable, place all plant parts into a thick 3 mil black construction trash bag and securely closed. Let the bag sit in a warm, sunny site until all material is liquefied. Afterwards, bags may be disposed of at a trash dump.

#2—Burning: When cutting large material bagging is not an option. Burning, either in a burn pile or in your home stove, is a safe and effective way to destroy plant parts. Note: If plants have berries or fruit present, the seeds can fall off during transportation and re-infest a new site. Be aware of where you are taking material and check those transport areas for future infestations.

3—P**iling:** Creating brush piles of woody plant material decreases the likelihood of plants re-rooting into the soil and provides habitat for native animals.

Mechanical Controls for Vermont's Common Invasive Terrestrial Plants	
garlic mustard (*Alliaria petiolata*)	**Hand pulling**: March - May before plants go to seed. **Mowing:** Cut at ground level after flowering but before seed set from mid-April to early May. Remove cut stalks from site and dispose of properly. *Disposal method #1 & 2.*
wild chervil (*Anthriscus sylvestris*)	**Hand pulling**: April to June prior to seed set. **Mowing:** Mow twice a year—when plants begin to flower in mid-May and again during the second flowering in early July. Replanting with a seed mix in the fall will decrease re-infestations. *Disposal method #1 & 2.*
goutweed (*Aegopodium podagraria*)	**Hand pulling**: Small patches may be eliminated by persistent hand pulling, but that must include all rhizomes and roots. Properly dispose of all removed parts. **Mowing:** Frequent mowing 3-5 times a year will slow spread but not eliminate infestations. **Smothering:** Remove all top growth prior to covering. Best if established in Spring and allowed to remain through entire season. Disposal method #1 & 2.
Asiatic bittersweet (*Celastrus orbiculatus*)	**Mowing:** Regular weekly mowing of grounded populations will exclude bittersweet from an area. Less frequent mowing of 2-3 times a year will stimulate root-suckering and should be avoided. Disposal method #1 & 2.
black swallowwort (*Cynanchum louiseae*)	**Hand Pulling:** Root crowns may be dug up any time during the growing season. Mowing and cutting will stimulate growth and increase the patch size and should be avoided. **Smothering:** Remove all top growth prior to covering. Best if established in Spring and allowed to remain through entire season. Disposal method #1 & 2.
purple loosestrife (*Lythrum salicaria*)	**Hand pulling:** For small, limited stands removing the entire stalk and taproot prior to seed set in August will provide effective control. Disposal method #1 & 2.
common reed (*Phragmites australis*)	**Mowing:** Set mower blade higher than 4 inches but insure cuts are below the first leaf. Best treatment time is after September until the first frost—cut annually until dead. Mowing before July will stimulate growth. **Smothering:** Remove all top growth prior to covering. Best if established in Spring and allowed to remain through entire season. Disposal method #1 & 2.
Japanese knotweed (*Polygonum cuspidatum*)	**Mowing:** Will only be effective if plants are cut 5+ times a year throughout the growing season, for at least 3 seasons. **Smothering:** Remove all top growth prior to covering. Best if established in Spring and allowed to remain through entire season. Knotweed has thick stalks that will easily lift up smothering material. Heavy objects, like concrete blocks or your wood pile, should be placed *on top* of the entire sheet to suppress the plant. Disposal method #1 & 3.

Woody Shrubs & Trees**	**Hand pulling:** Pull small seedlings, insuring that the entire tap root is removed, any time during the growing season. **Mowing:** For larger plants in open field settings, mowing at least biannually will prevent saplings from establishing in the area. Disposal method #1, 2 & 3. ** Bush honeysuckle *(Lonicera spp.);* Common buckthorn *(Rhamnus cathartica);* Glossy buckthorn *(Frangula alnus);* Japanese barberry *(Berberis thunbergii);* Burning bush *(Eunoymous alatus)* **

Chemical Control Methods for Vermont's Common Invasive Terrestrial Plants

√ **Use an integrated approach.** Herbicides are an effective method for controlling invasive plants. Use them judiciously and in combination with other management methods.

√ **Develop an invasive plant management plan**. Decide what your short and long term land management goals. Use this plan to determine which plants you want to work on, where, and when. Good planning will result in in more effective treatment and well used resources.

√ **Learn before you buy or apply.** Before you head to the store or pull the trigger, research which chemicals and methods are most appropriate for your land and the plants that you want to manage. Take a workshop from a reputable person or organization.

√ **The label is the law.** Each herbicide comes with a label that tells you where you can apply the herbicide, and how to mix and apply it to the problem species.

√ **Use aquatic formulations on any plant within ten feet of water, including open water, wetlands, vernal pools and seeps.**

√ **You need to be certified to apply herbicides on any land that you do not own.** Contact the Vermont Department of Agriculture Pesticide Certification & Training Program at 802-828-3482.

√ **You need a permit to apply herbicides in wetlands.** Contact the VT Department of Water Quality at 802-241-3761.

√ **If you are working with large infestations, hire a contractor.** Contractors have years of experience to draw upon, and already own the necessary chemicals. Contact the Vermont Department of Agriculture Pesticide Certification & Training Program at 802-828-3482.

CUT STUMP: This method is used for shrubs, trees, vines, and knotweed. Cut the plant 4" from the ground. Wipe the stump with a herbicide solution mixed with a colored dye to help you remember which stumps have been treated. This is most effective in from late August through mid-November when plants are relocating resources to their root systems.

LOW VOLUME FOLIAR SPRAY: When you have a large, dense population it is more efficient and uses less chemical to apply chemicals using a backpack or mist sprayer. This technique is the most likely to affect non-target plants when the spray drifts, so apply a spray when there is no wind. Foliar spray is done during the growing season when plants are in flower or fruit.

BASAL BARK: This method is most successful on small trees under 6 inches in diameter. It is only effective with the ester-triclopyr herbicide (Garlon 4®) and should not be used in wetlands. Use a backpack sprayer or handheld bottle to coat the lower 12-18 inches of the trunk. Avoid herbicide dripping down the bark.

Chemical Control Methods for Vermont's Common Invasive Terrestrial Plants	
garlic mustard ***(Alliaria petiolata)***	**Foliar Spray:** A 1-3% glyphosate solution will provide greater than 95% control when infestations are treated from September to October . Most native species are dormant at this time, and spraying will not affect them.

GLYPHOSATE: A non-selective herbicide which inhibits the synthesis of amino acids necessary in protein formation in most annual and perennial plants. Most formulations have additions of surfactants to increase the efficacy of absorption into plants. This surfactant makes these highly toxic to aquatic organisms and should not be used near water. Common non-aquatic trade names are Roundup®, Roundup-Pro®, Accord®. A few formulations are registered for use in aquatic areas, including Rodeo**®, and Aquamaster**.® In Vermont, you need to be a certified applicator before you can purchase aquatic formulations.	**TRICLOPYR:** A selective herbicide which mimics a plant hormone and causes uncontrolled growth in plants. It is labeled for use on woody and herbaceous broadleaved plants, and does not affect monocots (grasses, lillies, orchids). It comes in 2 formulations, a salt and an ester. Both can only be applied in upland, dry sites. Common trade names are Garlon™, Pathfinder™, and Brush-B-Gone™ You need to have a herbicide applicators license in order to purchase products with Garlon.

goutweed ***(Aegopodium podagraria)***	**Foliar Spray:** A 2—10% glyphosate solution will brown goutweed leaves but not kill the roots. Repeat applications are necessary. After spraying the patch, cover the area with a thick plastic sheet. Secure around the edges with ground staples or sandbags. Keep covered for at least an entire season. Monitor yearly.
Asiatic bittersweet ***(Celastrus orbiculatus)***	**Foliar Spray:** Low, dense patches may be cut to the ground in April and May. After 1 month, foliar applications of 1 –2% concentrations of triclopyr herbicide to re-growth will result in nearly 100% rootkill. **Cut Stump:** Cut vines 6" from the ground and treat stumps with 25% glyphosate solution. **Basal bark:** Spray 2-4% triclopyr around the vine's stump. This is best done in the fall or early winter, after herbaceous plants are gone and before there is snow on the ground.
black swallowwort **(*Cynanchum louiseae*)**	**Foliar spray**: Provides the most effective control when applied prior to seed production before mid-July. A 2% glyphosate solution or 1% triclopyr-ester solution reduces biomass by over 80% and density of stems by over 60%. Repeat applications are necessary.
purple loosestrife **(*Lythrum salicaria*)**	**Foliar Spray:** Apply a 1-2% glyphosate solution after peak bloom in late August. Cut and dispose of flower heads before treating. Because of the sensitivity of wetland areas, hand spraying or wiping plants with sponges will protect other plants from herbicide drift. *Contact the state to obtain the proper permits.*
common reed ***(Phragmites australis)***	**Foliar Spray:** Good for dense stands of reed with no other vegetation present. Spray, or wipe using gloves and a sponge, a 2% glyphosate solution after the plants tassel (late August through October). If possible, return to site to cut back and remove dead stalks to encourage growth of suppressed vegetation. *Contact the state to obtain the proper permits.* **Cut Stump:** Cut and dispose of stalks. Drip into the hollow middle of the stem a 25% glyphosate solution from July to August.
Japanese knotweed **(*Polygonum cuspidatum*)**	**Foliar Spray:** In May, cut back the plants. In August, when other knotweed is blooming, spray a 3%-8% glyphosate or triclopyr solution on the regrowth. It is likely that repeat applications will be necessary the following year. *Foliar spray uses a lesser concentration of the active chemical, it is therefore a better choice when faced with a large stand of knotweed.* **Cut Stump:** Cut stems and dispose of stalks. Drip into the hollow middle of the stem with 21% glyphosate solution from July to August. An injector gun can also be used.
Woody Shrubs & Trees **	**Foliar Spray:** This method is best used for dense populations. In the fall, when native plants are losing their leaves, spray a 2% glyphosate or triclopyr solution on the entire leaf surface of the plant. In order to avoid drift to native plants, spray on calm days. **Cut Stump:** Cut the plant 4" above the ground. Use a drip bottle to apply a 18—21% glyphosate solution to the stump. Apply chemical within one hour of cutting. This is best done in late summer through winter when plants transport resources to their root systems. **Basal Bark:** Spray the base of plants with a 2-4% triclopyr solution from August through November. **Bush honeysuckle *(Lonicera spp.)*, Common buckthorn *(Rhamnus cathartica)*, Glossy buckthorn *(Frangula alnus),* Japanese barberry. *(Berberis thunbergii) and* Norway Maple *(Acer platanoides).*

Appendix 2: Personal Protection in Herbicide Handling

PERSONAL PROTECTION IN HERBICIDE HANDLING

Adapted from Ohio State University's Extension Publication #825 "Applying Pesticides Correctly" by Jennifer Hillmer, The Nature Conservancy-Ohio.

PERSONAL PROTECTIVE EQUIPMENT

- ✓ Herbicide labels indicate the minimum protective equipment required. This may vary by application technique.
- ✓ Cotton, leather, canvas, and other absorbent materials are not chemical resistant, even to dry formulations.
- ✓ Always wear at least a long-sleeved shirt, long pants, sturdy shoes or boots, and socks. The more layers of fabric and air between you and the pesticide, the better the protection.
- ✓ A thick layer of spray starch on clothing will add some protection from pesticides.
- ✓ Hands and forearms usually receive the most pesticide exposure. Wear chemical-resistant gloves, and tuck shirt sleeves into gloves (gloves should reach up the forearm, with cuffs to catch runs and drips).
- ✓ Canvas, cloth, and leather shoes or boots are almost impossible to clean adequately. Wear chemical-resistant rubber boots that come up at least halfway to the knee if the lower legs and feet will be exposed to herbicides or residues.

AVOIDING CONTAMINATION

- ✓ Wear chemical-resistant gloves (rubber or plastic such as butyl, nitrile, or polyvinyl chloride are common types).
- ✓ Make sure gloves are clean, in good condition, and worn properly. Replace gloves often. Wash and dry hands before putting on gloves. Wash gloves before removing them.
- ✓ Wash hands thoroughly before eating, drinking, using tobacco products, or going to the bathroom.
- ✓ Cuff gloves if pesticide is expected to run down towards the sleeves. Tuck sleeves into gloves.

EYE AND RESPIRATORY PROTECTION

- ✓ Labeling might require goggles, face shields, or safety glasses with shields. Some formulas or handling activities pose more risks to eyes than others. Dusts, concentrates, and fine sprays have the highest risk of causing pesticide exposure.
- ✓ There are many types of dust-mist masks and respirators, all of which must fit and be used properly to be effective.
- ✓ Respiratory protection is most important in enclosed spaces or when the applicator will be exposed to pesticides for a long time.
- ✓ Pesticides that can volatilize require the use of respirators. Check label requirements.

PERSONAL CLEAN-UP AFTER HERBICIDE USE

- ✓ Wash gloves and footwear (if possible) with detergent and water before removing them.
- ✓ Change clothing and put clothes used during application in a plastic box or bag, and keep it away from children or pets. Use a mild liquid detergent and warm water to wash your hands, forearms, face, and any other body parts that may have been exposed to pesticides. Take a warm shower and wash your hair and body at the end of the work day.

LAUNDRY

- ✓ Do not wash work clothing and personal protective equipment in the same wash water with the family laundry.
- ✓ Handle with care and wash your hands after loading the machine.
- ✓ If you have chemical-resistant items, follow the manufacturer's washing instructions. Wash boots and gloves with hot water and liquid detergent. Wash twice, once outside and once inside. Air-dry boots and gloves.
- ✓ Rinse clothes in a machine or by hand. Wash in plenty of water for dilution and agitation.
- ✓ If using a washing machine, using heavy-duty liquid detergent in hot water for the wash cycles. After washing the clothes, run the washer through one complete cycle with detergent and hot water, but no clothing, to clean the machine.
- ✓ Hang items to dry if possible in plenty of fresh air. Do not hang in living areas.
- ✓ Using a clothes dryer is acceptable, but over time the machine may become contaminated with pesticide residue.

Appendix 3: Technical Assistance Resources

United States Department of Agriculture Natural Resources Conservation Service (NRCS) Programs and Contact Information

The following USDA NRCS programs are available to eligible landowners. They can help landowners pay for a portion of the cost of invasive plant removal. For more information, contact your regional NRCS office. Office locations and contact information can be found below and at http://www.vt.nrcs.usda.gov/contact/.

USDA NRCS Wildlife Habitat Incentive Program (WHIP)

WHIP is a voluntary program for private landowners who want to develop and improve wildlife habitat on their land. This program can also aid landowners who are interested in invasive species removal efforts. Through WHIP, the Natural Resources Conservation Service (NRCS) provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed.

USDA Environmental Equality Incentives Program (EQIP)

EQIP, another NRCS program, offers financial and technical assistance to help eligible private landowners install or implement structural and management practices on eligible agricultural land. It can also cost share certain invasive plant control activities. EQIP payment rates may cover up to 75 percent of the costs of certain conservation practices, including invasives removal.

Addison County 68 Catamount Park, Suite B, Middlebury VT 05753 (802) 388-6748	**Bennington County** P.O. Box 505, Bennington VT 05201 (802) 442-2275	**Caledonia & Essex Counties** 481 Summer St., Suite 202, St. Johnsbury VT 05819 (802) 748-2641	**Chittenden County** 1193 South Brownell Rd., Suite 35, Williston VT 05495 (802) 865-7895
Orange & Washington Counties 617 Comstock Rd., Suite 1, Berlin VT 05602 (802) 828-4493	**Franklin & Gran Isle Counties** 27 Fisher Pond Rd., Suite 1, St. Albans VT 05478 (802) 527-1296	**Lamoille County** 109 Professional Drive, Suite 2, Morrisville VT 05661 (802) 888- 4935	**Orleans County** 59 Waterfront Plaza, Suite 12, Newport VT 05855 (802) 334-6090
Rutland County 170 South Main St., Suite 6, Rutland VT 05701 (802) 775-8034	**Windham County** 28 Vernon St., Suite 330, Brattleboro VT 05302 (802) 254-9766	**Windsor County** 28 Farmvu Drive, White River Jct. VT 05001 (802) 295-7942	

Vermont Forest, Parks & Recreation County Foresters

Vermont County Foresters are available to meet with landowners, walk their properties, and assist them in accessing information that will help them to manage and steward forestlands. They are often a good first step for better understanding your land. For more about county foresters and the work they do, contact your local office or go to http://www.vtfpr.org/resource/for_forres_countfor.cfm.

Franklin & Grand Isle Counties Nancy Patch 278 S. Main, Suite 2 St. Albans, VT 05478 (802) 524-6501 nancy.patch@state.vt.us	**Addison County** Chris Olson 68 Catamount Park, Suite C Middlebury, VT 05753-1292 (802) 388-4969 chris.olson@state.vt.us	**Windham County** Bill Guenther 11 University Way, Suite 4 Brattleboro, VT 05301 (802) 257-7967 bill.guenther@state.vt.us
Lamoille & Orleans County Ray Toolan 29 Sunset Dr. Suite 1 Morrisville, VT 05661 (802) 888-5733 raymond.toolan@state.vt.us	**Orange County** David Paganelli 5 Perry Street Barre, VT 05641-4265 (802) 476-0173 david.paganelli@state.vt.us	**Windham & Windsor Counties** Assistant County Forester Sam Schneski 100 Mineral Street, Suite 304 Springfield, VT 05156-3168 (802) 885-8823 Sam.schneski@state.vt.us
Chittenden County Mike Snyder 111 West Street Essex Junction, VT 05452 (802) 879-5694 michael.snyder@state.vt.us	**Rutland County** Eric Hansen 271 North Main St. Suite 215 Rutland, VT 05701 (802) 786-3853 eric.hansen @state.vt.us	**Bennington County** Nate Fice 478 Shaftsbury SP Rd. Shaftsbury, VT 05262 (802) 375-1217 nate.fice@state.vt.us
Washington County Russ Barrett 5 Perry Street Barre, VT 05641-4265 (802) 476-0172 russ.barrett@state.vt.us	**Windsor County** Jon Bouton 220 Holiday Drive, Suite 5 White River Junction, VT 05001 (802) 281-5262 jon.bouton@state.vt.us	**Caledonia & Essex Counties** Matt Langlais 1229 Portland St., Ste. 201 St. Johnsbury, VT 05819 (802) 751-0111 matt.langlais@state.vt.us

Appendix 4: Additional Resources

Invasive Plant Identification and Management

The Nature Conservancy of Vermont. The Wise on Weeds! Program provides outreach and technical assistance to landowners and land managers around the state. Contact The Conservancy at 802.229.4425 or go to www.nature.org/vermont/weeds

The Vermont Invasive Exotic Plant Committee (VEIPC). The VIEPC website includes a "Gallery of Invaders", useful for identifying species. www.vtinvasiveplants.org

Center for Invasive Species and Ecosystem Health. Website includes invasive species fact sheets, information on controlling invasives and a wide variety of invasive exotic species information. www.bugwood.org

USDA Plants Database. This incredible resource houses fact sheets, distribution maps, and photos, and extensive information on native and non-native flora in the United States. http://plants.usda.gov/

Invasive Plant Atlas of New England. (IPANE) provides trainings, outreach materials, and useful data on invasive terrestrial plants. Go to http://nbii-nin.ciesin.columbia.edu/ipane/

Master Gardener of Vermont is a fantastic resource for education and information. Contact them at 1-800-639-2230 or go to www.uvm.edu/mastergardener/invasives/invasives.htm

iMapinvasivess Invasive plant species summaries for a number of species. These are at iMapinvasives http://www.imapinvasives.org/GIST/ESA/

Land Management Resources

Vermont Coverts offers weekend trainings on sustainable land management to landowners. www.vtcoverts.org

Northern Woodlands Magazine publishes a magazine and other media to encourage a culture of forest stewardship. http://northernwoodlands.org/programs/

Vermont Woodland Owners Association provides outreach and training that advocates for sustainable management of Vermont's forests. http://www.vermontwoodlands.org/index.html

Vermont Family Forests provides education and resources that promotes the cultivation of forest community health. http://www.familyforests.org/about/

Natural Resource Conservation Districts provide training, technical assistance, and information for the conservation and stewardship of Vermont's resources. http://vacd.org/mission.html

Impacts of Invasive Plants on Natural Resources, Wildlife, and the Economy

Center for Invasive Plant Management. Provides a solid bibliography of articles www.weedcenter.org.

Bringing Nature Home is a website that supports entomologist Douglas Tallamy's work, including his book with the same namesake. www.bringingnaturehome.net

National Invasive Species Information Center is hosted by the USDA and contains a number of useful resources, including up to date articles on impacts. www.invasivespeciesinfo.gov/

Planting with Alternatives and Natives

New England Wild Flower Society offers books, workshops, and web-based resources to help you plan and implement native plant gardens. They have beautiful display gardens, a nursery and retail shop at two locations. www.newfs.org

BePlantWise: The Lady Bird Johnson Wildflower Center has lists of recommended native plants by region and state. www.beplantwise.org

The Vermont **Agency of Natural Resources Division of Water Quality** published a *Guide to Native Plant Nurseries,* listing dozens of sources of native plants. www.anr.state.vt.us/dec//waterq/cfm/ref/ref_wetlands.cfm

Appendix 5: References

Thank you to the following people and organizations for giving us permission to edit and utilize their materials for this guide. In particular, the *Invasive Exotic Plants: Give Them A Niche, and they Take a Mile* by permission of Vermont Game and Fish; *Why Should I Care about Invasive Plants* by permission of the Midwest Invasive Plant Network; "The Economics of Invasive Species" by permission of Samual Chan; *Fighting Invasive Weeds-A Northeastern Nevada Landowner's Guide to Healthy Landscapes* by permission of J. Kent McAdo; *Invasive Plant Management: Guidelines for Managers* by permission of Julie Richburg; *Guidance Document of the Purple Loosestrife Biocontrol Project* of the Massachusetts Office of Coastal Zone Management by permission of Georgeann Keer; *Invasive Exotic Plant Management Tutorial for Natural Land Managers* by permission of Lisa Smith; *Developing Bid Specifications from Invasive Plant Control Programs* by permission of Lee Patrick.

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