New Hampshire
Department of Transportation

BEST MANAGEMENT PRACTICES FOR ROADSIDE INVASIVE PLANTS

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Acknowledgements

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This manual is available online at:
http://www.nh.gov/dot/bureaus/environment/documents.htm

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Introduction

Impacts of Invasive Plants

An invasive plant is a non-native plant that is able to persist and proliferate outside of cultivation, resulting in ecological and/or economic harm. These plants readily colonize disturbed areas and habitat edges, such as transportation and river corridors. Once established in these areas, invasive plants often continue to spread to adjacent habitats. All invasive plant species are aggressive competitors with the ability to significantly reduce diversity of native plant and animal species.

The land adjacent to roadways tends to be ideal habitat for invasive plants because of its high level of disturbance and abundant sunlight. According to the Federal Highway Administration, roadside rights-of-way account for more than 10 million acres of land in the United States. This is a significant amount of land on which invasive plants readily establish. The right-of-way environment creates long, linear habitats that serve as pathways for the spread of invasive plants into new regions and onto adjacent lands. Once established, invasive plants can affect the safety and maintenance of transportation infrastructure and wreak havoc on the natural environment.

Invasive plants impact transportation corridors in a variety of ways. Certain invasive plants can reduce sight distance, block signs, increase the risk of fire, and encroach on travel lanes. Some species are capable of pushing up through pavement and damaging shoulders and road edges. In addition, some species plug ditch lines and block culverts, reducing the effectiveness of these drainage structures and hindering their maintenance.

Some invasive plants contain compounds that can cause health problems to people who come into contact with the plants. Two invasive species are of particular concern. Giant hogweed (*Heracleum mantegazzianum*) contains phototoxic sap that can severely burn and blister the skin. Spotted knapweed (*Centaurea biebersteinii*) contains compounds that may be carcinogenic in large quantities. Gloves and long sleeves should be worn when working with or near these plants. Although not an invasive plant, poison ivy can also cause severe skin reactions when any part of the plant comes into contact with skin. (Note: Because it is not an invasive plant, poison ivy is not included in this manual. A separate guidance document will be written to address the presence of poison ivy along roadways.)

When invasive plants become established in natural areas, they can impact native species and ecosystem processes. Next to habitat loss, invasive species are considered the second most important factor in the decline of biodiversity in North America. It has been

estimated that environmental damages and losses caused by invasive species in the United States total $120 billion each year.[1]

Invasive Plant Prevention

Invasive plants spread by a variety of mechanisms, including birds, wind, and water. Human activities are also a major factor in the spread of these plants, from gardening and transport of nursery stock to erosion control and wildlife plantings. Routine maintenance and construction activities along transportation corridors can also play a significant role in the spread of invasive plants by dispersing or introducing seeds and other viable plant materials.

Eliminating or reducing the spread and establishment of invasive plants requires a proactive approach, in which there are two key elements. First, new introductions, especially those that occur due to human activities, must be avoided to the maximum extent possible. Second, there must be an emphasis on early detection and eradication of new populations. Control measures are far more likely to be successful, as well as significantly less expensive, on small, young populations rather than on larger, more established populations, as shown in Figure 1.

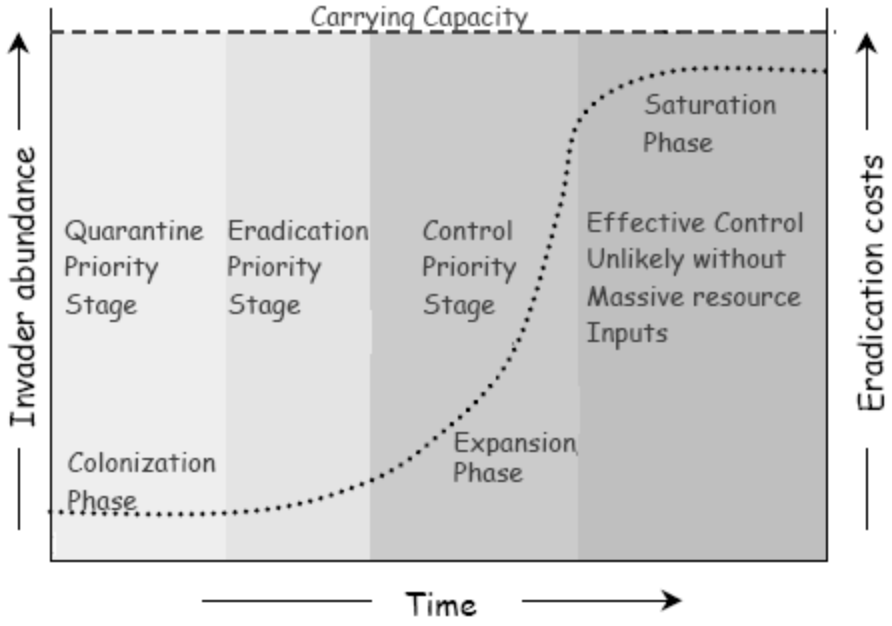

Figure 1. Typical invasive species population curve (from the University of Arizona and USGS Desert Laboratory http://wwwpaztcn.wr.usgs.gov)

[1] Pimental, David, Rodolfo Zunigo and Doug Morrison. "Update on the environmental and economic costs associated with alien-invasive species in the United States." College of Agriculture and Life Sciences, Cornell University, 2004.

Regulatory Framework

The following federal and state laws and regulations pertain to preventing the spread of invasive species:

- Executive Order 13112 on Invasive Species (February 2, 1999)
- Federal Highway Administration Guidance on Invasive Species (August 18, 1999)
- Noxious Weed Control and Eradication Act (October 30, 2004)
- U.S. Army Corps of Engineers State Programmatic General Permit (June 28, 2007)
- NH Department of Agriculture Code of Administrative Rules, Invasive Species, Chapter Agr 3800; RSA 430:55 (2004)
- NH Department of Environmental Services Code of Administrative Rules, Invasive Aquatic Species, Chapter Env-Wq 1303.02; RSA 487:16-a (1998)

Prohibited Invasive Plants in NH

Recognizing the problem of invasive plants in New Hampshire, the NH Department of Agriculture, Markets & Foods adopted the Invasive Species Rule, AGR 3800, in June of 2004. The rule was enacted to preserve the integrity of the natural environment and commercial agriculture and states "*no person shall collect, transport, sell, distribute, propagate or transplant any living and viable portion of any listed prohibited invasive plant species, which includes all of their cultivars and varieties*." Prohibited plant species are listed below.

Scientific Name	Common Name	Growth Form
Acer platanoides	Norway maple	tree
Ailanthus altissima	tree of heaven	tree
Alliaria petiolata	garlic mustard	annual herb
Berberis thunbergii	Japanese barberry	shrub
Berberis vulgaris	European barberry	shrub
Celastrus orbiculatus	Oriental bittersweet	woody vine
Cynanchum nigrum	black swallow-wort	vine
Cynanchum rossicum	pale swallow-wort	vine
Elaeagnus umbellata	autumn olive	shrub
Euonymus alatus	burning bush	shrub
Heracleum mantegazzianum	giant hogweed	perennial herb
Iris pseudacorus	water-flag	aquatic emergent
Ligustrum obtusifolium	blunt-leaved privet	shrub
Lonicera bella	showy bush honeysuckle	shrub
Lonicera japonica	Japanese honeysuckle	woody vine
Lonicera morrowii	Morrow's honeysuckle	shrub
Lonicera tatarica	Tatarian honeysuckle	shrub
Polygonum cuspidatum	Japanese knotweed	perennial herb
Rhamnus cathartica	common buckthorn	shrub
Rhamnus frangula	glossy buckthorn	shrub
Rosa multiflora	multiflora rose	shrub

The Department of Agriculture is currently updating the Prohibited Invasive Species list to add the following species:

Scientific Name	Common Name	Growth Form
Centaurea biebersteinii	spotted knapweed	perennial herb
Hesperis matronalis	dame's rocket	perennial herb
Lepidium latifolium	perennial pepperweed	perennial herb
Microstegium vimineum	Japanese stilt grass	grass
Polygonum perfoliatum	mile-a-minute vine	vine
Reynoutria x *bohemica*	Bohemian knotweed	perennial herb

In addition to the species regulated by the Department of Agriculture, the Department of Environmental Services prohibits the distribution, propagation, transportation, and introduction of twenty-nine aquatic invasive species (Env-Wq 1303.02):

Scientific Name	Common Name	Growth Form
Butomus umbellatus	flowering rush	aquatic emergent
Cabomba caroliniana	fanwort	aquatic submerged
Crassula helmsii	swamp stonecrop	aquatic submerged
Egeria densa	Brazilian elodea	aquatic submerged
Epilobium hirsutum	great willow herb	aquatic emergent
Glyceria maxima	manna grass	aquatic grass
Hydrilla verticillata	hydrilla	aquatic submerged
Hydrocharis morsus-ranae	frogbit	aquatic floating
Hygrophila polysperma	East Indian hygrophila	aquatic emergent
Ipomoea aquatica	water spinach	aquatic emergent vine
Iris pseudocarus	yellow flag iris	aquatic emergent
Lagarosiphon major	African oxygen weed	aquatic submerged
Limnophila sessiliflora	ambulia	aquatic submerged
Lythrum salicaria	purple loosestrife	aquatic emergent
Marsilea quadrifolia	water fern	aquatic floating
Myosotis scorpioides	water forget-me-not	aquatic emergent
Myriophyllum aquaticum	parrot-feather	aquatic submerged
Myriophyllum heterophyllum	variable milfoil	aquatic submerged
Myriophyllum spicatum	Eurasian milfoil	aquatic submerged
Najas minor	European naiad	aquatic submerged
Nymphoides peltata	yellow floating heart	aquatic floating
Phragmites australis	common reed	aquatic emergent
Potamogeton crispus	curly leaf pondweed	aquatic submerged
Sagittaria japonica	Japanese arrowhead	aquatic emergent
Sagittaria sagittifolia	giant sagittaria	aquatic emergent
Trapa natans	water chestnut	aquatic floating
Typha gracilis	slender cattail	aquatic emergent
Typha laxmanii	dwarf cattail	aquatic emergent
Typha minima	miniature cattail	aquatic emergent

Using This Manual

The intent of this manual is to bring awareness to invasive plants and the role that the NH Department of Transportation (NHDOT) can play in limiting the spread of these species along our rights-of-way and into adjacent habitats. The information in this manual is meant as guidance for maintenance and construction personnel, as well as contractors working for the Department. This manual is divided into three sections:

Section I: The general Best Management Practices (BMPs) that are discussed are applicable to all invasive plants, including those listed on the NH Prohibited Invasive Species list. When followed, these BMPs will reduce the likelihood of introducing invasive plants into new areas via maintenance and construction activities.

Section II: Priority invasive plant species are discussed, including appropriate species-specific BMPs and Preferred Control Methods. Priority species are those species that have at least two of the following characteristics: 1) easily spread by NHDOT activities, 2) significant negative impact on transportation infrastructure, and 3) very difficult to eradicate. The five priority species are knotweed, purple loosestrife, phragmites, Oriental bittersweet, and spotted knapweed. All of the priority species are on the NH Prohibited Invasive Species list. Most of the priority species are already widespread throughout New Hampshire, with the exception of spotted knapweed, which is currently found only in scattered populations in the state.

Section III: Contacts and other resources are listed to provide sources for more information, especially in regard to invasive plant identification. The websites listed in this section provide detailed identification characteristics and photographs of invasive plants. A glossary is also included to define terms used throughout the manual.

Section I – General Best Management Practices

Soil Disturbance and Stabilization

- **BMP #1:** Minimize soil disturbance whenever possible. Invasive plants readily colonize areas of disturbed soil. Monitor recent work sites for the emergence of invasive plants for a minimum of two years after project completion.

- **BMP #2:** Stabilize disturbed soils as soon as possible by seeding and/or using mulch, hay, rip-rap, or gravel that is free of invasive plant material. Seeds of native species should be used whenever possible. Species on the prohibited invasive plant list should never be planted.

- **BMP #3:** Materials such as fill, loam, mulch, hay, rip-rap, and gravel should **not** be brought into project areas from sites where invasive plants are known to occur. If the absence of invasive plant parts in these materials cannot be guaranteed, recent work sites should be monitored for the emergence of invasive plants for a minimum of two years after project completion.

Movement and Maintenance of Equipment

- **BMP #4:** If work in areas containing invasive plants cannot be avoided, then the movement of maintenance and construction equipment should be from areas not infested by invasive plants to areas infested by invasive plants whenever possible. This is especially important during ditch cleaning and shoulder scraping activities.

- **BMP #5:** Locate and use staging areas that are free of invasive plants to avoid spreading seeds and other viable plant parts.

- **BMP #6:** If equipment must be used in areas where invasive plants occur, all equipment, machinery, and hand tools should be cleaned of all visible soil and plant material before leaving the project site. Equipment should be cleaned at the site of infestation. Acceptable methods of cleaning include, but are not limited to:
    - Portable wash station that contains runoff from washing equipment (containment must be in compliance with wastewater discharge regulations);
    - High pressure air;
    - Brush, broom, or other hand tools (used without water).

- **BMP #7**: If equipment must be used in areas containing Japanese knotweed, phragmites, or purple loosestrife, aboveground plant material should be cut and properly disposed of (see BMP #11) prior to the start of work. *If excavation occurs in these areas, see BMPs #13-16.*

Mowing

- **BMP #8:** These invasive plants have the ability to sprout from stem and root fragments: **purple loosestrife, phragmites, and Japanese knotweed.** Mowing these plants should be avoided whenever possible. Staking roadside populations of these plants as "do not mow" is one way to accomplish this. If these plants are cut, all plant material must be rendered nonviable and extra care should be taken to avoid spreading plant fragments (see BMP #11).

- **BMP #9:** In areas where invasive plants occur and the plants listed in BMP #8 (purple loosestrife, phragmites, and Japanese knotweed) are *not* present, an attempt should be made to mow the right-of-way prior to seed maturation (approximately August 1st). This could be accomplished by identifying specific roads that are either heavily infested with invasive plants or roads that are in sensitive habitat areas, and making those roads a priority in the mowing schedule.

- **BMP #10:** Mowing equipment should be cleaned at least daily, as well as prior to transport (see BMP #6). This is particularly important if mowing occurs after seed maturation (after August 1st).

Disposal of Plants

- **BMP #11:** When invasive plants are cut or removed for roadside maintenance, construction, or control of plants, the spread of viable plant material must be avoided by rendering plant material nonviable. The following methods can be used to destroy plant material:

  - Drying/Liquefying: For large amounts of plant material or for plants with rigid stems, place the material on asphalt, tarps, or heavy plastic, and cover with tarps or heavy plastic to prevent the material from blowing away. For smaller amounts of plant material or for plants with pliable stems, bag the material in heavy-duty (3-mil or thicker) garbage bags. Keep plant material covered or bagged for at least one month. Material is nonviable when it is partially decomposed, very slimy, or brittle. Once material is nonviable, it can be disposed of in a landfill or brush pile.
    Recommended for: Japanese knotweed, purple loosestrife, phragmites.

  - Brush Piles: Plant material from most invasive plants can be piled on site to dry out. However, when piling purple loosestrife, phragmites, and Japanese knotweed, care must be taken to pile stems so that cut surfaces are not in contact with the soil.
    Recommended for: Woody shrubs, trees, and vines; spotted knapweed; large quantities of purple loosestrife, phragmites, and Japanese knotweed.
    NOT recommended for: any invasive plant with seeds or fruit attached, unless plants can be piled within the limits of the infestation.

  - Burying: Plant material from most invasive plants can be buried a minimum of three feet below grade. This method is best used on a job site that already has disturbed soils.
    Recommended for: any invasive plant.
    NOT recommended for: Japanese knotweed, unless other options are not feasible and knotweed can be buried *at the site of infestation at least **five** feet below grade*.

  - Burning: Plant material should be taken to a designated burn pile. (All necessary permits must be obtained before burning.)
    Recommended for: any invasive plant, especially purple loosestrife, phragmites, Japanese knotweed.

- **BMP #11 (continued)**
    - Herbicide: Herbicide applications must be carried out by a licensed applicator with a permit from the NH Department of Agriculture Division of Pesticide Control.

      Recommended for: any invasive plant, especially purple loosestrife, phragmites, Japanese knotweed.

- **BMP #12:** Invasive plant material must be covered during transport.

Excavated Material

- **BMP #13:** Excavated material taken from sites that contain invasive plants cannot be used away from the site of infestation until all viable plant material is destroyed. Excavated material from areas containing invasive plants may be reused within the *exact* limits of the infestation.

- **BMP #14:** Any excavated material that contains viable plant material and is not reused within the limits of the infestation must be stockpiled on an impervious surface until viable plant material is destroyed OR the material must be disposed of by burying a minimum of three feet below grade. Japanese knotweed must be buried at least five feet below grade.

- **BMP #15:** Whenever possible, excavation should be avoided in areas containing Japanese knotweed, purple loosestrife, and phragmites. If excavation does occur in these areas, the BMPs described in Section II must be followed.

- **BMP #16:** Soil and other materials containing invasive plants must be covered during transport.

Section II – NHDOT Priority Invasive Plant Species

Knotweed

Polygonum cuspidatum	Japanese knotweed, Mexican bamboo
Reynoutria x bohemica	Bohemian knotweed
Polygonum sachalinense	Giant knotweed

Close-up of stem

Dead stems

- **Knotweed BMP #1:** Any treatment or control of knotweed should take place prior to seed maturation (late August). While knotweed spreads primarily via vegetative reproduction, it does produce viable seeds that can germinate in the wild.

- **Knotweed BMP #2:** Do not mow knotweed, especially if it is growing near a ditch line, wetland, or surface water. Mowing knotweed creates small stem fragments that can be spread by the mowing equipment or moving water. These fragments can sprout and start new populations of knotweed.

- **Knotweed BMP #3:** If knotweed must be removed (i.e. for safety reasons), a control plan should be implemented using preferred control methods (see following page). If a control plan is not implemented, the preferred method of removal is hand cutting, especially near water. The cut stems must be rendered nonviable by using a method listed in Section I – General Best Management Practices (BMP #11).

- **Knotweed BMP #4:** If hand cutting is not feasible and mowing equipment must be used, the site should be raked immediately after mowing and as much plant material as possible should be collected and rendered nonviable by using a method listed in Section I (BMP #11). All mowing equipment should be cleaned prior to leaving the site (see Section I – BMP #6). *Note that cutting, whether manual or mechanical, is generally not an effective method for eradicating knotweed.*

- **Knotweed BMP #5:** If excavation will occur in areas containing knotweed, one or more of the following methods must be used to avoid spreading viable plant material:

    a) Treat all knotweed stems with herbicide (see Control Option #1 on the following page). This control method should be carried out at least two years prior to excavation in order to allow time to perform an adequate number of herbicide treatments to kill the entire root system.

    b) Excavate as needed and spread all material containing roots and stems on an *impervious surface*. Care must be taken not to spread plant material during excavation and transport. Root material should be broken up as much as possible to promote a faster drying time. Once material has completely dried out, it is nonviable and can be used or disposed of on or off site.

    c) If the above methods are not feasible, excavated material can be buried *at the site of infestation* at least **five** feet below grade.

- **Knotweed Control Option #1:** Chemical Control

Herbicide treatment is the most effective way to eradicate knotweed. The best time to apply herbicide is late summer or early fall, when the plants are just starting to flower. The following application methods are effective; however, treatments will likely be required for at least two consecutive years, regardless of the method used.

Effective herbicide treatments:

a) Early summer cut followed by a late summer/early fall foliar spray – best for small to medium sized populations
b) Foliar spray twice in one growing season – best for large, dense populations
c) Stem injection – best for small to medium sized populations
d) Cut & fill (stem cut and filled with herbicide) – best for small to medium sized populations

Important considerations:

- Any method that requires cutting the knotweed stems necessitates proper disposal of the cut stems.
- Presently, the NH Department of Agriculture Division of Pesticides requires knotweed to be listed on the herbicide label as a target species for a specific application method.
- A permit from the Division of Pesticides must be obtained prior to applying herbicide. Application of herbicide must be consistent with herbicide label and carried out by a licensed applicator.
- Currently, the Division of Pesticides allows only cut stem treatments along public road rights-of-way during the period of green foliage.
- Applying herbicide to the right-of-way between June 1st and October 15th requires going through a public notification process to obtain a permit. However, cut stem treatments do not require public notification.
- Avoid herbicide drift and spillage to minimize impacts to non-target species.

- **Knotweed Control Option #2:** Mechanical Control

If herbicide treatment is not an option, cutting is sometimes successful in eradicating knotweed, but only with small, young populations, and only when done repeatedly (at least 4 times each growing season) for several years. Cutting by hand with a scythe or loppers is preferable to mowing. Cut material should be destroyed as described in Section I (BMP #11), and all equipment should be cleaned prior to leaving the site (see Section I - BMP #6).

Purple Loosestrife

Lythrum salicaria

- **Loosestrife BMP #1:** Any treatment or control of loosestrife should take place prior to seed maturation (early August). A mature loosestrife plant can produce more than 2 million seeds.

- **Loosestrife BMP #2:** Do not mow loosestrife if it can be avoided. Mowing loosestrife creates small stem fragments that can be spread by the mowing equipment or moving water. These fragments can sprout and start new populations of loosestrife.

- **Loosestrife BMP #3:** If excavation will occur in areas containing purple loosestrife, one or more of the following methods must be used to avoid spreading viable plant material:

    a) Treat all loosestrife stems with herbicide (see Control Option #3 on the following page). This control method should be carried out at least two years prior to excavation in order to allow time to perform an adequate number of herbicide treatments to kill the entire root system.

    b) Excavate as needed and spread all material containing roots and stems on an *impervious surface*. Care must be taken not to spread plant material during excavation and transport. Root material should be broken up as much as possible to promote a faster drying time. Once material has completely dried out, it is nonviable and can be used or disposed of on or off site.

    c) Excavated material can be buried on or off site at least **three** feet below grade.

- **Loosestrife Control Option #1:** Mechanical Control

Cutting or pulling by hand can be effective in eradicating small, young populations. However, this treatment must be continued for several years and any disturbed soil must be stabilized. Any material that is cut or pulled must be rendered non-viable (see Section I - BMP #11). Both stem and root fragments can sprout new plants.

- **Loosestrife Control Option #2:** Biological Control

Biological control measures have been developed for loosestrife and consist of leaf-feeding and root-feeding beetles. This control method is best for large, dense populations. More information about this option can be obtained from the NHDOT Bureau of Environment or the NH Department of Agriculture.

- **Loosestrife Control Option #3:** Chemical Control

Herbicide can be applied in late July. The selected herbicide must be approved for use in wetlands. Treatments will likely be required for at least two consecutive years, regardless of the method used.

Effective herbicide treatments:
a) Foliar spray
b) Cut stem

Important considerations:

- Presently, the NH Department of Agriculture Division of Pesticides requires loosestrife to be listed on the herbicide label as a target species for a specific application method.
- A permit from the Division of Pesticides must be obtained prior to applying herbicide. Application of herbicide must be consistent with herbicide label and carried out by a licensed applicator.
- Currently, the Division of Pesticides allows only cut stem treatments along public road rights-of-way during the period of green foliage.
- Applying herbicide to the right-of-way between June 1st and October 15th requires going through a public notification process to obtain a permit. However, cut stem treatments do not require public notification.
- Avoid herbicide drift and spillage to minimize impacts to non-target species.

Phragmites

Phragmites australis Common Reed

- **Phragmites BMP #1:** Do not mow phragmites if it can be avoided. Phragmites spreads vigorously by vegetative reproduction. Mowing phragmites creates small stem fragments that can be spread by the mowing equipment or moving water. These fragments can sprout and start new populations.

- **Phragmites BMP #2:** Cutting by any method, when done at the wrong time, can increase stand density. Cutting should be timed to coincide with tasseling (when flowers begin to develop at the top of stem - late July/early August). This is when most of the plant's food reserves are aboveground.

- **Phragmites BMP #3:** If excavation will occur in areas containing phragmites, one or more of the following methods must be used to avoid spreading viable plant material:

    a) Treat all phragmites stems with herbicide (see Control Option #2 on the following page). This control method should be carried out at least two years prior to excavation in order to allow time to perform an adequate number of herbicide treatments to kill the entire root system.

    b) Excavate as needed and spread all material containing roots and stems on an *impervious surface*. Care must be taken not to spread plant material during excavation and transport. Root material should be broken up as much as possible to promote a faster drying time. Once material has completely dried out, it is non-viable and can be used or disposed of on or off site.

    c) Excavated material can be buried on or off site at least three feet below grade.

- **Phragmites Control Option #1:** Mechanical Control

Cutting by hand, pulling, or digging can be effective in eradicating small, new populations. These methods should be used in late July or early August when the plants are close to or in tasseling stage. This treatment must be continued for several years and any disturbed soil must be stabilized. Any material that is removed must be rendered non-viable (see Section I - BMP #11). Both stem and root fragments can sprout into new plants.

- **Phragmites Control Option #2:** Chemical Control

Herbicide can be applied in late summer (after tasseling). The selected herbicide must be approved for use in wetlands. Treatments will likely be required for at least two consecutive years, regardless of the method used.

Effective herbicide treatments:
a) Foliar spray
b) Stem injection

Important considerations:

- Presently, the NH Department of Agriculture Division of Pesticides requires phragmites to be listed on the herbicide label as a target species for a specific application method.
- A permit from the Division of Pesticides must be obtained prior to applying herbicide. Application of herbicide must be consistent with herbicide label and carried out by a licensed applicator.
- Currently, the Division of Pesticides allows only cut stem treatments along public road rights-of-way during the period of green foliage.
- Applying herbicide to the right-of-way between June 1st and October 15th requires going through a public notification process to obtain a permit. However, cut stem treatments do not require public notification.
- Avoid herbicide drift and spillage to minimize impacts to non-target species.

Oriental Bittersweet

Celastrus orbiculatus Round-leaved bittersweet

Best Management Practices

- **Bittersweet BMP #1:** Any treatment or control of bittersweet should take place prior to seed maturation (August). Bittersweet produces abundant, colorful fruit that is spread primarily by birds and people.

Preferred Control Methods

- **Bittersweet Control Option #1:** Chemical Control

Herbicide treatment is the most effective way to control bittersweet. The best time to apply herbicide is late summer. The following application methods are effective; however, treatments will likely be required for at least two consecutive years, regardless of the method used.

Effective herbicide treatments:
a) Foliar spray – best for small, young plants
b) Cut stem – best for large plants

Important considerations:

- Presently, the NH Department of Agriculture Division of Pesticides requires bittersweet to be listed on the herbicide label as a target species for a specific application method.
- A permit from the Division of Pesticides must be obtained prior to applying herbicide. Application of herbicide must be consistent with herbicide label and carried out by a licensed applicator.
- Currently, the Division of Pesticides allows only cut stem treatments along public road rights-of-way during the period of green foliage.
- Applying herbicide to the right-of-way between June 1st and October 15th requires going through a public notification process to obtain a permit. However, cut stem treatments do not require public notification.
- Avoid herbicide drift and spillage to minimize impacts to non-target species.

- **Bittersweet Control Option #2:** Mechanical Control

If herbicide treatment is not an option, cutting can be successful, but usually only with small, young stems, and only when done repeatedly (at least 4 times each growing season for several years). Cut material should be destroyed as described in Section I - BMP #11.

Spotted Knapweed

Centaurea biebersteinii

Best Management Practices

- **Knapweed BMP #1:** Any treatment or control of knapweed should take place prior to seed maturation (early August). Knapweed produces copious amounts of seeds that are spread by wind, by sticking to passing vehicles and machinery, and through contaminated hay and fill. These seeds can remain viable in the soil for up to eight years.

Preferred Control Methods

- **Knapweed Control Option #1:** Mechanical Control

Small populations of knapweed can be controlled by pulling or cutting by hand (gloves should be worn), and larger populations can be controlled by mowing. These control options are most effective when carried out just prior to seed maturation and must be continued for several years to achieve eradication.

- **Knapweed Control Option #2:** Chemical Control

Herbicide can be applied in late summer (before seed maturation). Treatments will likely be required for at least two consecutive years, regardless of the method used.

Effective herbicide treatments:
c) Foliar spray
d) Cut stem

Important considerations:

- Presently, the NH Department of Agriculture Division of Pesticides requires knapweed to be listed on the herbicide label as a target species for a specific application method.
- A permit from the Division of Pesticides must be obtained prior to applying herbicide. Application of herbicide must be consistent with herbicide label and carried out by a licensed applicator.
- Currently, the Division of Pesticides allows only cut stem treatments along public road rights-of-way during the period of green foliage.
- Applying herbicide to the right-of-way between June 1st and October 15th requires going through a public notification process to obtain a permit. However, cut stem treatments do not require public notification.
- Avoid herbicide drift and spillage to minimize impacts to non-target species.

Section III – Resources

Contacts

Bureau of Environment, NH Department of Transportation

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Contact for information on: plant identification, best management practices, and control methods

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Roadside Development, Bureau of Highway Design, NH Department of Transportation

- **Guy Giunta**, Landscape Specialist Supervisor

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Contact for information on: herbicides

NH Department of Agriculture, Markets, & Food

- **Doug Cygan**, Invasive Species Coordinator

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Contact for information on: plant identification, control methods

Websites

http://www.lib.uconn.edu/webapps/ipane/search.cfm Invasive Plant Atlas of New England—photographs and information on habitat

http://www.na.fs.fed.us/fhp/invasive_plants/weeds/ US Forest Service—fact sheets on invasive plants in the northeastern United States

http://tncweeds.ucdavis.edu/esadocs.html The Global Invasive Species Initiative—photographs, management information

http://www.invasivespeciesinfo.gov/plants/main.shtml National Invasive Species Information Center—species profiles with links to other resources

http://agriculture.nh.gov/divisions/plant_industry/documents/InvasivesBooklet2005.pdf NH Department of Agriculture—Guide to Invasive Upland Plant Species in New Hampshire

http://www.fhwa.dot.gov/modiv/invasive.htm Federal Highway Administration—Guide to Roadside Invasives—photographs grouped by flower color; includes many weeds that are not considered invasive in NH.

Publications

Vehicle Cleaning Technology for Controlling the Spread of Noxious Weeds and Invasive Plants
USDA Forest Service (2005)
www.fs.fed.us/eng/pubs/

Control of Invasive Species: A Synthesis of Highway Practice
National Cooperative Highway Research Program - Synthesis 363 (2006)
www.trb.org

Dangerous Travelers: Controlling Invasive Plants Along America's Roadways
USDA Forest Service (Training Video)
www.fs.fed.us/invasivespecies/prevention/dangeroustravelers.shtml
Copies are available to borrow from the NHDOT Bureau of Environment

Roadside Weed Management
US Department of Transportation, Federal Highway Administration
Contact the NHDOT Bureau of Environment for a hardcopy

Glossary

Annual – a plant that completes its life cycle in one year.

Emergent – having most vegetative growth above water.

Germination – beginning of growth, as from a seed.

Herb – a plant that does not produce woody, persistent tissue.

Herbaceous – having aboveground stems that are fleshy instead of woody.

Native – occurring naturally in a given range; not introduced by humans.

Non-native – introduced to areas outside of the species' natural geographic range.

Nonviable – not capable of living or developing.

Perennial – a plant that lives for two years or more.

Rhizome – a horizontal, underground stem that can produce roots and aboveground stems.

Vegetative reproduction – propagation by means other than seeds, including rhizomes, runners, stem cuttings, and root cuttings.

Viable – capable of growing or developing.

Woody – having hard, lignified stem tissue that persists throughout the year.