

Spotted Knapweed

(*Centaurea stoebe*)

Best Management Practices in Ontario

Foreword

These Best Management Practices (BMPs) provide guidance for managing invasive spotted knapweed (*Centaurea stoebe*) in Ontario. Funding and leadership for the production of this document was provided by Environment and Climate Change Canada, Canadian Wildlife Service - Ontario (CWS - ON). The BMPs were developed by the Ontario Invasive Plant Council (OIPC) and its partners to facilitate the invasive plant control initiatives of individuals and organizations concerned with the protection of biodiversity, agricultural lands, infrastructure, crops and natural lands.

These BMPs are based on the most effective and environmentally safe control practices known from recent research and experience. They reflect current provincial and federal legislation regarding pesticide use, habitat disturbance and species at risk protection. These BMPs are subject to change as legislation is updated or new research findings emerge. They are not intended to provide legal advice. Interested parties are advised to refer to the applicable legislation to address specific circumstances. Check the website of the Ontario Invasive Plant Council (www.ontarioinvasiveplants.ca) for updates.

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For more information on invasive plants in Ontario, please visit the following websites:

www.ontario.ca/invasivespecies, www.ontarioinvasiveplants.ca, www.invadingspecies.com or
www.invasivespeciescentre.ca

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Spotted knapweed.

Photo courtesy of Rob Routledge,
Sault College, Bugwood.org



Spotted knapweed thrives in disturbed environments such as roadside ditches.

Photo courtesy of Kathy Walpole.

Introduction

Spotted knapweed (*Centaurea stoebe*) is a plant belonging to the sunflower (*Asteraceae*) family. It is a perennial, polycarpic plant, meaning that it lives and flowers for several years, produces more than one stem and then dies. It was accidentally introduced into North America from Western, Central and Eastern Europe in the later 1800s in contaminated alfalfa and clover seed and in soil used for ship ballast. It was present on Vancouver Island as early as 1893. Before it was considered a serious weed, it was spread in domestic hay and through human activities.

Five invasive knapweed species occur in Ontario; spotted knapweed (*Centaurea stoebe*), black knapweed (*C. nigra*), brown knapweed (*C. jacea*), diffuse knapweed (*C. diffusa*) and Russian knapweed (*Rhaponticum repens*). All knapweeds are highly competitive herbs and can form dense colonies in disturbed or overgrazed lands. The most prevalent of the five knapweed species in Ontario is spotted knapweed, therefore the following best management practices information will focus primarily on this species.

This document was developed to help guide the effective and consistent management of this invasive plant across Ontario.

Identification

Size and shape:

Up to 1.5 m (3 - 4 ft) tall, with several branched upright stems growing from a stout taproot. Leaves become smaller as they advance up the stem.



Spotted knapweed can reach 1.5 m in height with several upright stems from a stout taproot.

Photo courtesy of L.L Berry, Bugwood.org.

Stems:

The first year rosette of deeply lobed leaves are borne on short stems. Mature plants have slender stems with many branches and have a single flower at the tip of each branch. Flowering stems have alternate leaves.



Slender stems with many branches and a single flower at the tip of each branch.

Photo courtesy of Rob Routledge, Sault College, Bugwood.org.

Roots:

The plant has a stout taproot.



The stout taproot of spotted knapweed.

Photo courtesy of Montana State University.

Leaves:

Immature plants emerge in the fall, overwinter as a rosette of leaves, and resume growth in the spring. Rosette leaves are deeply lobed and are up to 20 cm long. The principal stem leaves are pinnately divided and have smooth margins. Second year leaves are alternate along the stem with the leaves deeply lobed toward the base, becoming progressively smaller with fewer lobes toward the top of the plant.



First year rosette of deeply lobed leaves.

Photo courtesy of Rob Routledge, Sault College, Bugwood.org.



The alternate, slender and smooth margined leaves.

Photo courtesy of Bruce Ackley, The Ohio State University, Bugwood.org.

Flowers:

The closed flower heads are egg-shaped and surrounded by green bracts (a modified leaf or scale, typically small, with a flower or flower cluster in its axil). Bracts are sometimes larger and more brightly colored than the true flower, (as in a poinsettia) marked with fine vertical streaks and tipped with a dark comb-like fringe. The bracts give a "spotted" appearance to flower head, which is a key identification feature. The flower colour is pink-purple, but can be a light purple or white.



Flowers embedded within the axil of green bracts with fine vertical streaks and comb-like fringe. The bracts give a "spotted" appearance to the flower.

Photo courtesy of Rob Routledge, Sault College, Bugwood.org.

Seeds:

Seeds have a tuft (bunch) of persistent bristles. Each flowering head produces 12 - 74 seeds (spacing). A single flowering plant can produce more than 1,000 seeds, or approximately 140,000 seeds per square metre in one life-cycle. The number of flowers and seeds produced depends on environmental factors such as site condition and precipitation. Once seeds disperse, they can remain viable in the soil for five years or more.



Tuft of persistent bristles which can produce between 12 - 74 seeds (spacing).

Photo courtesy of Steve Dewey, Utah State University, Bugwood.org.

Lookalikes

Table 1: The main identification features of spotted knapweed in comparison to five species that may appear similar.

	Spotted knapweed <i>(C. stoebe)</i>	Diffuse knapweed <i>(C. diffusa)</i>	Russian knapweed <i>(Centaurea repens)</i>	Black knapweed <i>(C. nigra L.)</i>	Brown knapweed <i>(C. jacea L.)</i>	Pitcher's thistle <i>(Cirsium pitcher)</i>
	 <p>Photo courtesy of Rob Routledge, Sault College, Bugwood.org.</p>	 <p>Photo courtesy of L.L. Berry, Bugwood.org.</p>	 <p>Photo courtesy of Steve Dewey, Utah State University, Bugwood.org.</p>	 <p>Photo courtesy of Rob Routledge, Sault College, Bugwood.org.</p>	 <p>Photo courtesy of Cindy Roche, Bugwood.org.</p>	 <p>Photo courtesy of Rob Routledge, Sault College, Bugwood.org.</p>
Habitat	<ul style="list-style-type: none"> • Introduced to Ontario • Prefers light textured, well-drained soils, but can occur in a wide range of soil types • Invades disturbed areas quickly, and can invade healthy, undisturbed plant communities as well • Occasionally found growing in open forests • Common along roadsides, pasturelands and ditches 	<ul style="list-style-type: none"> • Introduced to Ontario • Similar soil and habitat types preferences to spotted knapweed including open forests, pasture lands, roadsides and ditches 	<ul style="list-style-type: none"> • Introduced to Ontario • Similar habitat type to spotted and diffuse knapweed but its tolerance for poorly drained, saline, alkaline soils, extends its range to irrigation ditches, flood plains and shorelines 	<ul style="list-style-type: none"> • Introduced to Ontario • Pastures, meadows, roadsides, forest edges • Shade intolerant • Drought resistant 	<ul style="list-style-type: none"> • Introduced to Ontario • Dry meadows, pastures, forest margins, banks • Prefers more moist and cooler conditions than other knapweed species 	<ul style="list-style-type: none"> • Federally listed endangered species, provincially listed threatened species • Open, windswept, dry, semi-stable sand dune surfaces with little other vegetation like those where it is found in Ontario along the upper shores of the Great Lakes
Height	<ul style="list-style-type: none"> • 1.5 m 	<ul style="list-style-type: none"> • 10 - 60 cm 	<ul style="list-style-type: none"> • 18 - 91 cm 	<ul style="list-style-type: none"> • 20 - 80 cm 	<ul style="list-style-type: none"> • 30 cm to 1.5 m 	<ul style="list-style-type: none"> • 50 cm to 1 m
Roots	<ul style="list-style-type: none"> • Taproot 	<ul style="list-style-type: none"> • Taproot 	<ul style="list-style-type: none"> • Rhizomatous 	<ul style="list-style-type: none"> • Taproot 	<ul style="list-style-type: none"> • Taproot 	<ul style="list-style-type: none"> • Taproot up to 2 m long

Spotted knapweed
(*C. stoebe*)



Photo courtesy of Rob Routledge, Sault College, Bugwood.org.

Diffuse knapweed
(*C. diffusa*)



Photo courtesy of L.L. Berry, Bugwood.org.

Russian knapweed
(*Centaurea repens*)



Photo courtesy of Steve Dewey, Utah State University, Bugwood.org.

Black knapweed
(*C. nigra* L.)



Photo courtesy of Rob Routledge, Sault College, Bugwood.org.

Brown knapweed
(*C. jacea* L.)



Photo courtesy of Cindy Roche, Bugwood.org.

Pitcher's thistle
(*Cirsium pitcher*)



Photo courtesy of Rob Routledge, Sault College, Bugwood.org.

Stems

- First year rosette of deeply lobed leaves borne on short stems
- Mature plants have slender stems with many branches and have a single flower at the tip of each branch
- Flowering stems have alternate leaves

- Single main stem divided into numerous branches halfway up stem, giving it a ball-shaped appearance
- Each branch produces a single flower at the tip

- Thin and stiff
- Covered with soft, short hairs

- Dull green stems entirely covered with small, rough hairs (key feature)
- Upright stems are branched at the top, with narrow upper leaves and larger lobed leaves below
- Swollen below the flower head (key feature)

- Ridged
- Sometimes purple-striped

- Slender and covered in fine, whitish fuzz
- At maturity the plants produce an upright stem (~50-100 cm tall) with one to many spiny, urn-shaped thistle heads of many white or pale pink flowers

Leaves

- First year rosette has deeply lobed leaves 20 cm long
- Alternate
- Second year leaves are alternate along the stem with the leaves deeply lobed toward the base, becoming progressively smaller with fewer lobes toward the top of the plant

- Rosette leaves stalked and divided into narrow, hairy segments
- Alternate
- Mature leaves are small, less divided, stalkless and become bract-like near the flower clusters

- Rosette leaves narrow at the base and widen toward the tip
- Alternate
- Bottom leaves on mature plants are narrowly oblong to lance-shaped and deeply lobed
- Upper leaves on mature plants are oblong, toothed and become progressively smaller

- Rosette leaves broad, stalked and shallowly lobed
- Mature leaves are small and not lobed
- Upper leaves on stem are narrow and with entire margins; lower leaves are lobed with some coarse teeth

- Rosette leaves up to 15 cm long; tapering at both ends with broadest part above the middle of the leaf, occasionally lobed
- Mature leaves lance-shaped, shallowly-lobed and stalkless
- Entire or toothed

- Can remain in rosette form for 2 – 11 years
- Rosettes are generally 15-30 cm in diameter
- Greyish-green and deeply divided into narrow
- Leaves are slender and covered in fine, whitish fuzz
- Spineless except at the tips

Spotted knapweed
(*C. stoebe*)



Photo courtesy of Rob Routledge, Sault College, Bugwood.org.

Diffuse knapweed
(*C. diffusa*)



Photo courtesy of L.L. Berry, Bugwood.org.

Russian knapweed
(*Centaurea repens*)



Photo courtesy of Steve Dewey, Utah State University, Bugwood.org.

Black knapweed
(*C. nigra L.*)



Photo courtesy of Rob Routledge, Sault College, Bugwood.org.

Brown knapweed
(*C. jacea L.*)



Photo courtesy of Cindy Roche, Bugwood.org.

Pitcher's thistle
(*Cirsium pitcher*)



Photo courtesy of Rob Routledge, Sault College, Bugwood.org.

Flowers

- Closed flower heads are egg-shaped and surrounded by green bracts marked with fine vertical streaks and tipped with a dark comb-like fringe – bracts give a “spotted” appearance to flower head (key feature)
- Flower colour is pink-purple, but can be a light purple or white
- Individual flower heads bloom for two to six days before bracts close
- Bracts re-open after 20 days, allowing seed dispersal

- Broadly urn-shaped
- Bracts have a rigid terminal spine about 1/4 to 1/3 inch long with four to five pairs of shorter lateral spines
- Bracts can have dark-coloured tops but lack dark fringe present on spotted knapweed
- Flowers are usually white
- Flowers bloom from mid-summer to early fall

- Flower head bracts have light, thin hairs, a paper, translucent tip and are green at the base
- Flower colour is light pink to purple
- Bloom from mid-summer to early fall

- Rose to purple; thistle-like
- Tubular
- Fringes are longer than the bracts are wide in contrast to spotted knapweed fringes which are shorter than bract width (key feature); fringe is black

- Rose to purple, rarely white
- Up to 2.5 cm wide
- Solitary at the ends of the upper branches
- Bracts closely resemble Russian knapweed; both species have a papery, translucent tip and no spines or fringes, however, brown knapweed bracts are brown compared to yellow-green bracts of Russian knapweed (key feature)

- Light, pale pink and white
- Will grow without flowers for three to 11 years before flowering once and then dying
- Eventually produces between two and 125 flowering heads, made up of many small pinkish or creamy-white flowers

Seeds

- Tuft of persistent bristles attached

- Light brown to black

- Oval and compressed
- Gray or ivory, with long white bristles at tip when young; fall from the seed as it matures

- Light brown to light gray, 3mm long, fringed at the top

- Small
- Light brown
- Plumeless

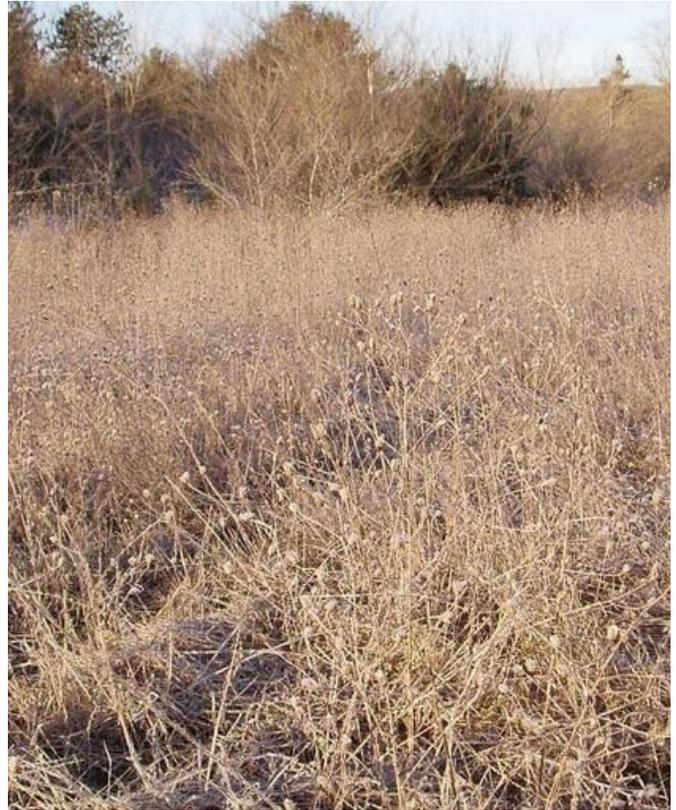
- Each flower produces a seed-like fruit that may be blown from the plant by wind due to a fluffy attachment that serves as a parachute

*General status according to *Species at Risk Act*

Biology and Life Cycle

Spotted knapweed is a short-lived perennial, reproducing only by seeds. It is a prolific seed producer with 1,000 or more seeds per plant (although this can depend on site conditions and how many flowers are produced). Seeds remain viable in the soil for five years or more, therefore new plants and infestations may occur years after the plant has been controlled or eradicated.

Seeds, which germinate from the spring through early fall, are usually dispersed in the immediate vicinity of the parent plant due to their weight, however the seeds are equipped with pappuses (little hairs) which enable wind dispersal as well. Seedlings emerge in the fall and overwinter as a rosette of leaves, resuming growth in the spring. The rosettes can either remain as rosettes, or flower in the spring. If the rosette becomes a flowering plant (mid-summer to early fall) it remains a flower until it dies. The flower stage is the seed-producing stage. Individual flower heads bloom for two to six days before the bracts close and then re-open after 20 days, allowing for seed dispersal.



Seeds may remain viable in the soil for five years or more, even after management has occurred.

Photo courtesy of Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.



Spotted knapweed is a prolific seed producer with 1,000 or more seeds per plant.

Photo courtesy of L. L Berry, Bugwood.org.

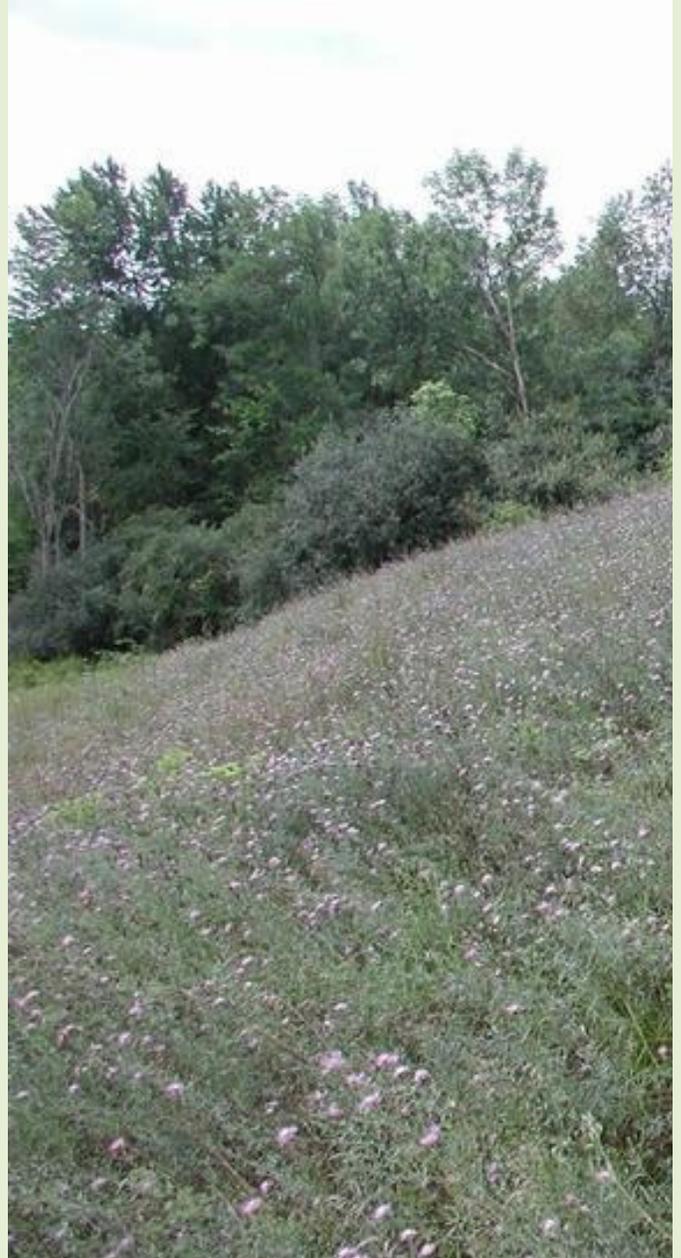
Habitat

Spotted knapweed is adapted to a wide range of habitats and soil types, but is especially suited to dry or well-drained sites with light-textured soils. In its native range of Western, Central and Eastern Europe, it is most aggressive in the forest steppe (a temperate-climate ecotone and habitat type composed of grassland interspersed with areas of woodland and forest) but it can form dense stands in moist areas on well-drained soils like gravel and in drier sites where summer precipitation is supplemented by runoff. It has not been documented to compete with vigorously growing grass in moist areas. In seasonally dry areas, its taproot allows it to access water from deep in the soil, where other grasses cannot reach. It spreads rapidly in disturbed areas, but can invade well-managed rangelands as well.



Spotted knapweed is especially well-suited to disturbed, dry or well-drained sites with light textures soils.

Photo courtesy of Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.



Spotted knapweed can form dense, monoculture-type stands in a wide range of habitat and soil types.

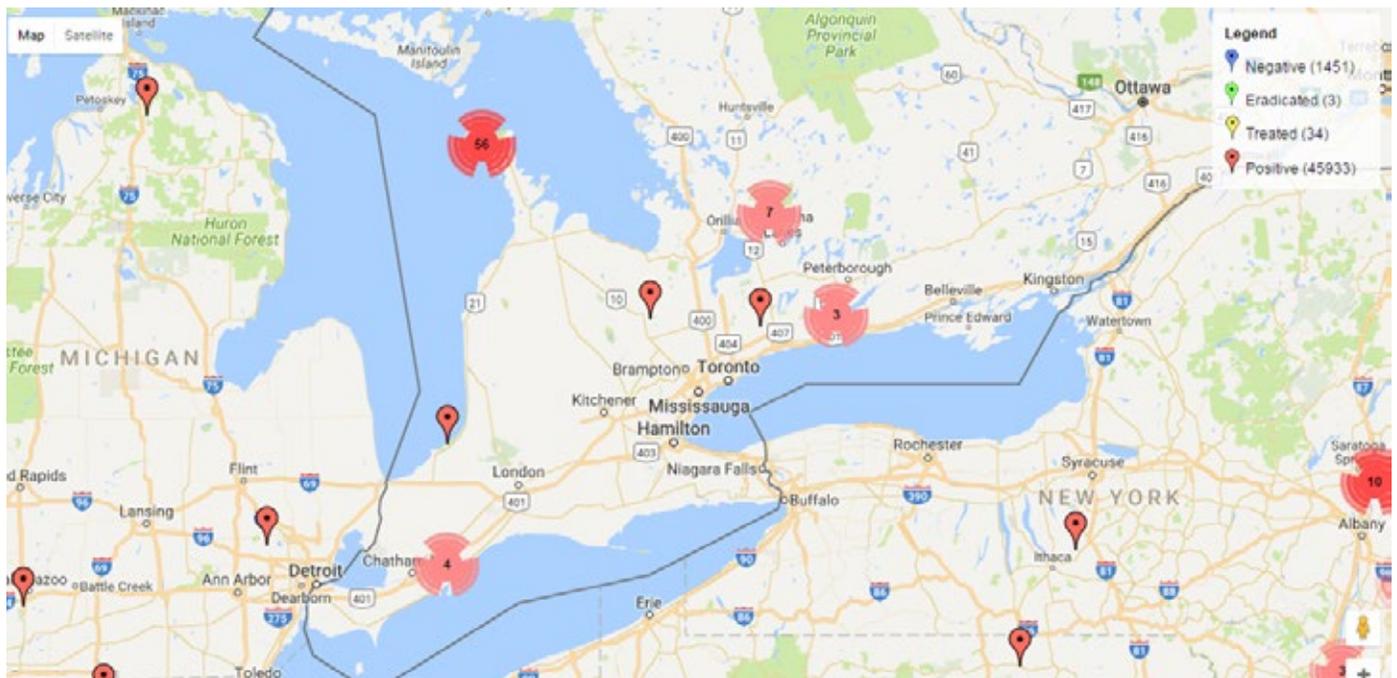
Photo courtesy of Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Pathways of Spread and Distribution in Ontario

Spotted knapweed can spread naturally via wildlife, birds, strong winds, or through human activity via contaminated equipment like vehicle undercarriages or in hay.

It occurs in 45 of the 50 US states and most Canadian provinces. However, it is found primarily in the north-western states and south-western Canada. It is considered a serious threat to rangelands in Montana, Washington, Idaho, Oregon, Wyoming and British Columbia.

Spotted knapweed can be found mostly throughout Southern Ontario especially in Grey and Hastings counties. However, there are also a number of reported sightings of it near Tobermory, as seen on EDDMapS Ontario. It's also prevalent along the border between Minnesota and Ontario, near Thunder Bay.



Distribution map showing the locations of formally reported spotted knapweed plants. Single red dots represent one record. Red dots with numbers indicates the number of records reported in the area.

Spotted knapweed distribution map courtesy of EDDMapS (www.eddmaps.org/ontario). The map point data is based on records contained in the Invasive Species Database, compiled as of December 2015 from various sources on a voluntary basis. This map is illustrative only. Please do not rely on this map as a definitive distribution as it is subject to change based on additional confirmed invasive species sites. This map may contain cartographic errors or omissions.

Impacts

Ecological

Vegetation Communities:

Spotted knapweed is a highly competitive weed that invades disturbed areas and degrades native plant communities including tallgrass savanna and sand barren habitats. This plant can form near monocultures in some areas. Once established, it can dominate an area and significantly reduce desirable vegetation, such as perennial grasses. Land in Montana with spotted knapweed infestations demonstrated higher surface water runoff and higher sediment yields than bluebunch wheatgrass (*Pseudoroegneria spicata*) dominated sites (a native North American bunchgrass). Spotted Knapweed often attains high densities on sunny, natural lands, even when the land hasn't been previously disturbed. This invasive species can occupy over 95% of the available plant community. There is some evidence that it may produce allelopathic chemicals, a biological phenomenon by which a plant produces one or more chemicals that influence the germination, growth, survival and reproductions of other plants.



Spotted knapweed is highly competitive and often invades and degrades desirable plant communities by forming dense monocultures.

Photo courtesy of Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Wildlife

Spotted knapweed can also have a negative impact on wildlife. In western Montana, Elk use was reduced by 98% on spotted knapweed-dominated range compared to bunchgrass-dominated sites. One study predicted a loss of 220 elk annually in Montana because of spotted knapweed infestations.

Studies have shown that wherever spotted knapweed establishes, it reduces plant species richness and diversity. This is especially concerning for the species designated under the *Species at Risk Act* (SARA) as being extirpated, endangered or of special concern in Canada. Many of these may be impacted by this reduction in biodiversity. The following is a list of Species at Risk for which spotted knapweed is named as a specific threat to the species in Ontario in either the federal Recovery Strategy (for species listed as Threatened or Endangered) or in the federal Management Plan (for species listed as Special Concern). More information can be found at the Species at Risk Act (SARA) Registry (www.sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Table 2: Species at Risk for which spotted knapweed is named as a specific threat in Ontario.

Species at Risk	Status	Habitat / Details	Primary Threat(s) from Spotted Knapweed
Rough agalinis (<i>Agalinis aspera</i>) (high threat)	<ul style="list-style-type: none"> Endangered 	<ul style="list-style-type: none"> Annual herb that occurs throughout the central plains of North America Prairie species found in wet meadows 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition
Forked three-awned grass (<i>Aristida basiramea</i>) (low/potential threat)	<ul style="list-style-type: none"> Endangered 	<ul style="list-style-type: none"> Annual plant restricted to North America Five known populations in Canada; four in Ontario Restricted to areas that are dry, open, and sandy or disturbed 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition
Crooked-stemmed aster (<i>Symphyotrichum prenanthoides</i>) (high threat)	<ul style="list-style-type: none"> Threatened 	<ul style="list-style-type: none"> Perennial wildflower that occurs in Ontario and in the U.S. Canadian populations occur in the Carolinian Forest Region Found in rich sandy, loamy, or clayey soil, commonly at the edge of woods and usually in partial to full shade 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition

Species at Risk	Status	Habitat / Details	Primary Threat(s) from Spotted Knapweed
<p>Western silvery aster (<i>Symphotrichum sericeum</i>) (low/potential threat)</p>	<ul style="list-style-type: none"> Threatened 	<ul style="list-style-type: none"> Perennial wildflower that occurs in central North America from Manitoba to Texas In Canada, it is at the northern limit of its distribution Well-drained calcareous (alkaline) soils in dry prairies and fields, glacial sand and gravel deposits, dry banks and open oak savannas 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition
<p>Slender bush-clover (<i>Lespedeza virginica</i>) (low/potential threat)</p>	<ul style="list-style-type: none"> Endangered 	<ul style="list-style-type: none"> Perennial herb which occurs in several southern States and in Canada Restricted to Essex County in Ontario Prairie-like habitat; open, dry or dry-mesic, sandy soils; exposed mineral soil 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition
<p>Common hoptree (<i>Ptelea trifoliota</i>) (low/potential threat)</p>	<ul style="list-style-type: none"> Threatened 	<ul style="list-style-type: none"> Small tree Occurs from the lower Great Lakes to Texas, eastward from eastern Pennsylvania and southern New England to northern Florida Ontario populations occur almost entirely along or near the Lake Erie shoreline Found in areas of natural disturbance where it forms part of the outer edge of shoreline woody vegetation 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition

Species at Risk	Status	Habitat / Details	Primary Threat(s) from Spotted Knapweed
Bird's-foot violet <i>(Viola pedata)</i> (low/potential threat)	<ul style="list-style-type: none"> Endangered 	<ul style="list-style-type: none"> Stemless perennial herb Occurs in eastern North America Populations in Canada are found only in isolated pockets in southern Ontario Found in black oak savannahs within deciduous forests, where the soils are sandy, acidic, and well drained 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition
Eastern prickly pear cactus <i>(Opuntia humifusa)</i> (low/potential threat)	<ul style="list-style-type: none"> Endangered 	<ul style="list-style-type: none"> Low succulent plant Occurs in North America Populations in Canada occur only in southwestern Ontario Found in dry sandy areas that are in the early stages of succession, such as sandy ridges or sandy dunes 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition
Karner blue <i>(Lycaeides melissa samuelis)</i>	<ul style="list-style-type: none"> Extirpated 	<ul style="list-style-type: none"> Small butterfly with wingspread of 22 - 32 mm which feeds exclusively on wild lupin (<i>Lupinus</i> sp.) Historic range was oak savanna habitats scattered within the deciduous forest region of southern Ontario Populations are restricted to sandy soils, sandy pine barrens and beach dunes (wild lupine habitat) 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition

Species at Risk	Status	Habitat / Details	Primary Threat(s) from Spotted Knapweed
Frosted elfin (<i>Callophrys irus</i>)	<ul style="list-style-type: none"> Extirpated 	<ul style="list-style-type: none"> Hairstreak subspecies butterfly with a largely brown upperside and variegated underside Range formerly included southern Ontario Presently occurs from Florida north to New England, and west to Alabama and Wisconsin Populations occur mostly in edge habitat of oak savannah and pine barren habitats, where lupines grow 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition
Eastern persius duskywing (<i>Erynnis persius persius</i>) (low/potential threat)	<ul style="list-style-type: none"> Endangered 	<ul style="list-style-type: none"> Small dark butterfly with a wingspan of 24 to 31 mm In Canada populations are restricted to southwestern Ontario, Pinery Provincial Park and St. Williams Believed to be restricted to open, sunny sites where the larval food plants, wild lupine and wild indigo, grow 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition
Illinois tick-trefoil (<i>Desmodium illinoense</i>)	<ul style="list-style-type: none"> Extirpated 	<ul style="list-style-type: none"> A perennial herb which was once found in southwestern Ontario Tall prairie environments 	<ul style="list-style-type: none"> Habitat loss due to invasion/competition



Spotted knapweed creates dense monocultures reducing habitat for native species, including species at risk.

Photo courtesy of Leslie J. Mehrhoff.

Economic

Agricultural

Spotted knapweed reduces or displaces understory and grassland plant species, thereby reducing plant availability for livestock and wildlife foraging. plant species, thereby reducing livestock and wildlife forage. One study found decreased bluebunch wheatgrass yield that was correlated with increased spotted knapweed. Bluebunch wheatgrass is palatable to all classes of livestock and wildlife and is a preferred feed for cattle, horses, sheep, elk, deer and antelope at various times during the year. Overall, knapweed can reduce crop yields, crop value and may even significantly devalue the land itself.

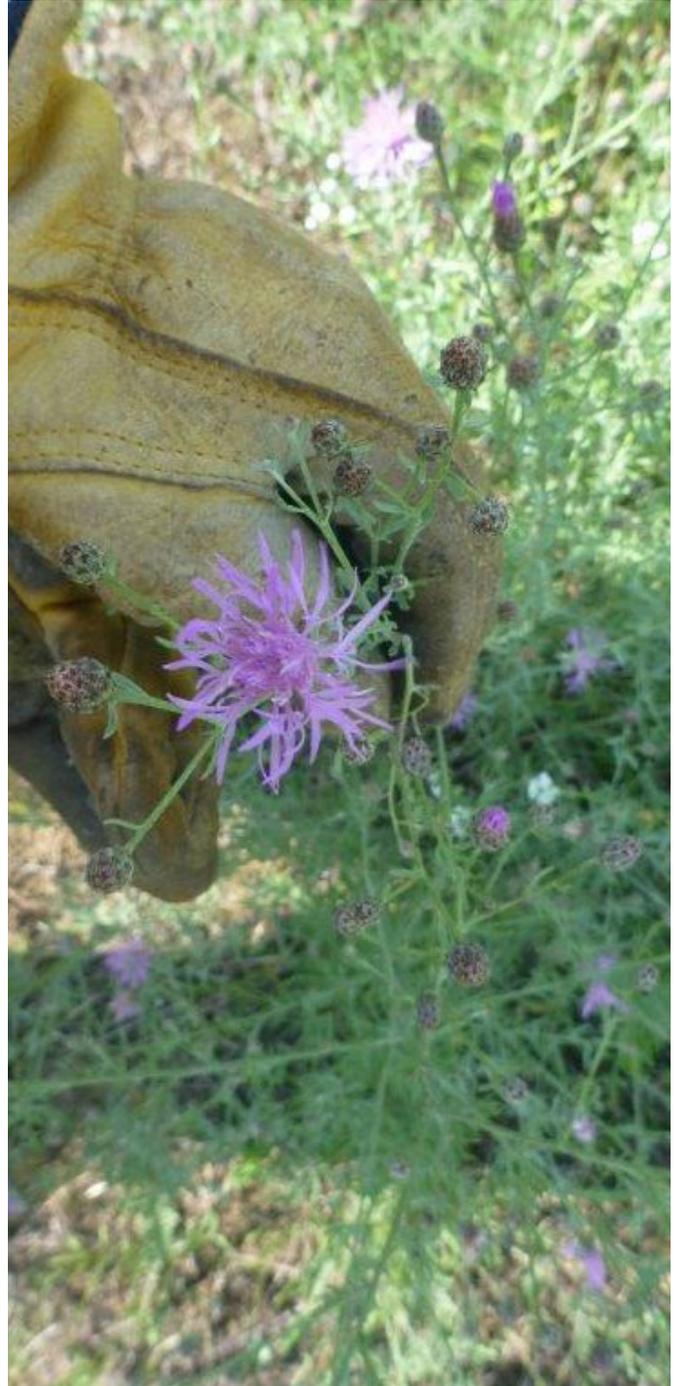


Spotted knapweed reduces or displaces desirable plant species, thereby reducing livestock and wildlife forage.

Photo courtesy of Leslie J. Mehrhoff, University of Connecticut, Bugwood.org..

Social

Spotted knapweed can cause irritation when in contact with bare skin.



Preventing the spread of an controlling spotted knapweed before it becomes locally established will reduce its impacts on human health, biodiversity, the economy and society.

Photo courtesy of Audrey Heagy.

Legislation

Many plant species and control methods are regulated under federal and/or provincial legislation. Regulations regarding spotted knapweed, chemical control and biological control of spotted knapweed at the time of writing are also summarized in this document. **Please note that this is for clarity only and not legal advice.**

You are responsible for ensuring that your project follows all relevant legislation. If protected species or habitats are present, an assessment of the potential effects of the control project could be required. Not all of the legislation below will apply to your project, therefore read carefully to determine the applicable legislative requirements needed for your project.

Consult with your local MNRF district office early in your control plans for advice (<https://www.ontario.ca/page/ministry-natural-resources-and-forestry-regional-and-district-offices>) or visit <https://www.ontario.ca/environment-and-energy/how-get-endangered-species-act-permit-or-authorization> to learn more about specific permitting requirements.

Federal

Plant Protection Act and Plant Protection Regulations

Under the *Plant Protection Act* and Plant Protection Regulations, the Canadian Food Inspection Agency (CFIA) is responsible for protecting plant resources in Canada by preventing the importation of new plant pests and limiting the movement and spread of pests within Canada. Invasive plants that are regulated under the *Plant Protection Act* are included in the list of [Pests Regulated by Canada](#). Spotted knapweed is not listed under the Pests Regulated by Canada.

Weed Seeds Order

The Weed Seeds Order (WSO), 2016 is a ministerial order made under the *Seeds Act* which lists invasive plants regulated under the *Seeds Act*. Under this order the CFIA restricts the presence of weed species in commercially sold seeds in an effort to prevent the introduction and spread of new weeds.

Spotted knapweed and diffuse knapweed are listed as Class 1, Prohibited Noxious Weed Seeds under the Weed Seeds Order 2016 <http://laws-lois.justice.gc.ca/eng/regulations/SOR-2016-93/page-2.html>.



Spotted knapweed tends to invade disturbed areas such as roadsides, ditches and old regenerating fields.

Photo courtesy of Eric Coombs.

Pest Control Products Act

The management of pesticides is the joint responsibility of the federal and provincial governments. Under the *Pest Control Products Act*, (PCPA) Health Canada's Pest Management Regulatory Agency (PMRA) registers pesticides for use in Canada with an approved label after conducting a stringent, science-based evaluation that ensures any risks are low level of risk. The pesticide label is a legal document that prescribes how the pesticide can be used; pesticides must be applied in accordance with all label directions. Ensure you have the most current label and are aware of any re-evaluation decision: visit the Pest Management Regulatory Agency's product label search site at <http://pr-rp.hc-sc.gc.ca/lr-re/index-eng.php>.

Fisheries Act

The Fisheries Act, administered by Fisheries and Oceans Canada (DFO) and Environment and Climate Change Canada (ECCC), applies to both the plant and pesticide use as it specifies that it is an offence to (for example):

- harmfully alter, disrupt, or destroy fish habitat, including streamside vegetation,
- move or introduce aquatic organisms (including plants) to new habitats,
- damage fish habitat or put harmful substances such as pesticides into water frequented by fish, including pesticide drift.

To find out if you need a permit under the *Fisheries Act*, consult <http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html>.

Species at Risk Act

ECCC also enforces the *Species at Risk Act* (SARA), whose purpose is "to prevent wildlife species in Canada from disappearing, to provide for the recovery of wildlife species that are extirpated (no longer exist in the wild in Canada), endangered, or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened." Permits are required by those persons conducting activities that may affect species at risk, such as invasive plant management. To find out which species are at risk, for more information about critical habitat, or information on obtaining a permit, consult the SARA Public Registry (<http://www.sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1>).

Migratory Birds Convention Act

The Migratory Birds Convention Act (MBCA) administered by ECCC, provides for the protection of migratory birds through the Migratory Birds Regulations and the Migratory Birds Sanctuary Regulations. For birds protected under the MBCA (<http://www.ec.gc.ca/nature/default.asp?lang=En&n=496E2702-1>), it is not permitted to kill a bird and/or disturb or destroy its nest or eggs anywhere they are found in Canada except under the authority of a permit issued under the Migratory Birds Regulations. Information on general nesting periods is available to minimize the risk to breeding birds (<https://www.ec.gc.ca/paom-itmb/default.asp?lang=En&n=4F39A78F-1>). However, operating outside nesting periods is not a guarantee that birds will not be killed or disturbed; therefore, it is the individual's responsibility to ensure they do not contravene the Act. To find out if you need a permit under the *Migratory Birds Convention Act*, visit: <https://www.ec.gc.ca/nature/default.asp?lang=En&n=2D16D723-1>.

Provincial

Weed Control Act

The *Weed Control Act* is administered by Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and enforced locally. The intent of the *Weed Control Act* is to reduce negative impacts of noxious weeds on agriculture and horticulture; to reduce plant diseases by eliminating plant disease hosts such as common barberry and European buckthorn; and to reduce health hazards to livestock caused by poisonous plants.

A noxious weed includes a plant that has been listed in the schedule of noxious weeds found in regulation 1096 made under the *Weed Control Act*. This list is commonly referred to as the “Noxious Weed List”.

In general, a species designated as a noxious weed under the *Weed Control Act* has one or more of the following characteristics:

- Difficult to manage on agricultural land once established and will reduce the yield and quality of the crop being grown
- Negatively affects the health and well-being of livestock
- Poses a risk to the health and well-being of agricultural workers

In Ontario, 25 weeds are designated as noxious under the *Weed Control Act*. Municipalities are responsible for appointing one or more weed inspectors at their discretion. The weed inspector is responsible for responding to calls made to the municipal clerk in regards to a noxious weed that has been reported on someone’s property. The weed inspector can order the person in possession of the land to destroy the weed within seven days.

All of the knapweed species mentioned in the beginning of this document are listed on the Noxious Weeds list under the *Weed Control Act*. Find the list here: http://www.omafra.gov.on.ca/english/crops/facts/noxious_weeds.htm.

Invasive Species Act

Under the *invasive Species Act*, there are rules to prevent and control the spread of invasive species. However, spotted knapweed is not listed under this Act. For more information on which species are, visit: <https://www.ontario.ca/page/stop-spread-invasive-species>.

Pesticides Act

A federally registered pesticide must also be classified by MOECC under the *Pesticides Act* before it can be sold, stored or used in Ontario. The provincial classification of federally registered pesticides can be found at www.lrcsde.lrc.gov.on.ca/PCDWeb/home.action. Pesticides must also only be used for purposes allowed under Ontario’s Cosmetic Pesticides Ban. The Ontario’s Cosmetic Pesticides Ban specifies exceptions for the use of certain pesticides (Class 9), including the use of pesticides related to protecting public works including roads, buildings and structures, and provided certain conditions are met. For example an exemption for a Class 9 active ingredient may apply if a plant interferes with the essential maintenance of a public works.

Endangered Species Act

The Ministry of Natural Resources and Forestry (MNRF) enforces the *Endangered Species Act*, whose purpose is to provide protection for species classified by the province as endangered or threatened, as well as to provide habitat protection for species classified by the province as endangered or threatened. Permits are required by those persons conducting activities that may affect Species at Risk, such as invasive plant management. To find out which species are at risk in Ontario or for information on obtaining a permit, consult www.ontario.ca/environment-and-energy/species-risk-ontario-list.

Conservation Authorities Act

Ontario's Conservation Authorities were formed under the *Conservation Authorities Act* to ensure conservation, restoration and responsible management of water, land and natural habitat through programs that balance human, environmental and economic needs. They provide approval for projects that are close to or affecting bodies of water, or above the high water mark, but not for projects that are directly in water, or below the high water mark*.

**The high water mark is the level where a body of water reaches its highest point in the season. Sometimes, an impression of the high water mark is left on the landscape, such as a line on rocks.*

Consult your local conservation authority here: <http://conservationontario.ca/> to determine if you need a permit to undertake your project.

Municipal

Under the *Building Code Act*, municipalities are able to pass bylaws to address the presence of invasive plants. Municipalities can enact bylaws to control plants when there is a risk of negative impact to human health and safety.

Municipalities are also responsible for enforcing the *Weed Control Act* to reduce the infestation of noxious weeds that negatively impact on agriculture and horticulture lands. Municipalities can designate additional plants not listed on the Ontario Noxious Weed list as noxious within their own jurisdiction.

Check with your local municipality to determine if there are further restrictions regarding spotted knapweed in your community.



The flower heads surrounded by green bracts marked with fine vertical streaks and tipped with a dark comb-like fringe gives these flowers the signature "spotted" appearance.

Photo courtesy of Rob Routledge.

Best Management Practices

Management Considerations

Preventing the spread of and controlling spotted knapweed before it becomes locally established will reduce its impacts on human health, biodiversity, the economy, and society.

It is important to use a control plan that incorporates integrated pest management (IPM) principles. This means using existing knowledge about the pest species and its surrounding environment to prevent and fight infestations and may require more than one type of control measure to be successful.

Once spotted knapweed has been confirmed at a location, a control plan can be developed based on infestation size, site accessibility, potential for spread and the risk of environmental, economic or social impacts. Specific conditions such as native plant diversity, wildlife usage and water table fluctuations should also be considered when developing control plans. A detailed inventory of each site is strongly recommended before starting control efforts to help ensure proper methods and timing are used to minimize negative impacts to surrounding wildlife and native plant species.

Mapping

If you are unsure if you have spotted knapweed on your land, map your area to determine if there are any infestations. For large land managers, like conservation authorities or municipalities, hiring a summer student or recruiting volunteers, can assist with this. For an individual landowner with a smaller property, mapping is more manageable on your own. If you know you have spotted knapweed in one area of your property, ensure you map the rest of your property to identify other infestations, to prevent them from spreading. For detailed information on mapping techniques consult the *Landowners Guide for Managing and Controlling Invasive Plants in Ontario*: http://ontarioinvasiveplants.ca/wp-content/uploads/2016/07/35266_LandOwnerGuide_June262013_FINAL_WEB.pdf.

To see what might already in your area, visit EDDMapS Ontario here: <http://www.eddmaps.org/ontario/>



Physical control such as cutting, girdling and burning will stimulate suckering and expedite colonization.

Photo courtesy of Jon L. Peter.

Landscape Level Management

If spotted knapweed has become established, a more detailed management strategy should be undertaken which should consider, where possible, a landscape-level management approach. This means engaging surrounding landowners and managers in your management strategy. Focusing on individual, local challenges, without looking at the broader landscape, can lead to intense labour and increased management costs and does not always have a strategic impact across larger areas. A strategic and integrated landscape level approach to management, conservation and planning serves to bring partners, landowners, and land managers together to work toward common and shared goals that consider both site-level needs and wider landscape considerations. This approach makes it easier to efficiently use and balance resources, coordinate activities, and accomplish shared strategic management goals.

Effective management and control requires a number of treatments and a combination of control measures. It's not always realistic, especially for large infestations, to try and eliminate the infestation all at once. Determine the desired plant community and the land use objective, and then develop an appropriate IPM strategy.



If you have limited resources, remove the outlying populations first to prevent further spread.

Photo courtesy of Eric Coombs, Oregon Department of Agriculture, Bugwood.org.

Setting Priorities

Determining what your highest priority locations for control are prior to management will help to determine your best course of action. Therefore, when developing a management strategy, it's important to take into account the following considerations to help inform control decisions:

1. If you have limited resources, remove the outlying populations (isolated plants or satellite populations) first, to prevent further spread.
2. If you have more resources, once the outliers are removed, focus on large infestations, as large infestations produce the greatest amount of seeds, which creates more of an opportunity for the plant to spread. Once the large infestation is under control, control the outlying populations in the same year if possible, and if not, the following year.
3. Concentrate on high-priority areas or areas where the plant is going to cause the most problems in terms of spread, such as the most productive or sensitive part of an ecosystem, along a creek, near species at risk, a favourite natural area, or the side of a trail where people may come into contact with the plants. Reduce the spread of spotted knapweed by following Clean Equipment Protocol, being sure to remove invasive plant material from boot soles, pant legs, hair, and manual and large scale equipment.
4. Protect rare species and communities. These include federal, provincial and regionally listed rare species.
5. Review the different control options and costs with considerations to surrounding water, habitat, time of year and type of land use i.e. high-traffic recreational areas, agriculture.
6. Ensure proper land ownership is defined before control takes place.
7. Consider dedicating a certain time each year to control efforts, and make it a joint effort with neighbouring landowners/land managers.
8. Begin to assess regeneration versus restoration, and if seeding or planting of native plants is needed to help jump-start natural succession and increase biodiversity in the area (see page x for more information).
9. Follow-up monitoring is crucial to remove seedlings that may sprout after initial control efforts.

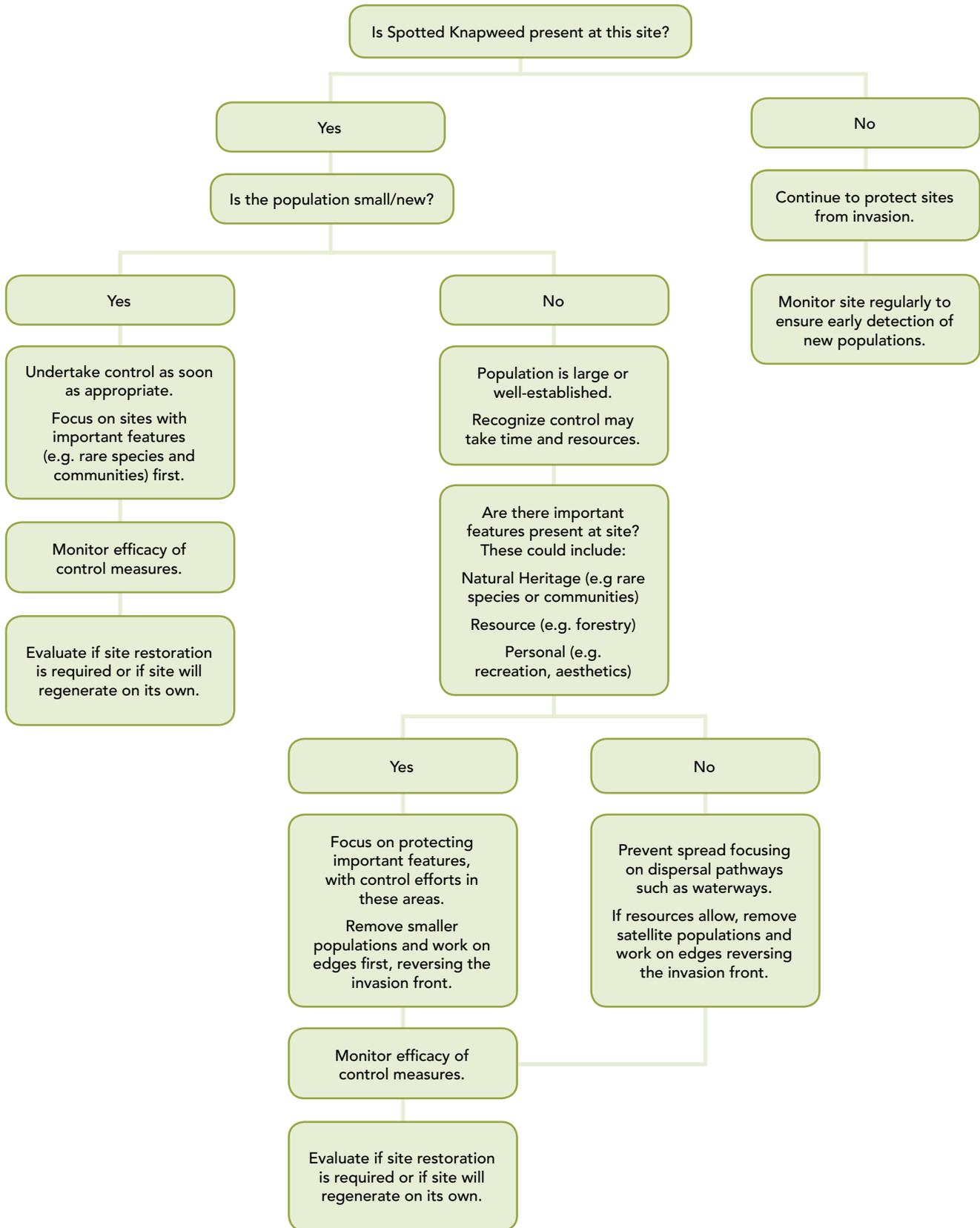
Prioritizing within a Control Area

(This section is modified from *The Landowners Guide to Managing and Controlling Invasive Plants*, published by Credit Valley Conservation).

1. Control small, younger, outlier (satellite) populations first..
2. Focus on large blocks of un-invaded areas and keep them free of invaders.
3. Remove outlying plants.

This flow chart can help land managers choose where to first focus control efforts if controlling satellite populations due to limited resources:

Figure 1: How to prioritize spotted knapweed sites for effective control with limited resources.



Long-term Management and Monitoring

Because of the persistent and aggressive nature of spotted knapweed and its ability to recolonize quickly, a long-term management and monitoring plan is imperative to achieve control success. A long-term management and monitoring plan should be created prior to control implementation. Monitoring will provide data to determine the effectiveness of the initial control treatments, and enable assessment of the initial control measures used as well as the types of follow-up treatments that are necessary. Long-term management is important because after removal, there are still other factors to consider including the seed bank left by spotted knapweed, other spotted knapweed populations that might be nearby, and other invasive plant seed banks. One of the most important factors to consider is which native plant species will return to the control area after control has been conducted.

Monitoring could be as simple as taking photographs or a visual inspection, or more complex and include extensive surveys. In general, annual treatment is imperative and should focus on selectively removing isolated populations as they appear. Spot treatment will assist in allowing for native plant regeneration. For more information on monitoring see the *Landowners Guide for Managing and Controlling Invasive Plants in Ontario*: <http://ontarioinvasiveplants.ca/resources/technical-documents>

After Management: Assessing Regeneration vs. Restoration

Consider the following factors:

1. **Level of disturbance at the site:** What is the level of disturbance at the site? Was it a heavily invaded site (e.g. a lot of disturbance was caused during control measures)? Will it continue to be disturbed (e.g. through beach use or trail use/management)?
2. **Invasive species biology:** What is the biology of the invasive species removed and is there a seed bank to consider (e.g. there is a long-lived spotted knapweed seedbank, but you should consider seedbanks of other invasive plants)?
3. **Re-invasion risk:** Are there invasive species nearby which could re-invade the site from nearby trails, watercourses or other pathways of introduction?
4. **Existing native vegetation:** What native vegetation is left? How long before it regenerates by itself? Does it need help? Species with specific habitat requirements or reproductive strategies resulting in low fecundity may require re-introduction, such as species at risk. The majority of plant species should be able to recover naturally, especially if healthy populations exist adjacent to the controlled area.

If you answered yes to most of the questions above, it is most likely that the site will be re-invaded before it has a chance to regenerate on its own or it will continue to invade and be present among the native species, resulting in annual control. Restoration will be needed to reduce the risk of re-invasion. See page X for restoration methods.

Control Measures

Mechanical

Pulling and Digging:	
Infestation Size:	small only
Goal:	eradication of small infestations, with follow-up for missed plants
Timing (season):	if soils are moist, plants can be pulled after they bolt, but before they flower (June-July).
Treatment Frequency:	once, but return to the same location the following spring and summer to remove plants coming up from seeds already in the soil and continue to monitor the area for several years
Best Practices:	pull or dig when the soil is moist to remove the entire taproot. In areas where mature plants are pulled, search the area for rosettes and dig them up. Roots of rosettes easily break and re-sprout, so use a digging tool. If pulling or digging must occur when the plant is in flower, carefully cut, bag and dispose of flowering plants before removal.
Advantages:	very effective for small infestations
Disadvantages:	can only be used for small infestations; laborious
Ideal For:	landowners that don't have access to chemical control
Regulatory Considerations:	<i>Fisheries Act, Species at Risk Act, Migratory Birds Convention Act, Endangered Species Act, Invasive Species Act, Conservation Authorities Act</i>



For small, isolated populations, pulling and digging is an option to consider.

Photo courtesy of Audrey Heagy.

Mowing:

Infestation Size:	small to large
Goal:	prevent seed production
Timing (season):	in the early flowering stage; plants are less likely to re-sprout if allowed to bolt before cutting
Treatment Frequency:	once per year; must be repeated over several years to deplete the seed bank
Best Practices:	mowing will not eradicate the plant, but can help keep it in check through the growing season and can prevent it from flowering and dispersing seeds. Use a regular lawn mower, or a large mowing tractor. A handheld weed wacker or brush saw blade can be used to remove flower heads prior to seeding in large patches. Mowing is most effective where the surrounding plant community contains healthy perennial grasses that will respond to mowing with renewed growth.
Advantages:	will assist in keeping the plant in check and can prevent it from flowering and dispersing seeds, preventing further spread
Disadvantages:	can only be used for small infestations; laborious
Ideal For:	landowners who do not have access to chemical control but have access to mowing equipment
Regulatory Considerations:	<i>Fisheries Act, Species at Risk Act, Migratory Birds Convention Act, Endangered Species Act, Invasive Species Act, Conservation Authorities Act</i>



A handheld weed wacker or brush saw blade can be used to remove flower heads prior to seeding in large patches.

Photo courtesy of Eric Giles.

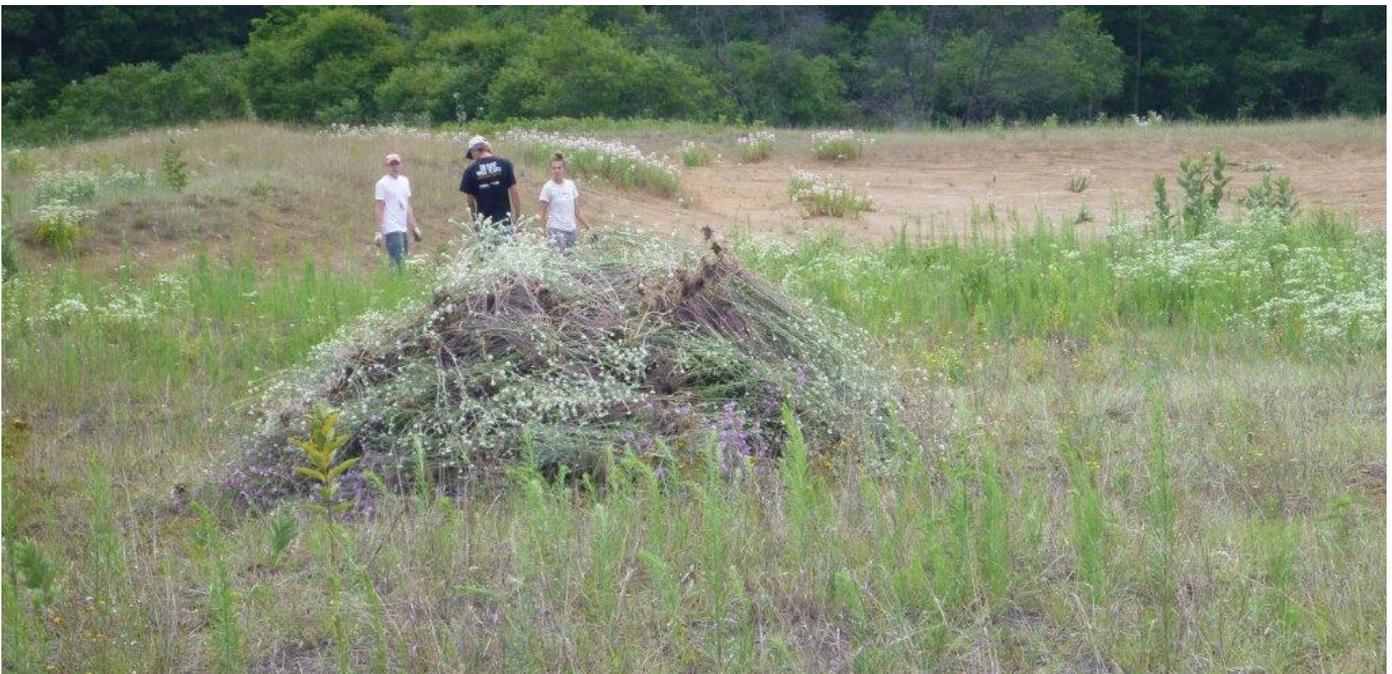
Rototilling/plowing:

Infestation Size:	medium to large
Goal:	eradication of young plants and seedlings
Timing (season):	for young plants and seedlings, anytime throughout the growing season, however if mature plants are within the infestation of young plants and seedlings and management takes place after June, this may contribute to seed spread from mature plants
Treatment Frequency:	once per year; must be repeated for several years to deplete the seed bank
Best Practices:	rototill or plow to depths of seven inches or more, follow Clean Equipment Protocol
Advantages:	great for agriculture landowners and for larger infestations
Disadvantages:	can only be used for small infestations; laborious
Ideal For:	agricultural landowners
Regulatory Considerations:	<i>Fisheries Act, Species at Risk Act, Migratory Birds Convention Act, Endangered Species Act, Invasive Species Act, Conservation Authorities Act</i>

Cultural

Burning:

Not recommended. The seeds are protected by tough, fire resistant seed head bracts. The required temperature would damage native plant species.



Medium to large sized infestations might require several years of eradication to deplete the seed bank.

Photo courtesy of Audrey Heagy.

Biological

Targeted Grazing:	
Infestation Size:	small to large
Goal:	reduction in plant vigor, density, size, flower stems and seed production
Timing (season):	for young plants and seedlings, anytime throughout the growing season, however if mature plants are within the infestation of young plants and seedlings and management takes place after June, this may contribute to seed spread from mature plants
Treatment Frequency:	if grazing occurs at the bolting stage an additional grazing period is recommended, but if grazing occurs at the late-bud to early flower stage, a single grazing period can significantly reduce viable seed production. Stem reductions, smaller plants and lower seed production can occur after three to six years of consecutive grazing
Best Practices:	although mature plants are unpalatable to livestock, young plants can be grazed by sheep and goats at low to moderate levels, with most grazing during the rosette stage. Animals that have grazed knapweed beyond the bolting stage need to be quarantined for seven to 10 days before moving to non-infested pastures in order to prevent seed transport in animal waste
Advantages:	limits the use of mechanical or chemical control means
Disadvantages:	sheep digestive systems may suffer if diets are composed of more than 70% knapweed
Ideal For:	agriculture landowners with access to sheep or goats
Regulatory Considerations:	<i>Fisheries Act, Species at Risk Act, Migratory Birds Convention Act, Endangered Species Act, Invasive Species Act, Conservation Authorities Act</i>

Biological Control:

Biological control is the use of a herbivore, predator, disease or other natural enemy to reduce established populations of invasive species. Most invasive species have few natural enemies in their new habitats. Biological control aims to re-establish relationships between invasive species and its natural enemies by selecting highly host-specific natural enemies from the country of origin, and moving them to the country where the invasive species is a problem. This is only done after extensive host-range testing in the country of origin or quarantine, to ensure that the potential biocontrol agent is host-specific to the targeted invasive species. This method has been used successfully for invasive plants in North America, including purple loosestrife (*Lythrum salicaria*), leafy spurge (*Euphorbia esula*) and St John's wort (*Hypericum perforatum*). Biological control agent selection, testing, and initial release is coordinated by agencies of the federal government.

Due to the scale of the invasive knapweed problem in western Canada and the cost and difficulty of conventional control treatments, spotted knapweed and diffuse knapweed were among the first invasive weeds targeted for biological control in Canada with the first biological agent released in 1970.

There have been 12 biological control agents released in Canada for spotted knapweed and diffuse knapweed, with seven insect species now relatively common. Two insect species, the seed head weevil (*Larinus minutus* Gyllenhal) and the root weevil (*Cyphocleonus achates* Fahraeus) have been implicated in successful biological control of both spotted knapweed and diffuse knapweed. No new biological agents have been released in Canada since 1993.

Since 2000, the primary focus of the knapweed biological control project has been on 1. Understanding the impact and spread of the seed head and root weevils and 2. Redistribution of these biological agents as part of operational release programs in all regions with new populations of invasive knapweeds.

Historically, British Columbia has had the most serious problem with spotted knapweed and diffuse knapweed and thus has had the most active program of redistribution of the biological agents.

It has been suggested that future work on biological control for knapweeds focuses on long-term monitoring of the impact by the seed head and root weevil on all knapweed species in Alberta and British Columbia and to expand operational release programs to assist in limiting the spread of all knapweed species into areas where the biological agents are not established. Currently, research of using biological control agents for spotted knapweed in Ontario is limited.



The root weevil (*Cyphocleonus achates* Fahraeus) is one biological control agent released in Canada for spotted knapweed.

Photo courtesy of Laura Parsons, University of Idaho, PSES, Bugwood.org.

Chemical

The management of pesticides is a joint responsibility of the federal and provincial governments. Before a pesticide can be sold or used in Ontario, it must be registered under the federal *Pest Control Products Act* (PCP Act) by Health Canada's Pest Management Regulatory Agency (PMRA) and be classified under the provincial *Pesticides Act* by the Ministry of the Environment and Climate Change (MOECC).

It is important that pesticides are applied in accordance with all label directions. The pesticide label is a **legal document** and prescribes how the pesticide can be legally and safely used. Ensure you have the most current label and are aware of any re-evaluation decisions.

For an up-to-date list of pesticides labelled for spotted knapweed plant control and to access the most current label, visit the Pest Management Regulatory Agency's product label search site at <http://pr-rp.hc-sc.gc.ca/lr-re/index-eng.php>. To determine if a federally registered pesticide is also classified for use in Ontario, visit: <https://www.lrcsde.lrc.gov.on.ca/PCDWeb/home.action>

In addition to being used in accordance with label directions, pesticides must also only be used for purposes allowed under Ontario's cosmetic pesticides ban.

The province's cosmetic pesticides ban contains exceptions for the use of pesticides (class 9), including the use of pesticides related to agriculture, forestry, and the protection of natural resources (provided certain conditions are met) which may allow chemical control of spotted knapweed on your property (see below).

Furthermore, non-domestic (i.e. commercial, restricted etc.) herbicides can only be purchased, stored and applied by appropriately licensed exterminators.

For more information on pesticides and all aspects of weed control, The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA)'s Publication 75, Guide to Weed Control 2014-2015 can be found at: <http://www.omafra.gov.on.ca/english/crops/pub75/pub75toc.htm>.



Chemical control is often the most effective control method for dense infestations.

Photo courtesy of Leslie J. Mehrhoff.

Exceptions to the Ontario Pesticides Ban

Are you protecting a Natural Resource?

The “natural resources” exception exists for the use of prohibited pesticides to manage, protect, establish or restore a natural resource. In order to qualify for this exception your project must meet the criteria specified in Section 33 of Ontario Regulation 63/09, including the use of pesticides in accordance with Integrated Pest Management (IPM) principles outlined in this BMP guide. You will need to contact the Ontario Ministry of Natural Resources and Forestry (www.ontario.ca) to obtain a written letter of opinion from the MNRF Regional or Branch Director.

Are you a farmer?

The agriculture exception allows farmers to use Class 9 pesticides for the purposes of the agricultural operation that they own or operate. This exception may apply to the control of spotted knapweed if it impacts their agricultural or horticultural operation. Agricultural operations include agriculture, aquaculture and horticulture activities. Examples include:

- growing, producing or raising farm animals;
- production of crops, including greenhouse crops, maple syrup, mushrooms, nursery stock, tobacco, trees and turf grass, and any additional agricultural crops prescribed under the *Nutrient Management Act, 2002*;
- activities that are part of an agricultural operation such as maintenance of a shelterbelt for the purposes of the agricultural operation, and;
- the production of wood from a farm woodlot, if at least one of the activities described earlier is carried out on the property where the farm woodlot is located.

Some activities are not included in the definition of an “agricultural operation”. Please refer also to the Ministry of Environment and Climate Change’s factsheet titled “*Pesticides Act and Ontario Regulation 63/09 Agriculture May 2011*” www.ontario.ca/document/technical-guidance-pesticides-act-and-ontario-regulation-6309-agriculture.

Herbicides for Spotted Knapweed:

For an up-to-date list of registered herbicides for spotted knapweed, type “PMRA Label Search” into your search engine. Broadleaf herbicides are most effective for spotted knapweed control and are especially effective in pastures and grassy areas. Most established grasses are not harmed by these selective herbicides and will compete with knapweed seedlings. Herbicides containing the ingredient picloram can provide two to seven years of control depending on site conditions and is one of the most cost-effective herbicides. Herbicides containing the ingredient clopyralid applied at the bolting stage is as effective as picloram. Due to the long soil residual time of picloram, clopyralid may be a better alternative for more sensitive areas. Herbicides containing the ingredient aminopyralid is also very effective on spotted knapweed and has been shown to be as effective as picloram, and the lower use rates pose less risk to the environment.

Herbicides Application:

Infestation Size:	large and established
Goal:	eradication
Timing (season):	in the spring (May-June)
Treatment Frequency:	for herbicides containing aminopyralid, apply once per year from the rosette to the bolting stages or in the fall. For herbicides containing clopyralid, apply once per year, after the majority of basal leaves have emerged up to the bud stage or fall re-growth. For herbicides containing picloram, apply once per year, from rosette to mid-bolting stage or to fall re-growth. Herbicide control needs to be completed for at minimum two years to be effective.
Best Practices:	herbicide application is most effective when combined with mowing. Infested areas should not be mowed until after the herbicide has had a chance to translocate to the roots and the vegetation has visibly died back. In cases where desirable remnant vegetation still exists, persistent spot spraying over two to three years may be effective at reducing competition to desirable plants.
Advantages:	most effective control method for dense infestations
Disadvantages:	can only be conducted by a licensed applicator and if the project meets one of the exceptions under the Ontario Pesticides Ban
Ideal For:	agricultural landowners (as they fall under one of the exceptions) and large landowners, land managers or cottagers who have access to a licensed herbicide applicator and meet one of the exceptions under the Ontario Pesticides Ban
Regulatory Considerations:	<i>Pest Control Products Act, Pesticides Act, Fisheries Act, Species at Risk Act, Migratory Birds Convention Act, Endangered Species Act, Invasive Species Act, Conservation Authorities Act</i>

Disposal of Plant Material

Do not backyard compost:

Home composters do not reach the necessary temperature to kill viable parts of the plant.

Municipal disposal:

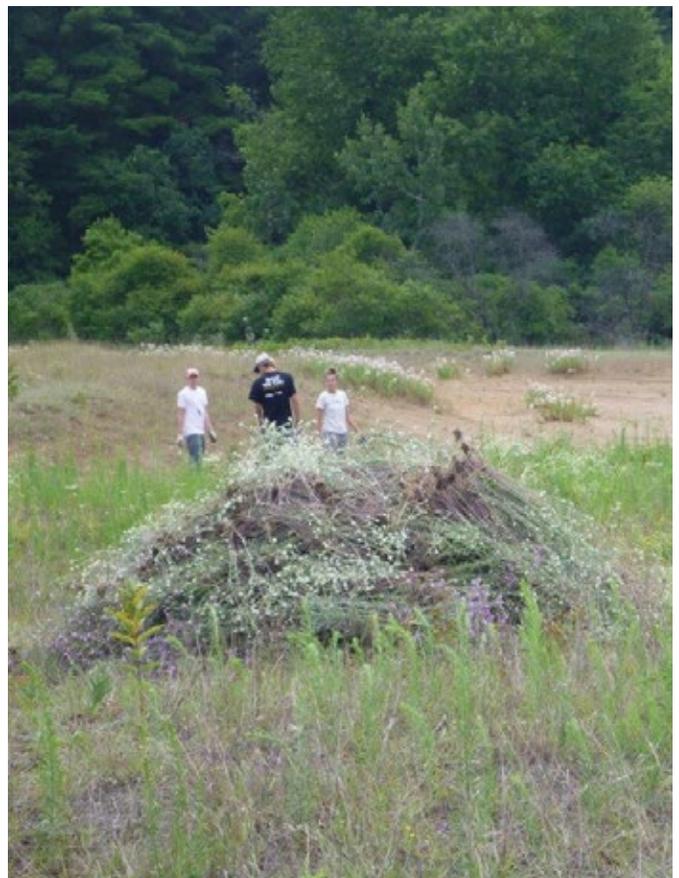
Call ahead to your local municipality about disposal availability for invasive plant material. If your local municipality accepts invasive plant material in the local landfill, carefully place reproductive plant material in black plastic garbage bags. Seal the bags tightly and leave in direct sunlight for one to three weeks, to kill any living plant material. Check the bags to make sure the plant material has died and then deposit in the landfill.

Municipal compost:

Parts of invasive plants capable of reproducing (seeds and roots) should only be composted if the material is taken to a large-scale municipal composting facility where temperatures in the compost pile reach high enough to kill the living material. Composting operations that demonstrate strict adherence to pathogen kill processes and maintain optimal moisture conditions may provide sufficient conditions to destroy most seeds or rhizomes of invasive plants. Ontario composting facilities are required to routinely monitor the compost process and meet strict, provincially regulated time-temperature parameters for pathogen kill.

Dry out the cut plant material and then burn, bury or let decompose:

For large amounts of plant material, identify a place to dry it out, free from wind (paved area, open field or rock is best, or leave in yard waste bags in storage for 3 months). Once the material is dry, burn it if permitted by local by-laws, bury it, or leave in a designated area far from the water to decompose.



Large quantities of biomass from mechanical removal should be brought to a local high-heat composting facility.

Photo courtesy of Audrey Heagy.

Restoration

Restoration can be a critical aspect of invasive plant management. Site restoration will result in a healthier ecosystem more resilient to future invasions. Monitor all restoration activities to ensure native species are becoming established, and continue removal of invasive plants that remain onsite.

Types of Restoration

During Control

Mulching:

Mulching sites immediately after spotted knapweed control (i.e. manual or chemical control) may aid in the recovery of native species and prevent immediate re-colonization by other invaders. Mulching reduces light availability, allowing more shade-tolerant native plant species to germinate and colonize the gaps left by spotted knapweed removal. This will also limit the amount of re-growth due to the seed bank.

Seeding:

Seeding an area with an annual cover crop or native plant species immediately after management activities may be useful to prevent the establishment of new invasive species. This can give desirable native species the chance to establish themselves.

After Control

Planting:

If there are invasive plants nearby or in the seedbank which may colonize the control area, planting larger native species stock (potted etc.) can help them outcompete invasive seedlings. It may however be better to monitor and remove invasive species over several seasons before investing in restoration planting. Wait until all management is completed before doing a large stock re-planting if you find it difficult to distinguish between newly planted native species and invasive seedlings.

When completing planting at control sites, consider light availability (have any trees recently been removed which have opened up an area?). These environmental changes should be taken into account when choosing plant species for restoration, as they will affect the growing and soil conditions. Also, additional management activities may disturb the newly planted materials, so it is best to postpone planting until all invasive plant control is complete.

Competitive desirable perennial grasses can promote long-term suppression of spotted knapweed, such as Canada wild rye. For other alternative non-invasive plant options, see the Grow Me Instead guide, available: <http://www.ontarioinvasiveplants.ca/resources/grow-me-instead>.

Control Measures Summary

Table 3: A summary of management strategies appropriate for spotted knapweed management.

Size of Area to be Managed		
Isolated plants	Small infestation < 0.5 hectare	Medium to Large >0.5 hectares
<ul style="list-style-type: none"> • Pulling and Digging 	<ul style="list-style-type: none"> • Pulling/Digging • Targeted Grazing 	<ul style="list-style-type: none"> • Mowing • Rototilling/Plowing • Targeted Grazing • Chemical



Large and established patches, such as these, will require more resources.

Photo courtesy of L L. Berry, Bugwood.org.

Preventing the Spread

Early detection is the most effective tool for controlling the spread of spotted knapweed and everyone can help. Follow these tips:

Report it.

If you think you see spotted knapweed take a picture, record the location and report it using the tools listed below.

Watch for it.

Learn what spotted knapweed looks like and then monitor hedges, property boundaries, riparian areas, fence lines and trails. Early detection of invasive plants can make it easier and less expensive to remove or control them.

Stay on trails.

Avoid traveling off-trail and in areas known to have spotted knapweed or other invasive species.

Stop the spread.

Follow Clean Equipment Protocol; inspect, clean and remove mud, seeds and plant parts from clothing, pets (and horses), vehicles (including bicycles, trucks, ATVs, etc.), and equipment such as mowers and tools. Clean vehicles and equipment in an area away from natural areas where plant seeds or parts aren't likely to spread (e.g. wash vehicles in a driveway or at a car wash) before travelling to a new area.

Keep it natural.

Try to avoid disturbing soil and never remove native plants from natural areas. This leaves the soil bare and vulnerable to invasive species.

Use native species

Try to use local native species in your garden. Don't plant spotted knapweed and if you have removed it, replant with native species. Encourage your local garden centre to sell non-invasive or native plants. [The Grow Me Instead guides list alternatives to plant instead of invasive species.](#)

Tracking the Spread (Outreach, Monitoring, Mapping)

Several reporting tools have been developed to assist the public and resource professionals to report spotted knapweed sightings, track the spread, detect it early, and respond to it quickly. These include:

- 1) EDDMapS: an online reporting tool where users can view existing sightings of spotted knapweed and other invasive species in Ontario, and document their sightings. This tool, at www.eddmaps.org/ontario, is free to use.
- 2) Toll-free Invading Species Hotline: a telephone number (1-800-563-7711) which individuals can use to report sightings verbally. Hours of operation: 9:00am – 5:00pm Monday to Friday EST, with the option to leave a recorded message.
- 3) Invading Species Website: an online reporting tool (www.invadingspecies.com).

If you think you have spotted knapweed on your property or if you see it in your community, please report it. You will be asked to send in photos of the leaf, stem and trunks and seedpods for identification.

Best Management Practices Documents Series:

- [Black Locust Best Management Practices for Ontario](#)
- [Common \(European\) Buckthorn Best Management Practices for Ontario](#)
- [Dog-strangling Vine Best Management Practices for Ontario](#)
- [European Black Alder Best Management Practices for Ontario](#)
- [Garlic Mustard Best Management Practices for Ontario](#)
- [Giant Hogweed Best Management Practices for Ontario](#)
- [Invasive Honeysuckles Best Management Practices for Ontario](#)
- [Japanese Knotweed Best Management Practices for Ontario](#)
- [Phragmites \(Common Reed\) Best Management Practices for Ontario](#)
- [Phragmites \(Common Reed\) Best Management Practices for Ontario Roadways](#)
- [Purple Loosestrife Best Management Practices for Ontario](#)
- [Reed Canary Grass Best Management Practices for Ontario](#)
- [Scots Pine Best Management Practices for Ontario](#)
- [Spotted Knapweed Best Management Practices for Ontario](#)
- [White Sweet Clover Best Management Practices for Ontario](#)
- [Wild Parsnip Best Management Practices for Ontario](#)

Additional Publications from the Ontario Invasive Plant Council:

Creating an Invasive Plant Management Strategy: A Framework for Ontario Municipalities

A Quick Reference Guide to Invasive Plant Species

Clean Equipment Protocol for Industry

Compendium of Invasive Plant Management

Grow Me Instead! Beautiful Non-Invasive Plants for Your Garden, a guide for Southern Ontario

Grow Me Instead! Beautiful Non-Invasive Plants for Your Garden, a guide for Northern Ontario

A Landowner's Guide to Managing and Controlling Invasive Plants in Ontario

Landowners Guide to Controlling Invasive Woodland Plants

Phragmites Site Prioritization Tool

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