

White Sweet Clover

(Melilotus albus)

Best Management Practices in Ontario

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Foreword

These Best Management Practices (BMPs) provide guidance for managing invasive White Sweet Clover (*Melilotus albus*) in Ontario. Funding and leadership for the production of this document was provided by Environment Canada – Canadian Wildlife Service. 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 research and experience. They reflect current provincial and federal legislation regarding pesticide usage, 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, and 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, visit www.ontario.ca/invasivespecies, www.ontarioinvasiveplants.ca, www.invadingspecies.com or www.invasivespeciescentre.ca

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White Sweet Clover.

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



White Sweet Clover.

Photo courtesy of Stan Gilliam @ USDA-NRCS PLANTS Database.

Introduction

White Sweet Clover (*Melilotus albus*) is typically a biennial plant. This means it blooms in its second year and then dies. In Ontario it is occasionally an annual or short-lived perennial. It is also known as Bokhara Clover, Honey Clover, Tree Clover, Sweet Clover, White-flowered Sweet Clover, Honey-lotus and White Melilot. For the purposes of this BMP, the common name of White Sweet Clover will be used.

This document has been developed to help guide the effective and consistent management of this invasive plant across Ontario. These BMPs emphasize targeting control efforts in areas where small populations of White Sweet Clover are present, but have not yet become dominant.

White Sweet Clover is native to Europe and Asia, where it is used as a forage crop. The first known record of this plant in North America is from 1664 in Boucherville, Quebec. It was introduced as a forage crop and honey plant.

White Sweet Clover is a threat to endangered grassland and prairie habitats in Ontario. It degrades these areas by out-competing native species. It is allelopathic, meaning the roots release chemicals into the soil which can prevent the growth of native plants. Each individual plant can produce up to 350,000 seeds. Seeds can remain viable in the soil for up to 80 years.

It grows in open, disturbed areas and can invade sensitive habitats. This plant is used in roadside seed mixes because it is drought-resistant and hardy (can survive road salt). The seeds of this plant can be dispersed intentionally (in seed mix or rarely, as a cover crop) or unintentionally by vehicle tires, moving water, or as a contaminant in crop seed.

Description

White Sweet Clover is a biennial or annual herbaceous plant. It is monocarpic which means that it dies after it flowers and sets seed. The first year, the plant grows a primary stem up to 1.5 m tall, and puts down a deep taproot. In ideal conditions it may flower and set seed in its first year. If the flowering is done in the second year, the plant will over-winter just under the soil surface and the stem will appear in spring. Roots don't grow as much in the second year; most of the growth is done by the stem and energy is used to flower and set seed. White Sweet Clover is able to self-pollinate, meaning that a single plant can produce a new population.

It is a member of the Fabaceae (Legume or Pea) family, and although it is called a 'clover' it is more closely related to Alfalfa than to true clovers. It is a species that thrives in disturbed areas, and can often be found along roadsides, in old fields and in hydro corridors. It also thrives in open habitats such as prairies, savannahs, dunes, alvars and meadows. These habitats are often at risk in

Ontario, and White Sweet Clover has a negative impact on their recovery. This species is still used in Ontario in roadside seed mixes and occasionally for soil rehabilitation as it is a nitrogen-fixer (the bacteria in its roots take nitrogen from the air and add it to the soil). White Sweet Clover grows mainly in calcareous (limestone-based) soil, but can also be found on the Canadian Shield. It grows taller in Northern Ontario along roadways, but the reason for this is unknown.

White Sweet Clover flowers are attractive to bees and butterflies and in some areas it is a popular plant for honey production. The plant contains the chemical compound coumarin, which if ingested at certain times of the year, can be poisonous to livestock and pets by preventing blood clotting. The seeds of White Sweet Clover require scarification (breaking down of a protective outer layer) to germinate. Scarification may result from freezing/thawing, fire, or being passed through the digestive tract of a bird or mammal.



White Sweet Clover removal at Alderville First Nation Black Oak Savanna.

Photo courtesy of OFAH.

Identification

Stems:

The stem of White Sweet Clover is smooth and hairless, erect, and branched, grooved or channeled. The stems are usually up to 1.5 m in height. The root crown produces somewhere between 1 to 10 stems.



The stem is smooth and hairless.

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

Leaves:

The leaves of White Sweet Clover have 3 leaflets, and are alternate along the stem. Each leaflet is fully toothed. They can be hairy but are usually smooth. The leaves are 1 to 7 cm long. The middle leaflet has a distinct stalk.



White Sweet Clover leaves have 3 leaflets and are alternate along the stem.

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

Roots:

White Sweet Clover forms a taproot which can grow up to 1.5 m deep in the soil. Adventitious roots form on its stem and extend outwards 30-40 cm. The roots contract to pull the plant crown down slightly under the soil in the fall to help it survive winter and grow again in its second year.



White Sweet Clover removal at Alderville First Nation Black Oak Savanna.

Photo courtesy of OFAH.

Flowers/Fruit:

The flowers appear from June to October in the plant's second year in multiple racemes (clusters which are separate from the stem). They are white, 4-5 mm in size, and the flower stalks each have between 20 and 65 flowers.



Flowers are white and appear in the second year.

Photo courtesy of Chris Evans, Illinois Wildlife Action Plan, Bugwood.org

Seeds:

Small and similar in appearance to alfalfa seed with ridges on the fruit. The seed pods are black to dark grey and each contain a single seed. The seeds are yellow and oval to kidney shaped and each plant can produce up to 350,000 seeds. Seeds often remain on the plant over the winter and fall as it dries out.



The fruits are ridged.

Photo courtesy of Mary Ellen (Mel) Harte, Bugwood.org



White Sweet Clover can grow in a variety of habitats, including the nutrient poor and disturbed soil of roadsides.

Photo courtesy of Caleb Slemmons, University of Wisconsin, Stevens Point, Bugwood.org.

Habitat

White Sweet Clover prefers to grow in calcium-rich (calcareous) loamy soil, but it can also grow in a variety of soil conditions. It can grow in full-sun or partial-shade, but is shade-intolerant. Due to its nitrogen-fixing capabilities, it is also able to grow in nutrient poor soil.

Distribution

Its native range includes much of Europe and Asia. (Europe: Austria, Czech Republic, Slovakia, Germany, Hungary, Poland, Estonia, Latvia, Lithuania, Greece, Italy, Cyprus, France, Spain, Bulgaria, Belarus, Republic of Moldova, Ukraine and Romania. Asia: Afghanistan, Iran, Iraq, Israel, Jordan, Lebanon, Turkey, Armenia, Azerbaijan, Russian Federation, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, China, Bhutan, India, Pakistan and Myanmar/Burma).

It has been introduced to the United States, Canada, Mexico and Australia and is considered weedy or invasive in all of these countries. In Canada, it has been found in every Province and Territory. Quebec and Alberta have added White Sweet Clover to their noxious weed list.

Look-alikes

Yellow Sweet Clover (*Melilotus officinalis*):

Yellow Sweet Clover is another alien species that is present in Ontario. It is differentiated from White Sweet Clover by the yellow flowers which flower at a different time than White Sweet Clover. It is also smaller, more widely branching, finer stemmed and more drought tolerant than White Sweet Clover.



Yellow Sweet Clover has yellow flowers.

Photo courtesy of Nelson DeBarros @ USDA-NRCS PLANTS Database.

Alfalfa (*Medicago sativa*):

Alfalfa is a perennial plant that is also in the Pea family. It was introduced to North America as a forage plant, and may be mistaken for White and Yellow Sweet Clover. It also flowers at a different time and has purple to yellow flowers.



Alfalfa has purple to yellow flowers.

Photo courtesy of Wikimedia Commons.

Yellow Melilot (*Melilotus altissima*):

Yellow Melilot also has yellow flowers and is another alien species in Ontario. It has hairy seed pods.



Yellow Melilot also has yellow flowers and is another alien species in Ontario.

Photo courtesy of François Van Der Biest, Wikimedia Commons.

White Sweet Clover
(*Melilotus albus*)



Photo courtesy of Stan Gilliam @ USDA-NRCS PLANTS Database.

Yellow Sweet Clover
(*Melilotus officinalis*)



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

Alfalfa
(*Medicago sativa*)



Photo courtesy of Wikimedia Commons.

Height	<ul style="list-style-type: none"> • Up to 1.5 m 	<ul style="list-style-type: none"> • 1.2 – 1.8 m 	<ul style="list-style-type: none"> • Up to 1 m
Stem	<ul style="list-style-type: none"> • Smooth and hairless • Branched 	<ul style="list-style-type: none"> • Smooth and hairless • Branched 	<ul style="list-style-type: none"> • Woody and hairless • May have several stems from one root
Leaves	<ul style="list-style-type: none"> • 3 leaflets • Alternate • 1 to 7 cm long • Can be hairy but are usually smooth • Fully toothed 	<ul style="list-style-type: none"> • 3 leaflets • The middle leaflet has its own short stalk • Alternate • Fully toothed 	<ul style="list-style-type: none"> • 3 leaflets • Alternate • Only has teeth on the tip of the leaflets
Flowers and Seeds	<ul style="list-style-type: none"> • White • Flowers are 4-5 mm long • Flowers from June to October • Seeds are yellow and oval to kidney shaped 	<ul style="list-style-type: none"> • Yellow • Flowers are 5-7 mm long • Flowers from April to September • Seeds are oblong and have a notch on one end 	<ul style="list-style-type: none"> • Vary from purple to yellow • Flowers from June to September • Spiral shaped seed pods • Seeds are small and kidney shaped

Impacts

Biodiversity

In Ontario, we have several ecosystems which are globally rare and are threatened. These habitats support a number of rare, endangered and threatened species of plants, birds and mammals.

Tallgrass prairies are only found in North America. In Ontario, we have remnants of these tallgrass prairie habitats which are threatened by invasive species, such as White Sweet Clover. It grows easily in the open, full-sun habitats provided by tallgrass prairies, and grows taller and denser than many native plants found there, shading them out. Because White Sweet Clover is a nitrogen fixer, it adds nitrogen to soil, making it nutrient-rich. This makes invaded areas unsuitable for native tallgrass prairie species that have evolved to grow on nutrient poor soil.



Prairie (Wood) Lilies grow in a tallgrass prairie.

Photo courtesy of Nature Conservancy of Canada.

Black Oak Savannahs are similar to tallgrass prairies. These habitats are also rare in Ontario, with only remnants remaining. Restoration efforts are ongoing. Black Oak Savannahs are also threatened by White Sweet Clover due to its aggressive growth, nitrogen-fixing, and ability to colonize immediately after disturbance. Land managers have reported that White Sweet Clover is often one of the first species to grow back after

prescribed burns on tallgrass prairies and Black Oak Savannahs, outcompeting slower-growing native species.



High Park in Toronto is home to a remnant Black Oak Savannah habitat.

Photo courtesy of Andrew Yee.

Alvars are areas of limestone pavements exposed or overlain by shallow soils which support unusual or unique collections of plants and animals. A large proportion of the alvars in North America are in Ontario's Great Lakes Basin. Many alvar plant and animal species are adapted to open, sunny, frequently dry habitats. Natural succession (often in the absence of fire) and encroachment by and competition with invasive alien plant species such as White Sweet Clover are the main threats to alvar habitat.



Prairie Smoke plants are an indicator of Alvar habitats

Photo courtesy of Nature Conservancy of Canada.

Species at Risk

White Sweet Clover poses a direct threat to many of Ontario's species at risk. Because of its fast growth, abundant seed production, soil changing abilities, and the fact that it prefers similar habitat, it will out-compete and damage the populations of these important native species.

Species at Risk	Habitat / Details	Primary threat(s) from White Sweet Clover
Plants		
Showy Goldenrod (<i>Solidago speciosa</i>) (Great Lakes Plains Population)	<ul style="list-style-type: none"> Prairie with sandy soil and in partial shade in Black Oak savannah 	<ul style="list-style-type: none"> Out-competes
Lakeside Daisy (<i>Tetraneuris herbacea</i>)	<ul style="list-style-type: none"> Alvar 	<ul style="list-style-type: none"> Out-competes
Eastern Prickly Pear (<i>Opuntia humifusa</i>)	<ul style="list-style-type: none"> Cactus that grows near sand dunes and sandy savannah 	<ul style="list-style-type: none"> Out-competes
American Columbo (<i>Frasera caroliniensis</i>)	<ul style="list-style-type: none"> Upland, deciduous habitats 	<ul style="list-style-type: none"> Out-competes
White Prairie Gentian (<i>Gentiana alba</i>)	<ul style="list-style-type: none"> Tallgrass prairie and oak savannah 	<ul style="list-style-type: none"> Encroachment
Pink Milkwort (<i>Polygala incarnata</i>)	<ul style="list-style-type: none"> Tallgrass prairie 	<ul style="list-style-type: none"> Out-competes Soil changes
Common Hoptree (<i>Ptelea trifoliata</i>)	<ul style="list-style-type: none"> Shorelines, open areas and alvars that are low in nutrients 	<ul style="list-style-type: none"> Soil changes
Gattinger's Agalinis (<i>Agalinis gattingeri</i>)	<ul style="list-style-type: none"> Dry sand prairies, woodland openings, savannah, alvars 	<ul style="list-style-type: none"> Out-competes Soil changes
Skinner's Agalinis (<i>Agalinis skinneriana</i>)	<ul style="list-style-type: none"> Prairie 	<ul style="list-style-type: none"> Out-competes Soil changes
Dwarf Hackberry (<i>Celtis tenuifolia</i>)	<ul style="list-style-type: none"> Dry upland: sand dunes, sandy open woodlots, savannahs, alvars 	<ul style="list-style-type: none"> Could be threatened if White Sweet Clover invades its habitat
Forked Three-Awned Grass (<i>Aristida basiramea</i>)	<ul style="list-style-type: none"> Sand barrens. Is very intolerant of shade and competition 	<ul style="list-style-type: none"> Out-competes Shading

Species at Risk	Habitat / Details	Primary threat(s) from White Sweet Clover
Bird's-foot Violet (<i>Viola pedata</i>)	<ul style="list-style-type: none"> Open sandy oak savannah and sand barrens 	<ul style="list-style-type: none"> Shading Out-competes
Four-leaved Milkweed (<i>Asclepias quadrifolia</i>)	<ul style="list-style-type: none"> Open oak-hickory woodlands, alvar woodlands 	<ul style="list-style-type: none"> Shading Out-competes
Hill's Thistle (<i>Cirsium pumilum</i> var. <i>hillii</i> = <i>C. hillii</i>)	<ul style="list-style-type: none"> Alvar grasslands, openings in alvar woodlands 	<ul style="list-style-type: none"> Out-competes
Hoary Mountain-mint (<i>Pycnanthemum incanum</i>)	<ul style="list-style-type: none"> Sunny open slopes in oak-dominated woodlands 	<ul style="list-style-type: none"> Out-competes
Houghton's Goldenrod (<i>Solidago houghtonii</i>)	<ul style="list-style-type: none"> Alvar grasslands 	<ul style="list-style-type: none"> Out-competes
Juniper Sedge (<i>Carex juniperorum</i>)	<ul style="list-style-type: none"> Globally rare sedge species, grows in alvar woodlands/ savannahs 	<ul style="list-style-type: none"> Succession Out competes
Slender Bushclover (<i>Lespedeza virginica</i>)	<ul style="list-style-type: none"> Sandy openings in tallgrass prairie and oak savannah at a single Canadian site 	<ul style="list-style-type: none"> Out-competes
Goat's-rue (<i>Tephrosia virginica</i>)	<ul style="list-style-type: none"> Sandy, open oak woodlands and savannah at only a few sites in Ontario 	<ul style="list-style-type: none"> Out-competes, especially after prescribed burning
Insects		
Northern Barrens Tiger Beetle (<i>Cicindela patruela</i>)	<ul style="list-style-type: none"> Small bright green beetle found in sand barrens and sandy openings in oak savannah and woodland 	<ul style="list-style-type: none"> Succession and habitat loss (preferred bare sand openings are eliminated)
Birds		
Bobolink (<i>Dolichonyx oryzivorus</i>)	<ul style="list-style-type: none"> Grasslands, fields dominated by grasses or a mix of grasses and forbs 	<ul style="list-style-type: none"> Habitat loss due to invasion
Eastern Meadowlark (<i>Sturnella magna</i>)	<ul style="list-style-type: none"> Grasslands, fields dominated by grasses or a mix of grasses and forbs 	<ul style="list-style-type: none"> Habitat loss due to invasion

Infrastructure

Occasionally, White Sweet Clover can grow very tall along roadsides and obstruct traffic signs and visibility. While usually shorter in Southern Ontario, in Northern Ontario it can grow tall enough to block signage and rights-of-way. It can also increase roadside grazing, which may be a concern for animal-vehicle collisions.

Regulatory tools

Federally

White Sweet Clover is not a federally regulated plant species.

Provincially

White Sweet Clover is not a provincially regulated plant species. However, Quebec and Alberta have added this species to their noxious weed lists.

Municipal – Property Standards Bylaw

A municipality may wish to pass a property standards bylaw under the Building Code Act to address the presence of weeds deemed noxious or a threat to the environment or human health and safety. A municipality can regulate White Sweet Clover due to concerns for the environment or threatened habitats.



White Sweet Clover removal at Alderville First Nation Black Oak Savanna.

Photo courtesy of OFAH.

Best Management Practices

Controlling White Sweet Clover before it becomes locally established and builds a seed bank will reduce its impacts on biodiversity, the economy and society.

It is important to use a control plan that incorporates integrated pest management principles. Integrated Pest Management (IPM) is a holistic decision-making process that uses all necessary techniques to suppress pests effectively, economically and in an environmentally sound manner. IPM principles sustain healthy, functional landscapes while protecting human health. 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 measure to be successful. It is also important to note that control measures for White Sweet Clover are most successful when heavily infested sites are re-planted with native species that are able to out-compete new growth. White Sweet Clover thrives on disturbance (like that caused by control measures), and will likely re-invade or re-sprout if restoration measures are not taken.

Once White Sweet Clover has been confirmed at a location, a control plan should be developed based on infestation size, site accessibility, potential for spread and the risk of environmental, economic or social impacts. Site specific conditions such as native plant diversity, wildlife usage and water table fluctuations should also be considered. 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.

If confronted with an established infestation of White Sweet Clover, land managers should first focus their efforts on preventing spread. Isolated seedlings and small populations (satellite infestations) outside the main infested area should be removed first. When action is taken early it can significantly reduce the cost of control.

With large infestations and limited time and resources, control work can seem daunting. It is important to develop a feasible, long-term strategy with the following considerations:

1. Try to remove the outlying populations (isolated plants or satellite populations) first, to prevent further spread. White Sweet Clover does not start producing seed until its 3rd year, so older plants should be removed first to prevent seed spread. If removing the tree is not an option immediately, the branches can be removed to prevent seed spread (if they haven't gone to seed yet).
2. Concentrate on high-priority areas such as the most productive or sensitive part of an ecosystem or a favourite natural area.
3. Consider dedicating a certain time each year to control efforts. Make it a joint effort with neighboring landowners/land managers.
4. Plan to replant native tree and shrub species once the White Sweet Clover population is eradicated or under control. This will help jump-start natural succession and increase biodiversity in the area.
5. Follow-up monitoring is crucial to remove seedlings that may sprout after initial control efforts.

The following BMPs can be used as a guide in the development of a control plan. A number of natural resource considerations should be applied before starting control plans, including species at risk and habitat disruption.

Natural Resource Considerations

You are responsible for ensuring that your project follows all relevant laws, including the Endangered Species Act (ESA). If protected species or habitats are present, an assessment of the potential effects of the control project could be required. Consult with your local MNR district office early in your control plans for advice. If controlling White Sweet Clover in riparian areas, shoreline health must also be considered.

Setting Priorities

When creating management plans, it is important to make the most of resources by prioritizing invasive species control. The following will help you to prioritize sites and areas within sites for control of White Sweet Clover.

Site Prioritization

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

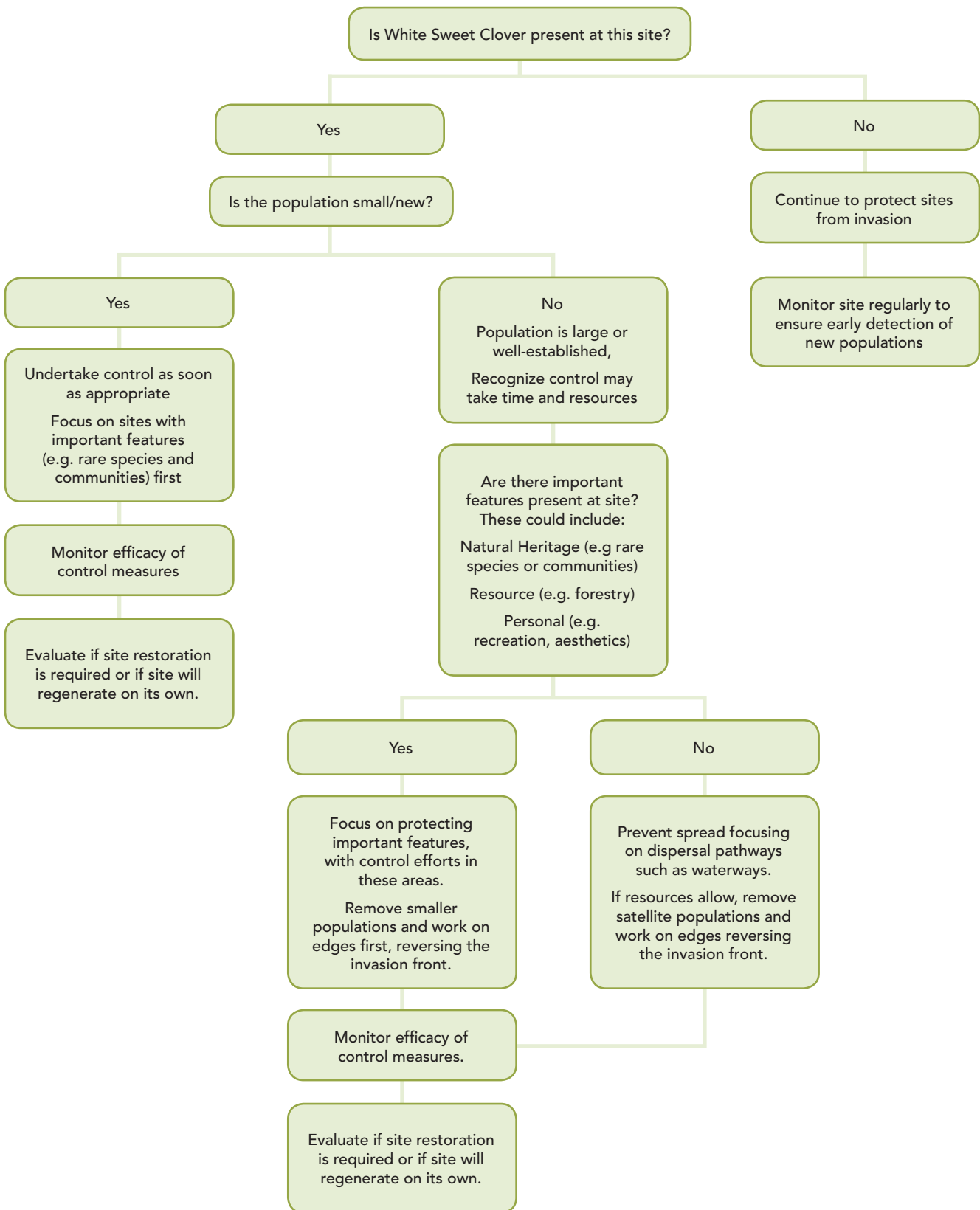
1. Protect areas where White Sweet Clover is absent or just appearing by preventing spread.
2. Protect rare species and communities. These include federal, provincial and regionally listed rare species and communities.
3. Protect important habitats and land values (e.g. industry).
4. Cost and effort: Will the area where White Sweet Clover has invaded require resources for restoration or can it be left to regenerate naturally? (Note – it is usually recommended to restore control areas to make them more resilient to future invasions).

Prioritizing within a Control Area

1. Focus on large blocks of un-invaded areas and keep them free of invaders
2. Control small, younger, outlier (satellite) populations first
3. "Unfragment" the boundaries of invaded areas by removing outlying plants
4. Reverse the invasion, expand the un-invaded area outward

It is crucial to find and eradicate satellite populations before they join larger populations.

This flow chart can help land managers choose which site to first focus control efforts:



Assessing Regeneration vs. Restoration

Consider the following factors:

- **Level of disturbance at the site**

What is the level of disturbance at site? Was it a heavily invaded site? (i.e. a lot of disturbance was caused when things were removed) Will it continue to be disturbed? (i.e. through trail use and management)

- **Invasive Species Biology**

What is the biology of the invasive species removed and is there a seed bank to consider?

- **Re-invasion Risk**

Are there invasive species in the area that could re-invade the site from certain pathways of introduction, such as nearby trails or watercourses?

- **Existing native vegetation**

What native vegetation is left? How long before it regenerates by itself? Does it need help?

Control Measures

Control measures must be continued for a minimum of five years to ensure that seedlings/the seed bank is depleted. Monitoring must continue as seeds may sprout seedlings for up to 80 years. Many of these control measures, if done only once, will actually increase densities by stimulating re-growth.

Manual Control

Mowing/Cutting:

Pulling can be effective in small areas in sandy soil, where the plants are in their first year and in the spring before they have developed a deep root system. Plants that haven't yet flowered can be pulled and left on site as they will not produce seeds.

Pulling:

Mowing or cutting the second year plants back to about 2.5 cm from the ground will reduce seed production and plant density. It will not eradicate the plants immediately and they may re-sprout in the 3rd year to produce seeds.

Digging:

For fewer plants or new infestations, first year plants can be removed by digging them out of the ground. It is crucial to cut the root under the soil and to conduct follow up monitoring for any re-sprouts.

Grazing:

Concentrated grazing during late summer and fall can reduce the root reserves of the plants, which may lead to plant mortality the next spring. However, grazing should be done with caution due to the concentration of coumarin (a chemical compound that causes blood thinning) in the plants. Cut plants should not be used as feed due to increased coumarin levels as the plant decomposes.



White Sweet Clover removal at Alderville First Nation Black Oak Savanna.

Photo courtesy of OFAH.

Cultural Control

Burning:

Extreme caution is necessary when using early season prescribed burning in prairies and oak savannahs. Seeds of White Sweet Clover are stimulated by fire, and will germinate rapidly following burns. Within a week the ground may be covered in White Sweet Clover seedlings. Fire may produce dense stands of White Sweet Clover where none existed prior to the burn. Several small test burns should be done before any large-scale prescribed burn. This will show if there are White Sweet Clover seeds in the seed bank and if a prescribed burn will make the invasion larger. Large infestations of new White Sweet Clover seedlings resulting from prescribed burns are best dealt with by spraying with herbicide a week after the burn, when maximum germination of seed has occurred, but before other species are in actively growing again.

Shading:

White Sweet Clover does not move into or establish in shade, so if restoration is being done where a native tree canopy is being re-established, the shade provided by those species may out-compete White Sweet Clover.

Chemical Control

Chemical control for White Sweet Clover is usually not necessary unless it is a very large population that cannot be controlled using manual/mechanical means. If confronted with a large infestation chemical control may be used as described below.

Herbicide Application

Herbicides must be applied in accordance with all label directions. For an up-to-date list of herbicides labelled for White Sweet Clover control, visit the Pest Management Regulatory Agency's web site at www.pmr-arla.gc.ca. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA)'s Publication 75, Guide to Weed Control is an excellent reference for all aspects of weed control, and includes a section on invasive plant management. To determine if a federally registered herbicide is also classified for use in Ontario, visit <http://app.ene.gov.on.ca/pepsis/>.

Foliar Spray:

Refer to the label of the herbicide you are using for rates and instructions for foliar application.

Anyone using a pesticide is responsible for complying with all federal and provincial legislation. Most non-domestic (i.e. commercial, restricted etc.) herbicides can only be applied by licensed exterminators. For more information, refer to the Ontario Pesticides Act and Ontario Regulation 63/09 (available on <http://www.elaws.gov.on.ca>), or contact the Ontario Ministry of the Environment (<http://www.ene.gov.on.ca/environment>).

Legislation governing pesticide use:

The Ontario Pesticides Act and Ontario Regulation 63/09 provide natural resources, forestry and agricultural exceptions which may allow chemical control of invasive plants on your property. Other exceptions under the Act include golf courses, and for the promotion of public health and safety.

Natural Resources Exception:

A 'natural resources' exception exists for the use of prohibited pesticides to manage, protect, establish or restore a natural resource. This exception allows the use of certain prohibited herbicides for control of invasive plants on your property if your project meets specific conditions and you obtain the necessary approvals.

If your project meets the natural resources criteria specified in [section 33 of Ontario Regulation 63/09](#) and includes the use of pesticides in accordance with Integrated Pest Management principles outlined in the BMP guide you will need to contact the Ontario Ministry of Natural Resources (www.ontario.ca) to obtain a written letter of opinion from the MNR Regional or Branch Director.

Forestry Exception:

If White Sweet Clover is within a forest*, chemical control may fall under the exception for forest management, and a letter of opinion may not be required. Class 9 pesticides can be used under the forestry* exception to protect trees from pests and to control competing vegetation.

*O. Reg. 63/09 defines 'forest' and 'forestry' as:

- Forest means a treed area of land that is one hectare in size or larger and is not used for producing an agricultural crop as part of an agricultural operation.
- Forestry means activities relating to any of the following: harvesting, renewing, maintaining or establishing a forest, protecting forest resources derived from a forest, and accessing a forest for these purposes.

Refer also to the Ministry of Environment's factsheet titled "Pesticides Act and Ontario Regulation 63/09 Private Land and Woodlot Owners April 2011" http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/stdprod_085367.pdf



White Sweet Clover removal at Alderville First Nation Black Oak Savanna.

Photo courtesy of OFAH.

Agriculture Exception:

There is an exception for the use of Class 9 pesticides for uses related to agriculture by a farmer. This exception may apply to the control of White Sweet Clover in agricultural fields or near farm operations.

A farmer is an individual who owns or operates an agricultural operation.

An agricultural operation is an agricultural, aquacultural or horticultural operation and includes:

- 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;
- 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.

Refer also to the Ministry of the Environment's factsheet titled "Pesticides Act and Ontario Regulation 63/09 Agriculture May 2011" http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/stdprod_080128.pdf

Biological Control

Biological control is the use of an herbivore, predator, disease or other natural enemy to reduce established invasive species populations. Most invasive species have no natural enemies in their new habitats. Biological control aims to re-establish an ecological balance 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*), Diffuse Knapweed (*Centaurea diffusa*) and St John's Wort (*Hypericum perforatum*).

There are many species which will feed on White Sweet Clover, including an alien sweet-clover weevil which is present in North America. However, no biological controls are currently being researched because of its use as a forage species in the US and in soil remediation and other industries.

Disposal

White Sweet Clover can be left on site if it is removed before it has flowered. If it has produced flowers, the plants can either be burned or put in black plastic bags. If disposed of in black plastic bags, seal the bags tightly and leave them to "cook" in direct sunlight for 1-3 weeks, depending on the temperature and amount of sunlight. These bags can then be disposed of at municipal waste facilities or landfills.



Prairie Smoke plants are an indicator of Alvar habitats

Photo courtesy of Nature Conservancy of Canada..

Control Measures Summary

Method	Population Characteristics	Purpose of Control	Notes
Pulling	<ul style="list-style-type: none"> • Small to medium populations 	<ul style="list-style-type: none"> • Removal of entire plant 	<ul style="list-style-type: none"> • Roots must be removed
Mowing/ Cutting	<ul style="list-style-type: none"> • Small to medium populations 	<ul style="list-style-type: none"> • Reduce seed production and plant density 	
Digging	<ul style="list-style-type: none"> • Small to medium population 	<ul style="list-style-type: none"> • Removal of entire plant 	
Grazing	<ul style="list-style-type: none"> • Large populations 	<ul style="list-style-type: none"> • Deplete root reserves for eventual plant death 	<ul style="list-style-type: none"> • Concentrated grazing should be done during late summer and fall – be aware of the effects of coumarin
Shading	<ul style="list-style-type: none"> • Restoration measure or long-term strategy 	<ul style="list-style-type: none"> • White Sweet Clover is intolerant of shade, shade can be used to prevent future invasions or seedling growth 	
Burning	<ul style="list-style-type: none"> • Any size population 	<ul style="list-style-type: none"> • Removal of top growth, depletion of root reserves 	<ul style="list-style-type: none"> • Burning stimulates White Sweet Clover growth – must be done more than once, might need to utilize chemical control after burning
Chemical	<ul style="list-style-type: none"> • Large populations 	<ul style="list-style-type: none"> • Spraying of herbicide on the leaves of plants to get absorbed in to the plant and kill it 	<ul style="list-style-type: none"> • Not usually necessary for White Sweet Clover
Biological	<ul style="list-style-type: none"> • Large populations 	<ul style="list-style-type: none"> • Introduction of a predator or pathogen to provide limited levels of control 	<ul style="list-style-type: none"> • No biological control is currently available

Restoration

Restoration is a critical aspect of invasive plant management. Site restoration will result in a healthier ecosystem more resistant 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 invasive species control (i.e. manual or chemical control of White Sweet Clover) may help with 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 fill the gaps left by the White Sweet Clover removal. This should only be utilized in areas where the native species can tolerate shade (i.e. not to be used on alvar habitats).

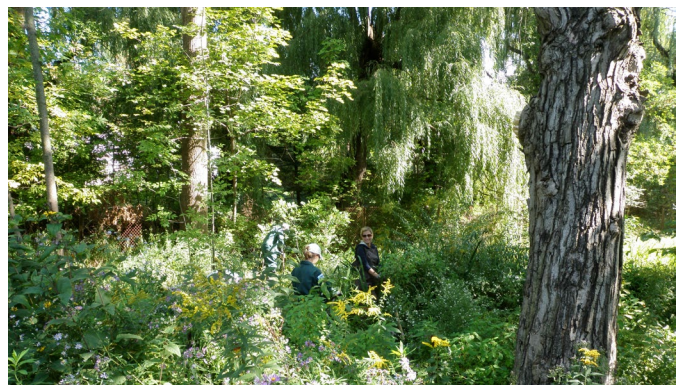
After Control:

Soil Rehabilitation:

White Sweet Clover completely changes soil chemistry by adding nitrogen to the soil. The soil may no longer support native plant species, and may in fact be better suited to other invaders moving in. When completing restoration after control, site preparation will be important to ensure that the soil is rehabilitated to achieve the pre-invasion levels of nutrients. Soil horizon mixing in restoration areas can assist in changing the nutrient levels back to what they were before White Sweet Clover colonization to assist native plants in re-establishing.

Planting:

When choosing plant species for restoration, consider what native species used to grow there. Ensure that seed mixes or plant mixes accurately represent the plant diversity present before the White Sweet Clover invasion. If there are invasive plants nearby which may colonize the control area, consider planting larger native species stock to out-compete or shade out invasive seedlings. Wait until control efforts are complete before doing a large stock re-planting, as it may be difficult to distinguish between newly planted native species and invasive seedlings. While planting, add carbon-rich mulch to the soil to reduce nitrogen availability. This will help the native species which are better able to grow in nutrient-poor soil. Wood mulch can be used, it should be applied again after three years.



This area was re-planted with native species after Sweet White Clover control.

Photo courtesy of Niagara Peninsula Conservation Authority.

Preventing the Spread

Everyone can help prevent the spread of White Sweet Clover by following these tips:

Report it.

If you think you see White Sweet Clover in an area where it has not been intentionally planted, take a picture, record the location and contact the Invading Species Hotline to report it. For more information and guidance call the Invading Species Hotline at **1-800-563-7711** or visit www.invadingspecies.com or www.ontarioinvasiveplants.ca.

Watch for it.

Learn what White Sweet Clover looks like. Monitor property boundaries, roadsides, fence lines and trails. Early detection of invasive plants can make it easier and cheaper to remove or control them.

Stay on trails.

Avoid traveling off-trail in areas known to have White Sweet Clover or other invasive species.

Stop the spread.

Inspect, clean and remove mud, seeds and plant parts from clothing, pets (and horses), vehicles (including bicycles), and equipment such as mowers and tools. Clean vehicles and equipment in an area 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 White Sweet Clover and if you have removed it, try to replant with native species. Don't transplant invasive species such as White Sweet Clover. 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 of White Sweet Clover

Locations of White Sweet Clover have not been documented in many parts of Ontario. There are gaps in our understanding of its provincial distribution and the scale of its invasion in many locations.

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

1) EDDMaps is an on-line reporting tool where users can view existing sightings of White Sweet Clover and other invasive species in Ontario, and document their sightings.

This tool, at www.eddmaps.org/ontario is free to use.

2) The toll-free Invading Species Hotline (1-800-563-7711) and website (www.invadingspecies.com), which individuals can use to report sightings verbally or on-line.

If you think you have White Sweet Clover on your property or if you see it in your community where it hasn't been intentionally planted, please report it. You will be asked to send in photos of the leaf, bark and flower for identification.

Best Management Practices Documents Series:

Common Buckthorn Best Management Practices for Ontario

Dog-strangling Vine Best Management Practices for Ontario

Garlic Mustard Best Management Practices for Ontario

Giant Hogweed Best Management Practices for Ontario

Phragmites (Common Reed) Best Management Practices for Ontario

Japanese Knotweed Best Management Practices for Ontario

Wild Parsnip Best Management Practices for Ontario

Exotic Bush Honeysuckles Best Management Practices for Ontario

European Black Alder Best Management Practices for Ontario

Additional Publications from the Ontario Invasive Plant Council:

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

References/Additional Resources

- Altherr, A. 2010. Unwanted Invaders Fact Sheet: White or Yellow Sweetclover *Melilotus officinalis*. Yukon Invasive Species Council.
- Conn, J.S., N.R. Werdin-Pfisterer, K.L. Beattie, and R.V. Densmore. 2011. Ecology of invasive *Melilotus albus* on Alaskan glacial river floodplains. *Arctic, Antarctic, and Alpine Research* 43(3) 343-354.
- DiTomaso, J.M, G.B. Keyser et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California. 544 pp.
- Gaertner, M., J.L Fisher, G.P. Sharma, and K.J. Esler. 2012. Insights into invasion and restoration ecology: Time to collaborate towards a holistic approach to tackle biological invasions. *Neobiota* 12: 57-75.
- Jacquart, E. 2009. Where do I start?! Prioritizing Invasive Plant Control. Indiana Chapter of The Nature Conservancy. Available at: < <http://www.inwoodlands.org/where-do-i-start-prioritizing/>> (Accessed November 5, 2012)
- Kaufman S. and Kaufman W. 2007. Invasive Plants: A guide to identification and the impacts and control of common North American species. Stackpole Books.
- Klein, H. 2011. White Sweetclover *Melilotus albus* Medikus Invasiveness Ranking. Alaska Natural Heritage Program, University of Alaska Anchorage.
- Kline, V.M. Unknown. Response of Sweet Clover (*Melilotus alba* Desr.) and associated prairie vegetation to seven experimental burning and mowing treatments. *Fire and Prairie Ecosystems* 6: 149-153
- Krick R., H. Anderson, G. Bales, F. Forsyth, E. Weisz , F. MacDonald, S. Bull, and R. Gagnon. 2012. A Landowners Guide to Managing and Controlling Invasive Plants. Credit Valley Conservation. 116 pp. Available at: <<http://www.creditvalleyca.ca/watershed-science/plants-animals-communities/invasive-species/resources/>> (Accessed 2012 Sept 18)
- Malcolm, G.M., D. S. Bush and S.K. Rice. 2007. Soil Nitrogen conditions approach preinvasion levels following restoration of nitrogen-fixing black locust (*Robinia pseudoacacia*) stands in a pine-oak ecosystem. *Restoration Ecology* 16(1) 70-78.
- Ohio Division of Natural Areas and Preserves. 2001. Invasive Plants of Ohio: White and Yellow Sweet-clover. Fact Sheet 16.
- Smith J. and H. Valenzuela. 2002. Green Manure Crops: White SweetClover. College of Tropical Agriculture and Human Resources Cooperative Extension Service. SA-GM-12.
- Tilley, D., D. Ogle, and L. St. John. 2008. Plant Guide: Yellow Sweetclover & White Sweetclover. United States Department of Agriculture Natural Resources Conservation Service.
- Turkington, R.A, P.B. Cavers, and E. Rempel. 1977. The Biology of Canadian Weeds 29. *Melilotus alba* Desr. And *M. officinalis* (L.) Lam. *Canadian Journal of Plant Science* 58: 523-537.

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