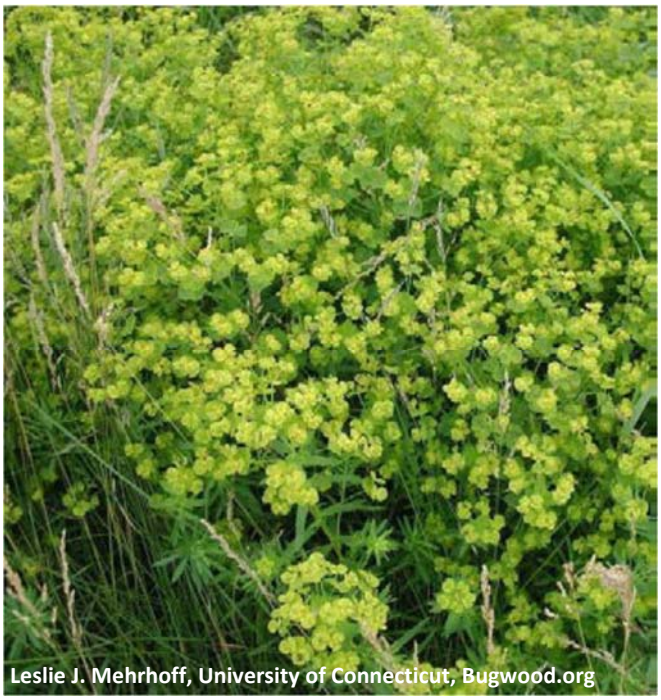
Leafy spurge

***Euphorbia virgata* Waldst. & Kit. (*E. esula* L.)**

Leafy spurge is native to Eurasia. It was introduced to North America multiple times in the nineteenth century, in ship ballast and as a seed contaminant. It was first collected in Michigan in 1855. Although some sources treat *Euphorbia esula* and *Euphorbia virgata* as varieties of a single species, Michigan Flora considers them distinct species. All Michigan plants are *Euphorbia virgata*, which has narrower leaves.

Leafy spurge can tolerate a wide variety of site conditions although it is most competitive on dry soils. It begins growing early in spring and its extensive root system allows it to outcompete native vegetation and rapidly dominate a site. It reduces biodiversity and threatens sensitive species.

Leafy spurge produces a milky sap that can cause severe diarrhea in cattle and horses, so they avoid areas where it grows. The sap can also cause blistering and irritation on skin, particularly when the plants have been recently mowed. It infests more than 5 million acres in the US and Canada, resulting in enormous economic losses.


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

Identification

Habit:

Leafy spurge is an herbaceous perennial that ranges from 15-92 cm (6-36 in) in height. It has an extensive, deep root system; vertical roots can reach almost 5 m (15 ft) in depth.

Leaves:

Leafy spurge has alternate, long, narrow, bluish-green leaves, which are 3.2-10 mm wide and 6-15 times as long as they are wide. They usually have pointed tips and blunt bases, and are drooping with smooth margins. They exude white milky sap when crushed.

Stems:

Stems are upright, often clustered and branch towards the top of the plant. They also release white, milky sap when broken. The dry stems may persist into the winter and following summer.

Flowers:

Leafy spurge's tiny green flowers are inconspicuous, but are surrounded by showy yellow-green heart-shaped bracts that open in late May. The flowers produce sticky pollen and abundant nectar and are pollinated by a wide variety of insects.

Seeds:

The seeds are smooth, oblong, and gray-brown. They are contained in three-lobed capsules that explode upon maturation. Seeds mature about a month after pollination and plants can produce more than one seed crop per year.


Norman E. Rees, USDA Agricultural Research Service - Retired, Bugwood.org


L.L. Berry, Bugwood.org


Norman E. Rees, USDA Agricultural Research Service - Retired, Bugwood.org


Julia Scher, Federal Noxious Weeds Disseminules, USDA APHIS ITP, Bugwood.org

Root:
The extensive woody root system has lateral roots that extend up to 15 feet from the deep taproot.

Habitat:
Leafy spurge invades sunny open sites, including roadsides, railroad tracks, pastures, hayfields, grasslands and open woods. It tolerates a wide range of soil moisture.

Similar Species

The related, invasive cypress spurge (*Euphorbia cyparrisias*) also has milky sap, but the leaves are less than 3 mm wide and the floral bracts are much smaller—3-6 mm wide compared to 8-16 mm.

Cypress spurge

Flowering spurge (*Euphorbia corollata*) has white 5-petaled flowers and shorter leaves that are not droopy.

Flowering spurge

Milkweeds (*Asclepias* spp.) have milky sap but they are larger plants with distinct long seedpods.

Whorled milkweed

Whorled milkweed

The leaves of butter and eggs (*Linaria vulgaris*) are even narrower than cypress spurge and their large, showy flowers are arranged along a terminal spike.

Butter and eggs

Reproduction/Dispersal

Leafy spurge is an herbaceous, creeping perennial that reproduces by seed and vegetatively from the root crown and root buds. Its small, green flowers are nestled in large, clustered yellow-green bracts, which develop in late spring. Flowers bloom by early summer and can bloom into the fall. Upon maturation in late summer and fall, the seed capsules explode, scattering seeds as far as 15 feet. Leafy spurge seeds have a high germination rate and can remain viable in the soil for over 5 years. Root fragments can also sprout to produce new plants.

Best survey period

It is easiest to detect leafy spurge in spring when the showy bracts first appear, through fall when it senesces. The bracts provide a bright contrast to adjacent vegetation and it is easily overlooked prior to their formation. With practice, leafy spurge can be detected at other times by its knee-high, leafy stems that have a bluish-green cast to them.

Planning a control program

Resources for invasive species control invariably fall short of the actual need, so it is important to prioritize sites for treatment and plan carefully. Assessing the scope of the problem is a critical first step:

- Map known populations.
- Identify leading edges and outliers.
- Is the species widely dispersed throughout the region or is it just beginning to appear?
- How is the species behaving in your area? Is it spreading rapidly?
- Identify potential dispersal pathways and monitor them; is the population along a pathway or stream?
- Does it lie in the path of road-mowing crews that might spread it further? Are there construction sites in the area where it might be introduced in fill dirt?
- Does it occur in high quality habitat or on important recreational, hunting or fishing lands?

Given this information, develop a strategy for control:

1. Prioritize high value sites where treatment success can be achieved.
2. Prevent further spread by monitoring the leading edges and outliers.
3. Choose appropriate control methods, given site conditions and available resources.
4. Determine whether any permits are required (e.g., herbicide application in wetlands, prescribed burning)?
5. Eradicate smaller satellite populations.
6. Treat larger core infestations
7. Monitor to ensure desired results are being achieved; adapt management to improve success.

Documenting occurrences

In order to track the spread of an invasive species on a landscape scale, it is important to report populations where they occur. The Midwest Invasive Species information Network (MISIN) has an easy-to-use interactive online mapping system. MISIN I-phone and android phone apps are also available. Links to the MISIN and its phone apps are provided in the "On-line resources" section. Herbaria also provide a valuable and authoritative record of plant distribution. The University of Michigan Herbarium's database can be searched online for county records of occurrence, for example. When leafy spurge is first encountered in a county where it had not been known previously, specimens should be submitted to the Herbarium to document its presence. Check the "Online Resources" section for links to both of these resources.

Control

Leafy spurge has been one of the most difficult invasive plants to control due to its extensive, deep, and branching root system. It establishes quickly and deeply in the soil and is difficult to suppress. Early detection is paramount for cost-effective control. Established populations almost always require the use of chemicals in combination with one or more additional control measures.

Hand pulling

Leafy spurge is nearly impossible to extract after the first year of establishment and hand-pulling will only be effective on small, young infestations. The entire root should be removed or it will re-sprout. Pulling should occur prior to seed production or it will facilitate its already highly effective explosive seed dispersal. Seedlings may be hand-pulled as a follow-up to other treatments.

Due to the potential for skin irritation, gloves should be worn when pulling.

Mowing

Mowing alone does not eradicate leafy spurge, but repeated mowing during the growing season can reduce seed production. Mowing should be conducted at 2-4 week intervals to ensure no flowers mature to produce seed. If it is not mowed prior to seed production, mowing will facilitate seed dispersal. Mowing can be used to boost herbicide effectiveness by producing a uniform cut surface for application. Herbicide should be applied 3-5 weeks after mowing, so there is enough foliage to take up the herbicide effectively.

Mowing prior to July 15 may kill or displace ground nesting birds and this should be considered during planning.

Mowing should be considered in the context of overall site conditions and management goals as there may be impacts to desired species.

Intensive cultivation

In sites where management goals allow for intensive cultivation, eradication is possible over 1-2 years; however, considerable care must be taken not to spread roots into previously uninfested areas.

Cultivation has been successful when conducted 2-4 weeks after spring emergence, at a depth of 4" and repeated at 3 week intervals until the ground freezes. Cultivating 3-6" plants in the fall over 3 years has also shown success in some sites.

Grazing

Leafy spurge is toxic to horses and cattle but sheep and goats can suppress populations by grazing. Where compatible with management goals and suitable for site conditions, this may be an effective control tool. Grazing should occur after floral bracts have developed but before seeds are produced, as seeds can be deposited and sprout after they have moved through the digestive system. Care should be taken to prevent grazing animals from spreading seed.

Significant suppression of leafy spurge has resulted when grazing is used in conjunction with fall herbicide application or biological control.

Chemical control

Chemical controls are almost always necessary for effective control of leafy spurge and are best used for all but small, first year populations which have not yet established an extensive root system.

Factors that should be considered when selecting an herbicide for use on a particular site include proximity to water or wetlands, presence or absence of desirable native vegetation, potential for erosion and the effectiveness of the herbicide under consideration on leafy spurge.

Every effort should be made to prevent infestations from reaching highly valued areas and to detect and respond to new infestations as early as possible, to minimize the need for wide-scale use of these more persistent herbicides. Herbicides should only be used where successful control is important and likely.

General considerations

Anyone applying herbicides as part of their employment must become a certified pesticide applicator. In addition, certification is required for the use of some herbicides under any circumstances. The exam is administered by the Michigan Department of Agriculture and Rural Development and a link to their website is included in the "Online Resources" section.

A permit from the Michigan Department of Environmental Quality is usually required to apply herbicide where standing water is present—in wetlands, along streams, rivers or lakes, or over open water. A permit is also required for herbicide use below the ordinary high water mark along the Great Lakes or Lake St. Clair shoreline, whether or not standing water is present. A link to their website is included in the "Online Resources" section.

A number of adjuvants or additives may be used with herbicides to improve their performance including mixing agents, surfactants, penetrating oils and dyes. Some are included in premixed products while others must be added. Adjuvants do not work with all products; consult the product label to determine which adjuvants may be used with a specific herbicide formulation.

Dyes are useful in keeping track of which plants have been treated, as well as detecting spills on clothing or equipment. Some premixed herbicides include them or they can be added to others. Clothing dyes such as Rit® can be added to water soluble herbicides, while other products require oil-based dyes. Consult the product label for specific instructions.

Crop Data Management Systems, Inc. (CDMS) maintains a database of agro-chemicals that includes herbicide labels for specific products. Herbicide labels contain information on application methods and rates, specific weather conditions, equipment types, nozzles etc., to provide the desired coverage and minimize the potential for volatilization or drift. They also contain critical information about the potential for damage to valuable non-target species. A link to the CDMS website is included in the "Online Resources" section.

Read the entire pesticide label before use. Follow all directions on the label.

Herbicide specifics

With the exception of glyphosate, which provides only moderate control of leafy spurge, chemicals shown to be most effective remain in the soil for long periods, require manure management and have restrictions due to the potential for contamination of ground and surface water.

Glyphosate (e.g., Roundup®, Rodeo®, Accord®) only provides moderate control of leafy spurge, but may be effective on small early detected populations over multiple years. It should be applied when seeds are forming in late summer and in the fall before a killing frost.

Glyphosate should be used with a vegetable oil based multi-purpose adjuvant (e.g. SprayTech® Oil) on upland sites or a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®) in wetlands.

Glyphosate is not selective and will kill desirable non-target species through overspray and drift, in some cases leading to increased erosion on site. Glyphosate works best at temperatures above 50 degrees.

Imazapic (e.g., Plateau®) has shown good results during the season of application, however, regrowth is significant the following year, requiring additional control effort. Imazapic should be applied in the fall prior to a killing frost and should be used with methylated seed oil.

Aminoclopyrachlor + Chlorsulfuron (e.g., Perspective®) and **Aminocyclopyrachlor + Metsulfuron** (e.g., Streamline®) are also highly effective during the season of application but exhibit better control during the following season than Imazapic. They should both be applied to flowering plants or in the fall prior to a killing frost.

None of the latter three herbicides can be applied to water and they should not be used in areas with permeable soils, especially where the water table is shallow, as ground water contamination may result. They are persistent in the soil for months and can also impact surface water in soils with poor drainage or where groundwater is shallow. Buffer strips are

recommended between areas of application and surface water features. Treated plants should not be composted as these herbicides can persist through the composting cycle. Manure management is also required.

Foliar application

The product label for the specific herbicide being used provides essential information on coverage; how much of the foliage should be treated and how wet it should be. Herbicide labels also contain information on specific weather conditions, application modes, equipment types, nozzles, etc., to provide the desired coverage and minimize the potential for volatilization or drift.

The herbicide applicator is responsible for managing drift and damage to non-target vegetation. Wind speeds between 3 and 10 miles per hour are best for foliar herbicide spraying. At higher wind speeds, herbicide may be blown onto adjacent vegetation or water bodies.

At lower wind speeds, temperature inversions can occur, restricting vertical air movement. Under these conditions, small suspended droplets of herbicide can persist in a concentrated cloud and be blown off-target by variable gusts of wind. Ground fog indicates the presence of a temperature inversion, but if no fog is present, smoke movement on the ground can also reveal inversions. Smoke that layers and remains trapped in a cloud at a low level indicates an inversion, while smoke that rises and dissipates indicates good air mixing.

In hot, dry weather, herbicide can evaporate rapidly. Setting equipment to produce large droplets can help compensate for this. In general, follow all directions on the label of the specific herbicide being used, in order to prevent damage to non-target vegetation or water bodies.

Prescribed Fire

General considerations

Permits are usually required before a prescribed fire. The Michigan Department of Natural Resources (DNR) is responsible for issuing burn permits in the Upper Peninsula and Northern Lower Peninsula unless a municipality wishes to do so. Municipalities located in the Southern Lower Peninsula issue burn permits under authority of the state law. A link to the DNR local fire contacts web page is included in the "Online Resources" section. In the Southern Lower Peninsula, contact the local Fire Marshall for permits and more information. In many situations, insurance is required before a permit is issued, to cover the cost of damages if the fire should escape.

Before initiating a program of prescribed fire, a written burn plan establishing the criteria necessary for starting, controlling, and extinguishing a burn is required. The burn plan includes details such as specific weather conditions, locations of fire control lines, ignition pattern, equipment and personnel needed, contingency plans, and important phone numbers. The burn plan is essentially the prescription for how to conduct the burn safely while accomplishing the management objectives.

Fire specifics

Spring burning can be useful in fire-adapted communities, but prescribed burning alone does not provide effective control of leafy spurge and is not recommended. Fire will usually control seedlings, however, its impact to older plants is variable, depending upon fire intensity. Established plants quickly re-sprout after fire and multiple years of treatment are required.

Fire can also stimulate seed germination, increasing leafy spurge's ability to compete with desirable plants. Burning should be followed up with seedling management by hand-pulling, chemical application, or burning with a hand-held propane torch.

Prescribed burning should be implemented to meet specified management goals in accordance with specific site conditions. Fire may pose a risk to desirable plants; however, it may benefit other fire-adapted species such as prairie grasses, resulting in improved competition with leafy spurge. This should be considered during planning.

Hand-held propane torch

Freshly emerged seedlings can be quickly killed with a handheld propane torch, but should be done when conditions are not too dry, to minimize risk of unintentional fire. As the first-year plants develop taproots and extensive branching, this method becomes less effective.

Interseeding

Interseeding alone has not provided effective control of leafy spurge. However, competitive grasses such as big bluestem can suppress populations once they are well established and interseeding may enhance other treatment efforts. However, when using herbicides with residual soil activity, forbs should not be planted during this time.

Assessment of the native seed bank prior to control efforts will help determine whether interseeding is needed.

Manipulation of the canopy

Leafy spurge can colonize openings in forests, however little data exists for its shade tolerance. Manipulation to close the canopy is likely to discourage further colonization; however, this should be investigated further.

Biological control

Biological control implemented in the western range lands and has been highly successful when employed in combination with grazing over a period of 4-5 years. The recommended agents, *Aphthona nigriscutis*, *A lacertosa*, and *A. czwalinae*, bore the root as larva and feed on foliage as adults.

Biological control can only be employed where it is compatible with management goals and where biocontrol agents are permitted. Success may be enhanced when combined with grazing or chemical treatment.

Integrated control

Integrated control first requires an understanding of the site management goals, the biology of leafy spurge and the environment in which it is growing. This information confers a combination of actions that collectively reduces its impact.

In Michigan, the most effective control of established populations of leafy spurge will likely be through a combination of chemical treatment or prescribed burning with follow-up spot treatments by hand-pulling, targeted chemical application or burning with a hand-held propane torch.

Grazing followed by fall chemical application has resulted in excellent control in the western range lands, and may be appropriate in Michigan sites where grazing is compatible with management goals.

Interseeding in combination with other techniques may enhance control over time.

Disposal of plant parts

Pulled plants should not be left on site or composted as root fragments can sprout. They should be disposed of in a manner that will ensure that their roots will dry out completely. In addition, if fruit is present, it should be burned or bagged and placed in a landfill. Where this is not possible, any resulting seedlings will require monitoring and control.

Although landscape waste cannot generally be disposed of in landfills, Michigan law permits the disposal of invasive species plant parts. See the "Online resources" section for a link to the relevant legislation.

Online resources:

CDMS - herbicide labels
http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=v

Fire Effects Information System, Pastinaca sativa
http://www.fs.fed.us/database/feis/plants/forb/eupesu/all.html

Invasive.org
http://www.invasive.org/

Michigan Department of Agriculture and Rural Development—Pesticide Certification
www.michigan.gov/pestexam

Michigan Department of Environmental Quality—Aquatic Nuisance Control
www.michigan.gov/deqinlandlakes
http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3710---,00.html

Michigan Department of Natural Resources—Local DNR Fire Manager contact list
http://www.michigan.gov/dnr/0,4570,7-153-30301_30505_44539-159248--,00.html

Michigan Invasive Species Coalition:
http://www.michiganinvasives.org/

Michigan's Invasive Species Legislation
Natural Resources and Environmental Protection Act 451 of 1994, Section 324.4130

http://legislature.mi.gov/doc.aspx?mcl-324-41301

Michigan Legislation—landscape waste, disposal of invasive species plant parts
Natural Resources and Environmental Protection Act 451 of 1994, Section 324.11521, 2 (d)
http://legislature.mi.gov/doc.aspx?mcl-324-11521

Midwest Invasive Species Information System:
https://www.misin.msu.edu/

Midwest Invasive Plant Network's Invasive Species Control Database
https://mipncontroldatabase.wisc.edu/

MISIN Mapping Phone Apps:
http://www.misin.msu.edu/apps/

The Nature Conservancy's Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas
http://www.invasive.org/gist/handbook.html

University of Michigan Herbarium - Michigan Flora Online
http://michiganflora.net/

Quick reference—Leafy Spurge

This chart has been provided as a convenience, to summarize the pros and cons of each herbicide and to present details on adjuvants, concentrations, etc., that do not fit into the discussion in the preceding sections. Although every attempt has been made to ensure accuracy, the product labels for the listed herbicides are the ultimate authority for their usage. Where there are conflicts, always follow the label directions. Techniques are listed in order of general preference by MDNR Wildlife Division staff but not all are suitable for wetlands or sensitive sites. Site conditions vary—choose a method that is best suited to conditions on the site being treated.

Anyone using herbicides in the course of their employment is required to be a certified pesticide applicator. Treatment in wetlands or over open water requires a permit from the Michigan Department of Environmental Quality.

These chemicals are available in a variety of formulations and concentrations. In some cases, concentration is listed below as a percentage of the active ingredient (AI) to facilitate use of different products. Where this is not possible, the label recommendation for the example product/brand is used. Always follow all directions on the product label including mixing instructions, timing, rate, leaf coverage and the use of personal protective equipment.

	Herbicide	% A.I.	Adjuvant	Timing	Pros	Cons
Foliar Spray	Glyphosate (e.g., Roundup®, Rodeo®, Accord®)	1-3%	Some products already contain a surfactant - if not, add one (e.g., Cygnet Plus®, NuFilm IR®).	Apply to rosettes in fall or spring or when plants are bolting.	Some products approved for use in wetlands.	**Non-selective!** Use only when few or no natives are present.
Foliar Spray	Imazapic (e.g., Plateau®)	6-12 fl oz/A (0.1-0.2 lb a.i./A)	Add methylated seed oil to the mixture as per label instructions.	Apply in fall before a killing frost.	Initial effective-ness is high. Residual effect on seedlings.	Persists in soil for months--this can be good or bad. Potential to contaminate surface water runoff. Can't use in porous soils or areas with high water table as it can contaminate groundwater. Persists in decaying plant materials and manure of animals that have grazed on treated lands--do not compost. Buffer strip between treatment area and surface water recommended.

	Herbicide	% A.I.	Adjuvant	Timing	Pros	Cons
Foliar Spray	Aminocylo-pyrachlor + Chlorsul-furon (e.g., Perspective®)	Maximum rate: 4.75-11 oz/A as per label instructions.	Add methylated seed oil to the mixture as per label instructions.	Apply to flowering plants or in fall prior to killing frost.	Initial effectiveness is high. Residual effect on seedlings.	Persists in soil for months--this can be good or bad. Potential to contaminate surface water runoff. Do not use in porous soils or areas with high water table as it can contaminate groundwater. Persists in decaying plant materials and manure of animals that have grazed on treated lands--do not compost. Buffer strip between treatment area and surface water recommended.
Foliar Spray	Aminocyclo pyrachlor + Metsulfuron (e.g., Streamline®)	Maximum rate: 4.75-9.5 oz/A as per label instructions.	Add methylated seed oil to the mixture as per label instructions.	Apply to flowering plants or in fall prior to killing frost.	Initial effectiveness is high. Residual effect on seedlings.	Persists in soil for months--this can be good or bad. Potential to contaminate surface water runoff. Do not use in porous soils or areas with high water table as it can contaminate groundwater. Persists in decaying plant materials and manure of animals that have grazed on treated lands--do not compost. Buffer strip between treatment area and surface water recommended.
Note: Hand-pull seedlings as follow-up or in small populations; wear heavy gloves.						