



GARLIC MUSTARD

(*Alliaria petiolata*)

IN BRIEF

Garlic mustard is a biennial (two-year life cycle), herbaceous plant that spreads rapidly by seed in many types of woodlands. One of the most invasive and difficult-to-control weeds in the region, it is a major threat to desirable woodland wildflowers, tree seedlings and wildlife. It displaces native species by competing for available light, nutrients and water resources.



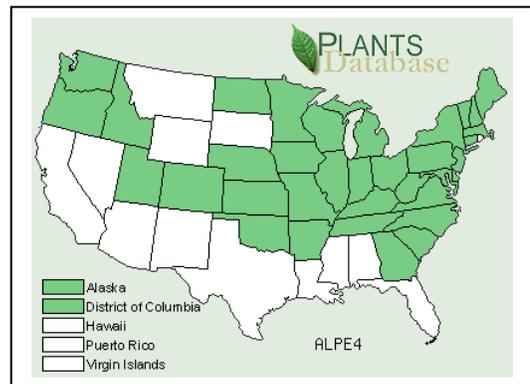
Flowering garlic mustard crowds out native species and dominates the forest floor.

DESCRIPTION

Plant habit. First-year plants form low rosettes of 4-8 leaves at ground level. Second-year flowering plants are erect-stemmed, from a few inches to 4 feet tall, and often are multiple-stemmed. Garlic mustard eventually forms extensive stands on the forest floor.

Leaves. First-year rosettes have dark green, kidney-shaped leaves with scalloped margins and deep veins (giving them a wrinkled appearance). In the second spring, a flower stalk rises from the rosette, bearing alternate, coarsely toothed, triangular leaves. Crushed leaves smell like garlic, especially in spring.

Flowers. Clusters of small, white, 4-petaled flowers occur only on second-year plants, which can blossom from late April through June. Flowers appear at the top of stalks and bloom progressively upward.



First-year plant -- a low rosette with kidney shaped leaves.



White, 4-petaled flowers.



Second year plants ready to flower.

Fruits / Seeds. Each flower soon develops into a slender, straight seedpod called a silique. (1–2.5 inches long). Pods are green at first, but turn tan as seeds ripen. Each contains one row of oblong dark brown to black seeds. Dispersion occurs in mid- to late summer. A single plant can produce as many as 3,000 seeds.



Roots. Plants develop a white, slender taproot, which often branches below ground. The top of the root typically has a bend or "S"-shape as it emerges from the ground.

Habitat. Garlic mustard grows in upland and floodplain forests, savannas, urban yards and along roadsides. It thrives in shady conditions, but can tolerate sunny habitats, usually resulting in smaller flowering plants. It prefers non-acidic soils.

DISTINCTIVE FEATURES

- Crushed leaves have the odor of garlic.
- The only tall, broad-leaved, 4-petaled, white woodland flower blooming in early spring.
- First-year basal rosettes remain green through fall and winter. They are one of the earliest plants to begin active green growth in spring.

LOOK-ALIKES

Several white-flowered native plants occur in the same habitats as garlic mustard and may be mistaken for it. These include Cut-leaved toothwort (*Cardamine concatenata*), another 4-petaled mustard, but low-growing with narrow, finger-like leaves; Sweet cicely (*Osmorhiza claytonia* and *O. longistylis*), with fern-like leaves, five petals; and Early saxifrage (*Saxifraga virginica*), with five white petals.



Sweet cicely with divided leaves

Garlic mustard with undivided leaves

Basal leaves resemble Creeping Charlie (*Glechoma hederacea*), a vine with square stems and purple flowers; Violets (*Viola* spp.), whose heart-shaped leaves have shallow teeth and pointed tip; and Kidney-leaf buttercup (*Ranunculus abortivus*), whose leaves are smooth, shiny, sometimes lobed. Fruiting structure is similar to other kinds of mustards with long capsules.



Violet leaf with shallow teeth and pointed tip



Left: First year garlic mustard leaf, deep veins
Right: Creeping Charlie, rounded leaf margin



Garlic mustard infestation

LIFE HISTORY AND INVASIVE BEHAVIOR

Garlic mustard is a herbaceous biennial that produces hundreds of seeds per plant. Seeds may lie dormant for 20 months before germinating, and remain viable for 5-8 years. They typically germinate in early spring, though some sprout throughout the summer. Reproduction is only by seed.

There are two primary patterns of spread: an advancing front, and satellite population expansion. The invasion of forests usually begins along a roadside or woods edge and progresses via streams, rainwater runoff, trails (including animal) and through human activity – especially shoes and boots, and bicycle and off-road vehicle tire treads. Satellite populations can appear in remote areas, probably introduced by animals that carry the seeds in their fur or on their feet.

Once established, garlic mustard rapidly dominates the forest floor and can displace most native herbaceous species within ten years. Few insects, deer or other herbivores will eat it.

IMPACTS ON FORESTRY AND FORESTERS

On Forestry: Unlike other plants that invade disturbed habitats, garlic mustard spreads readily into high quality forests. Once established, it competes with tree seedlings for available light, nutrients and water resources, thus preventing recruitment of replacement trees. In addition, plant chemicals produced by roots and decaying leaves inhibit the growth of other plants, including trees. Recent research discovered one of the ways this happens. Chemicals released by garlic mustard disrupt the growth of underground mycorrhizal fungi which the roots of tree seedlings depend on for healthy growth.

(For “Recent research” above, link to http://biology.plosjournals.org/archive/1545-7885/4/5/pdf/10.1371_journal.pbio.0040140-p-L.pdf)

On Foresters: Seeds are easily spread via mud on tires and other equipment, and by sticking on or falling into boots and shoes. Dispersal-prevention requires careful monitoring and washing of equipment and clothes.

CONTROL METHODS

	Method	Timing
Manual & Mechanical	Dig up by roots anytime	Spring, summer, fall
	Hand pull flowering plants	Spring, early summer
	Propane torch newly emerged seedlings	Spring
	Prescribed burning	Spring, fall
	Cut when flowering	Late spring, early summer
Chemical	Foliar application (glyphosate, triclopyr, 2,4-D)	Spring and fall
Biological	(Research on insects that attack garlic mustard is in progress. See link to website.)	

Once well-established, garlic mustard requires years of sustained effort to eradicate. The most effective strategy to prevent invasion is to monitor uninfested areas and prioritize the treatment of small populations. Heightened vigilance is required if populations exist nearby. Try to prevent the spread of seed by cleaning shoes, vehicles and equipment when leaving infested areas.

Management objectives in infested sites are 1) prevent further spread; 2) prevent seed production; and 3) exhaust the seed bank. First, conduct a thorough survey of the site to determine the extent of invasion, then work from the least infested to most infested areas. Begin control efforts on the leading edges of the invasion and on satellite populations. If resources allow, work on the densest infestations. If nothing else, try to prevent the spread of garlic mustard beyond its known boundaries.

Tailor control methods to the infestation. Hand pulling or cutting flower stalks is effective in small populations, and is necessary for follow-up after other treatments. Controlled burning, weed-torching and herbicide may be useful for larger populations. No single method is 100% effective, and full control often requires a strategy of multiple techniques consistently applied for many years.

Manual Control

Pulling or digging first-year, non-flowering rosettes can be an inefficient use of resources because: 1) many first-year plants will die naturally from overcrowding and drought; 2) it is difficult to remove the entire root without digging. On the other hand, plants uprooted in the rosette stage have no chance of flowering and hence do not need to be removed from the area.

Hand-pulling or digging flowering, second-year plants can be effective, especially in small infestations. **Hand pulling** alone is usually not practical in large or established patches, but is needed to catch flowering plants missed by other treatments. Plants can be pulled anytime during flowering and up until when seed pods are ready to shatter. (See below about removing pulled plants from the site.) When pulled, stems often break off at the base and the taproot may resprout if not removed. Hand-pulling can increase seed germination through soil disturbance, but this can expedite depletion of the seed bank.



Steve Swanson, Aldo Leopold Foundation
Manual control of garlic mustard

Cutting second-year plants close to the ground by hand or with a weed whip may be effective, depending on timing and weather. **Cutting too early in the season will result in resprouts, cutting too late will allow the seed pods to mature. For best results, cut just as flowering begins.** Resprouting will be reduced because plants will have used up most of their energy reserves producing flowers and seedpods. Try to revisit the site to look for plants that were missed. Note: Some

flowering plants are tiny, only a couple of inches tall and easily overlooked. These plants may have only one or two flowers, but still will produce a set of seeds!

After pulling or cutting, it is best to bag and remove all flowering plants. Depending on weather conditions, uprooted and cut plants will continue to develop and may set seed, especially later in the season as seedpods mature. For small populations, plants can be decapitated and just the flowering tops bagged and removed. Garlic mustard should not be composted, because seeds are likely to remain viable. Bagged plants can be landfilled, or dried out and burned. In large patches where removal is not possible, pile stems in the most densely-infested area, where the seed bank is already presumed great. This, at least, will prevent another crop of seeds from being deposited in the forest. Covering with black plastic will help limit the ripening and spread of seed from the pile.



Burning

In spring, the tender, freshly-emerged seedlings can be quickly flame-killed using a **propane weed torch**. This should be done on a wet day. As the first-year plants develop taproots, this method becomes less effective.

Controlled burning can be an effective way to treat large garlic mustard infestations. Burns conducted in spring will kill seedlings and emerging

second-year plants. Woodland burning exposes the soil, however, and may stimulate seed germination. As with hand pulling, this can cause a population increase, but also a more rapid depletion of the seed bank. If an area is burned, follow-up treatments will be needed every year, such as pulling, more burns, propane torch treatments or herbicide applications. Burning every two years without follow-up could actually make a garlic mustard problem worse.



Herbicide

Foliar application of a systemic herbicide is an efficient method for controlling large infestations. First-year plants are most vulnerable, and second-year plants should be treated well before seeds ripen.

Herbicide should be applied to rosettes in very early spring or late fall when most native vegetation is dormant but garlic mustard remains green. Because it begins active growth early in spring and stays green right through winter, identification is easy and spraying should not harm dormant, non-target species. Spring application is effective, and two generations of garlic mustard can be killed if both new seedlings and overwintering rosettes are targeted. By the time seedlings have sprouted, however, many other woodland species have emerged and will be harmed if sprayed. Herbicide can be applied until flowering begins, but if applied too late seeds may still mature. Fall application on first-year rosettes can also be very effective on a warm day, but dry conditions may inhibit translocation of herbicide to roots and limit the kill rate. Fallen leaves in autumn may also cover plants and shield them from the spray.

- **Glyphosate** (the active ingredient in many commercial brands) is most commonly used to control garlic mustard.
- **Triclopyr** (the active ingredient in many commercial brands) also is widely used.
- **2,4-D** alone gives inconsistent control, but a 1% solution of 2,4-D plus Dicamba applied to the foliage of young plants is effective.

NOTICE: Use pesticides wisely. Always read the product label carefully. Follow all mixing and application instructions and wear all recommended protective gear and clothing. Contact your state department of agriculture for any pesticide use requirements, restrictions or recommendations. Many states require individuals involved in the commercial application of pesticides be certified and licensed.

[Click Here](#) for further information on herbicide use.

Biological Control

Several European insects are being tested for biological control of garlic mustard. Among the promising candidates are four tiny weevils of the genus *Ceutorhynchus* that attack roots, stems or seeds.

Strict testing is required by the USDA before any exotic control agent is released, to ensure that it is specific to the intended host and will not damage crops and native plants. These tests are underway, but may take until 2010 or beyond to complete.



Biological control of garlic mustard may be possible with European weevils

Biological control someday may be the best long-term solution for limiting the damage caused by garlic mustard, but there is no guarantee that it will be practical or effective. For the foreseeable future, it is important to use available methods to eradicate this invasive and prevent it from taking over more forests.

HISTORY AND LORE



Pesto anyone?

Alliaria petiolata: Alli refers to the genus *Allium*, which includes garlic. Petiolata means “with petioles” (leaf stalks). Other common names: Hedge garlic, Jack-by-the-hedge, Sauce alone. Garlic mustard is widespread but not especially abundant in its native Europe, due to the many insects and herbivores that have evolved to feed on its roots, stems, leaves and seeds. Few North American insects or vertebrates can tolerate the plant’s pungent defensive chemicals.

Garlic mustard was brought by immigrants as a garden plant for food and medicine. It was first reported as an escaped weed on Long Island, New York in 1868.

Although no longer in common use as a medicinal, its edible leaves and flower heads are high in vitamins A and C. First- and second-year plants are edible, but older parts can be bitter and

tough after flowering starts. Garlic mustard is eaten cooked or raw and may be substituted for spinach in many recipes, yielding a strong, distinctive flavor. An internet search will turn up recipes for garlic mustard pesto and other delights. Here is a [site with four recipes](http://www.ma-eppc.org/morerecipes.html).

<http://www.ma-eppc.org/morerecipes.html>

Whole plants can be boiled to make a yellow or light green dye, using alum as a mordant. Tie-dyeing makes a fun activity for groups (especially kids) after a hard session of pulling.

LINKS and REFERENCES

Websites

Weeds Gone Wild – Garlic mustard factsheet

<http://www.nps.gov/plants/alien/fact/alpe1.htm>

Wisconsin DNR – Garlic mustard factsheet

<http://dnr.wi.gov/invasives/fact/garlic.htm>

Wisconsin State Herbarium – Garlic mustard records

<http://www.botany.wisc.edu/wisflora/scripts/detail.asp?SpCode=ALLPET>

The Nature Conservancy: 20-page stewardship document for garlic mustard

<http://tncweeds.ucdavis.edu/esadocs/documnts/allipet.pdf>

Invasive.org Project – Factsheet and biocontrol information

<http://www.invasive.org/eastern/biocontrol/29GarlicMustard.html>

Invasive Plants Association of Wisconsin – Garlic mustard resources

http://www.ipaw.org/invaders/garlic_mustard/gm.htm

Missouri Vegetation Management Manual – Garlic mustard section

<http://www.mdc.missouri.gov/nathis/exotic/vegman/eleven.htm>

Iowa Native Plant Society Newsletter – Garlic mustard control

<http://www.public.iastate.edu/~herbarium/inps/mar03.htm>

Books / Field guides

Invasive Plants Field & Reference Guide: An Ecological Perspective of Plant Invaders of Forests and Woodlands, by Cynthia D. Huebner, U.S. Forest Service, 2005.

(Also online -- <http://www.fs.fed.us/r9/wildlife/nis/invasive-species-field-guide.pdf>)

Invasive Plants of the Upper Midwest: An Illustrated Guide to their Identification and Control, by Elizabeth J. Czarapata, University of Wisconsin Press, 2005.