NAME OF SPECIES: *Alliaria petiolata (M.Bieb.) Cavara & Grande (1).*	
Synonyms: Alliaria alliaria (L.) Britton; Alliaria officinalis Andrz. ex M.Bieb.; Arabis petiolata M.Bieb.; Erysimum alliaria L.; Sisymbrium alliaria (L.) Scop. (1).	
Common Name: Garlic mustard (1). Garlic root, garlicwort, hedge garlic, Jack-by-the-hedge, Jack-in-the-bush, mustard root, poor man's mustard, sauce-alone (6).	
A. CURRENT STATUS AND DISTRIBUTION	
I. In Wisconsin?	1. YES ☒ NO ☐
	2. Abundance: 134 documented occurences (1), tough this species is vastly underreported in southern WI where it is abundant. Widespread in south, east and west counties, scattered populations in north counties.
	3. Geographic Range: Documented in 40 WI counties, mostly in the southern part of the state (1).
	4. Habitat Invaded: Roadsides, Forests, Bluffs, (1). Garlic mustard invades hardwood forests, savannas, woodlots, forest edges, and roadsides. It has been reported as invading coniferous forest, but infrequently. Disturbed orests are most often invaded, but high-quality, undisturbed forests can also be invaded. Stream sides and bottomland forest are the most common habitat invaded, but slope and upland sites are also vulnerable. Garlic mustard does best in partial light but can tolerate deep shade and full sun. Infestations usually start along an edge, trail or stream and spread throughout the remaining forest.(7) Disturbed Areas ☒ Undisturbed Areas ☒
	5. Historical Status and Rate of Spread in Wisconsin: First identified in WI in 1938.
	6. Proportion of potential range occupied: Probably just a fraction as most of the upland forests and woodlands of WI may provide suitable habitat. .
II. Invasive in Similar Climate Zones	1. YES ☒ NO ☐ Where (include trends): In North America, A. petiolata was first recorded on Long Island, New York in 1868. By 2000, A. petiolata was most abundant in the northeastern and midwestern United States, ranging from southern Ontario, south to Georgia, Arkansas, and Kansas. Isolated occurrences are known from Utah and Colorado, and populations established in the Pacific Northwest appear to be spreading. (5)
III. Invasive in Similar Habitat Types	1. Upland ☒ Wetland ☐ Dune ☐ Prairie ☐ Aquatic ☐ Forest ☒ Grassland ☐ Bog ☐ Fen ☐ Swamp ☐ Marsh ☐ Lake ☐ Stream ☒ Other: Natural forests, planted forests, riparian zones, ruderal/disturbed, urban areas. Garlic mustard is more likely in floodplain forests, forest edges, stream banks, and other disturbed areas, such as trail edges and road sides. (6)
IV. Habitat Effected	1. Soil types favored or tolerated: A. petiolata prefers shade but has been found in areas with full sunlight. It prefers moist, rich soil but is found in sand, loam, clay, limestone, and sandstone substrates. A. petiolata is less common on acidic soils. (6) A. petiolata frequently grows in well-fertilized sites, and is described as a nitrophile. In Europe, it increased in cover with deposition of

	air-borne industrial emissions, which increased soil nitrogen, nitrate, phosphorous and pH. (9)
	2. Conservation significance of threatened habitats: CT, IL, IN, MO, WI, MN - negative impacts on native species and/or habitat conservation (9). In WI, some threatened savanna and woodland habitats are listed as G1-G2, and S1-S2, some wetland forests are listed as G3 and S2-S3, and some upland forests are listed as G3 and S1-S3 (10).
V. Native Habitat	1. List countries and native habitat types: Northern Africa: Algeria; Morocco; Tunisia. Asia: Afghanistan; Cyprus; Iran; Iraq; Lebanon; Syria; Turkey; Armenia; Azerbaijan; Georgia; Ciscaucasia, Dagestan; Kyrgyzstan; Tajikistan; Turkmenistan; China; India; Nepal; Pakistan. Europe: Belarus; Estonia; Latvia; Lithuania; Moldova; Ukraine; Albania; Bulgaria; Greece; Italy; Yugoslavia; France; Portugal; Spain. (4) In its native Europe Alliaria is an edge species, growing in hedges and fencerows, and in open woods (9).
VI. Legal Classification	1. Listed by government entities? Noxious in AL, MN, VT, WA. Regulated in CT, MA, NH, OR. (2).
	2. Illegal to sell? YES ☒ NO ☐ Notes: CT, MA, MN, NH, OR, VT, WA (2)
B. ESTABLISHMENT POTENTIAL AND LIFE HISTORY TRAITS	
I. Life History	1. Type of plant: Annual ☐ Biennial ☒ Monocarpic Perennial ☐ Herbaceous Perennial ☐ Vine ☐ Shrub ☐ Tree ☐
	2. Time to Maturity: Plant flowers and goes to seed on the 2nd year (6).
	3. Length of Seed Viability: Seeds can lie dormant for up to six years and require a cold period to germinate. (6)
	4. Methods of Reproduction: Asexual ☐ Sexual ☒ Notes: Seed longevity has not been determined specifically but seeds have been known to germinate as long as six years after production. The majority of seeds germinate during the first spring following dispersal and the seedlings become established before the canopy closes over. A few seeds germinate in subsequent years. If seedlings develop within dense beds of second year rosettes, they are generally not successful because they cannot compete with the established plants. Because the majority of seeds germinate during their first spring, garlic mustard produces most of its flowering shoots in alternate years. For the same reason, only a small seed bank of reserve seeds forms in the soil. A single plant produces an average of 136 to 295 seeds, depending on the size of the plant and the quality of the soil and habitat. Seedling survival rates vary from 1.4 to 42.3%. (6)
	5. Hybridization potential: NA
II. Climate	1. Climate restrictions: NA
	2. Effects of potential climate change: NA

III. Dispersal Potential	1. Pathways - Please check all that apply: Unintentional: Bird ☒ Animal ☒ Vehicles/Human ☒ Wind ☐ Water ☐ Other: Humans, other animals, and water currents disperse seeds. Wind dispersal is ineffective. (6) Intentional: Ornamental ☐ Forage/Erosion control ☐ Medicine/Food: ☒ Other:
	2. Distinguishing characteristics that aid in its survival and/or inhibit its control: Alliaria petiolata grows rapidly in late fall and early spring when native species are dormant, and all individuals that overwinter successfully will flower and subsequently die. Flowers open as early as April and are insect pollinated, but plants can self-pollinate. (5) A. petiolata can form dense stands because it has no natural predators, and it thrives in disturbed areas (6).
IV. Ability to go Undetected	1. HIGH ☐ MEDIUM ☒ LOW ☐ Notes: Alliaria is frequently overlooked at low density levels. In many sites Alliaria can be present for a number of years before appearing to "explode" in favorable years. (9)
C. DAMAGE POTENTIAL	
I. Competitive Ability	1. Presence of Natural Enemies: A literature survey followed by field investigation in western Europe revealed that 69 insect herbivores and seven fungi are associated with garlic mustard in Europe. The most important groups of natural enemies associated with garlic mustard were weevils (Curculionidae), particularly the genus Ceutorhynchus, leaf beetles (Chrysomelidae) and butterflies and moths (Lepidoptera). Most of these species are not considered sufficiently host-specific for introduction to North America. Two stem-mining weevils, a stem-mining fly, a leaf-mining fly, a scale insect, two fungi, and aphids (taxonomic identification for all species is pending) were found attacking garlic mustard in North America. However, their attack was of little consequence to plant performance or reproduction of garlic mustard. Based on information on their restricted host range and their damage, five weevils and one flea beetle were selected as potential biological control agents for garlic mustard. (5)
	2. Competition with native species: Sites invaded by A. petiolata frequently have low native herbaceous richness and garlic mustard has been implicated as the cause of this low diversity. Garlic mustard invades sites independent of presence or cover of native species, and species-rich sites are more likely to be invaded than species-poor sites. Once established, A. petiolata becomes a permanent member of the community, steadily increasing in presence but with large annual fluctuations in cover and density. Long-term presence of garlic mustard was associated with a significant decline in cover of native perennial herbaceous species. (5)
	3. Rate of Spread: -changes in relative dominance over time: -change in acreage over time:

	HIGH(1-3 yrs) ☒ MEDIUM (4-6 yrs) ☒ LOW (7-10 yrs) ☐ Notes: At any given site Alliaria frequency and cover fluctuate annually, reflecting the biennial nature of the plant. These annual fluctuations are deceptive, as Alliaria consistently occurs with increasing frequency through time, on average doubling in four years. The greatest increases in presence occur in sites subjected to large-scale natural disturbances. One site, flooded in mid- summer, experienced a 241% increase in frequency two years later. In a site hit by a severe windstorm that blew down overstory trees, Alliaria frequency increased 1000% during the same time period. It has spread exponentially since introduction to North America. Experts determine expansion is rapid to moderate. (9)
II. Environmental Effects	1. <u>Alteration of ecosystem/community composition?</u> YES ☒ NO ☐ Notes: Garlic mustard emerges early in the growing season, competing with and shading the spring ephemerals. Garlic mustard is notable because a high shade tolerance allows it to invade high-quality mature forests, once thought to be relatively resistant to invasion. (7) It is a severe threat to community (plants and animals). Aggressively monopolizes light & resources. Deprives wildlife of native forage. Dominates the understory though there is no documented correlation with species richness and Alliaria petiolata presence. It has the potential to form monospecific stands (9).
	2. <u>Alteration of ecosystem/community structure?</u> YES ☒ NO ☐ Notes: In areas with Alliaria petiolata cover of native herbs declined; but species richness did not change. Impact is greatest early in the season. Community structure may undergo more profound changes over time, however: there is speculation that garlic mustard may supress seedling regeneration of dominant canopy trees by inhibiting the mycorrhizal fungi on which these depend; this may favor weedy herbaceous plants which have less mycorrhizal dependency. (9)
	3. <u>Alteration of ecosystem/community functions and processes?</u> YES ☒ NO ☐ Notes: A recent study indicates that garlic mustard produces a phytochemical that kills or inhibits mycorrhizal fungi on which many woody plants depend; there was virtual elimination of the activity of native arbuscular mycorrhizal fungi and there is speculation that this could cause profound changes in plant species composition over time (8). Presence of garlic mustard interferes with oviposition of the rare native butterflies Pieris napi oleraceae Harris and Pieris virginiensis W. H. Edwards (Lepidoptera: Pieridae). The native hosts of P. napi oleraceae and P. virginiensis are toothworts Cardamine concatenata [Dentaria laciniata] (Michx.) O. Schwarz and Cardamine [Dentaria] diphylla (Michx.) A. Wood, Brassicaceae. Eggs laid by females hatch but larvae are unable to complete development on garlic mustard. (5)

	4. Allelopathic properties? YES ☒ NO ☐ Notes: Phytotoxic chemicals produced by A. petiolata may interfere with growth of native species, potentially through inhibition of mycorrhizal activity (5) (8) (9).
D. SOCIO-ECONOMIC Effects	
I. Positive aspects of the species to the economy/society:	Notes: Food additives: flavoring; Medicines (4). Used as a potherb and a source of Vitamin C (9).
II. Potential socio-economic effects of requiring controls: Positive: Negative:	Notes: NA
III. Direct and indirect socio-economic effects of plant:	Notes: Garlic mustard may have a negative impact on tree regeneration in hardwood forests. Dominant native hardwood tree species of northeastern temperate forests, Acer saccharum (sugar maple), A. rubrum (red maple), and Faxinus americana (white ash), showed significantly less arbuscular mycorrhizal fungi (AMF) colonization of roots and slower growth when grown in soil that had been invaded by garlic mustard. AMF colonization was almost undetectable in soil that had been invaded by garlic mustard. These reductions were similar to those observed when seedlings were grown in sterilized soil from both garlic mustard–invaded and garlic mustard–free sites, strongly suggesting that the mechanism by which garlic mustard suppresses the growth of native tree species is microbially-mediated, and not the result of soil differences or direct allelopathy. (8)
IV. Increased cost to sectors caused by the plant:	Notes: NA
V. Effects on human health:	Notes: NA
VI. Potential socio-economic effects of restricting use: Positive: Negative:	Notes: NA
E. CONTROL AND PREVENTION	
I. Costs of Prevention (including education; please be as specific as possible):	Notes: Difficult to eradicate once established - considerable expenditures required (9).
II. Responsiveness to prevention efforts:	Notes: NA
III. Effective Control tactics:	Mechanical ☒ Biological ☐ Chemical ☒ Times and uses: Physical: Control of garlic mustard whether they are small or large infestations requires a long term committment, the seeds of garlic mustard can remain viable in the soil for five years. New studies indicate that cut, flowering garlic mustard may form viable seed. In the case of small infestations plants can be hand removed but care must be taken to see that the entire root system is removed, best results are achieved when the soil is soft. For larger infestations of garlic mustard, or when hand-pulling is not practical, flowering stems can be cut at ground level or within several inches of the ground, to prevent seed production. If stems are cut too high, the plant may produce additional flowers at leaf

	axils. Once seedpods are present, but before the seeds have matured or scattered, the stalks can be clipped, bagged and removed from the site to help prevent continued buildup of seed stores. This can be done through much of the summer. (6) Repeated annual prescribed burns in fall or early spring will control this plant, while "flaming" individual plants with propane torches has also shown preliminary success (7). Chemical: Glyphosate controls A. petiolata well, but should be applied during the dormant season to avoid damaging native species. If applied after germination, glyphosate will significantly reduce seedling populations. Any herbs or graminoids that are green at the the time of application will be damaged. Bentazon appears suitable for use in many forest communities but should be tested further before widespread use. 2,4-D and Acifluorfen are not recommended for control of A. petiolata . (6)
IV. Minimum Effort:	Notes: Suggestions on handling the seed bank problem with garlic mustard include immediately catching new populations which may not have a seed bank as well as removal of the green reproductive stage in autumn and winter. (6) Effective management is long-term - at least 5 years (9).
V. Costs of Control:	Notes: NA
VI. Cost of prevention or control vs. Cost of allowing invasion to occur:	Notes: NA
VII. Non-Target Effects of Control:	Notes: NA
VIII. Efficacy of monitoring:	Notes: NA
IX. Legal and landowner issues:	Notes: NA

F. REFERENCES USED:

☒ UW Herbarium
☒ WI DNR
☒ TNC
☒ Native Plant Conservation Alliance
☒ IPANE
☒ USDA Plants

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