INDIANA

NON-NATIVE PLANT INVASIVENESS RANKING FORM

ASSESSMENT FOR INVASIVE PLANTS NOT IN TRADE

Form version date: November 1, 2010

Scientific name:	Alliaria petiolata	USDA Plants Code: ALPE4
Common names:	Garlic mustard	
Native distribution:	Throughout most of Europe	
Date assessed:	November 15, 2010; revised to include riparian forests July 2, 2013	
Assessors:	Ellen Jacquart	
Reviewers:	Stuart Orr, Brenda Howard, Ken Collins	
Date Approved:	July 2, 2013	

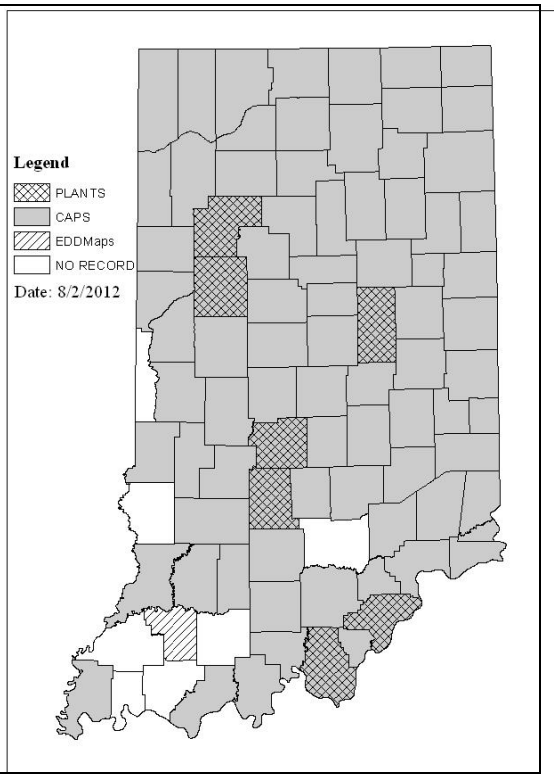
Indiana Invasiveness Rank: Very High (Relative Maximum Score >80.00)

Invasiveness Ranking Summary (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	40 (40)	37
2	Biological characteristic and dispersal ability	25 (25)	20
3	Ecological amplitude and distribution	25 (25)	24
4	Difficulty of control	10 (10)	6
	Outcome score	100 (100)[b]	87[a]
	Relative maximum score †		87.0
	Indiana Invasiveness Rank §	Very High (Relative Maximum Score >80.00)	

* For questions answered "unknown" do not include point value in "Total Answered Points Possible." If "Total Answered Points Possible" is less than 70.00 points, then the overall invasive rank should be listed as "Unknown."
†Calculated as 100(a/b) to two decimal places.
§Very High >80.00; High 70.00−80.00; Moderate 50.00−69.99; Low 40.00−49.99; Insignificant <40.00

A. DISTRIBUTION (KNOWN/POTENTIAL):

A1.1. Has this species been documented to persist without cultivation in IN? (reliable source; voucher not required)	
☒	**Yes – continue to A2.2**
☐	No – continue to A2.1
A2.1. What is the likelihood that this species will occur and persist outside of cultivation given the climate in Indiana? (obtain from occurrence data in other states with similar climates)	
☐	Likely – continue to A2.2
☐	Not likely



Documentation:
Sources of information: Range maps compiled from PLANTS database, http://plants.usda.gov/java/; Indiana CAPS database, http://extension.entm.purdue.edu/CAPS/index.html; Indiana IPSAWG reports (unpublished); and EDDMapS reports, http://eddmaps.org/
A1.1 CAPS map, 2007
A2.1 N/A

If the species does not occur and is not likely to occur in Indiana, then stop here as there is no need to assess the species.

A2.2. Describe the potential or known suitable habitats within Indiana (underlined). Natural habitats include all habitats not under active human management. Managed habitats are indicated with an asterisk.

Aquatic Habitats	**Wetland Habitats**	**Upland Habitats**
Rivers/streams	Marshes	**Forest**
Natural lakes and ponds	**Fens**	**Savannas**
Reservoirs/impoundments*	Bogs	Barrens
	Shrub swamps	Prairies
	Forested wetlands/riparian	**Cultivated***
	Beaches/dunes	**Old Fields***
	Ditches*	**Roadsides***

Other potential or known suitable habitats within Indiana:
No additional habitats.

Documentation:
Sources of information:
Author's personal observations.

B. INVASIVENESS RANKING

1. ECOLOGICAL IMPACT

1.1. Impact on Natural Ecosystem Processes and System-Wide Parameters (e.g. fire regime, geomorphological changes (erosion, sedimentation rates), hydrologic regime, nutrient and mineral dynamics, light availability, salinity, pH)

A.	No perceivable impact on ecosystem processes based on research studies, or the absence of impact information if a species is widespread (>10 occurrences in minimally managed areas), has been well-studied (>10 reports/publications), and has been present in the northeast for >100 years.	0
B.	Influences ecosystem processes to a minor degree (e.g., has a perceivable but mild influence on soil nutrient availability)	3
C.	Significant alteration of ecosystem processes (e.g., increases sedimentation rates along streams or coastlines, reduces open water that are important to waterfowl)	7
D.	Major, possibly irreversible, alteration or disruption of ecosystem processes (e.g., the species alters geomorphology and/or hydrology, affects fire frequency, alters soil pH, or fixes substantial levels of nitrogen in the soil making soil unlikely to support certain native plants or more likely to favor non-native species)	10
U.	Unknown	

Score 10

Documentation:
Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)

Produces large quantities of secondary compounds, including glucosinalates and cyanide, some of which end up in the soil where they affect the mineral dynamics and nutrient availability in ways that negatively impact the growth of many native plant species (Prati & Bossdorf, 1994; Stinson et al., 2006; Cippolini & Gruner, 2007; Rodgers et al., 2008). Large stands also reduce light availability in Spring for species growing on forest floor (Meekins & McCarthy, 1999; author's personal observations).
Sources of information:
Meekins & McCarthy, 1999; Prati & Bossdorf, 1994; Rodgers et al., 2008; author's personal observations.

1.2. Impact on Natural Community Structure

A.	No perceived impact; establishes in an existing layer without influencing its structure	0
B.	Influences structure in one layer (e.g., changes the density of one layer)	3
C.	Significant impact in at least one layer (e.g., creation of a new layer or elimination of an existing layer)	7
D.	Major alteration of structure (e.g., covers canopy, eradicating most or all layers below)	10
U.	Unknown	

Score 7

Documentation:
Identify type of impact or alteration:
Significantly impacts the density of the herb layer; dense infestations may create an herb layer in areas where other herbaceous plants were absent. Suppresses growth of seedlings of sugar maple, red maple and white ash, possibly leading to altered tree canopy with time (Stinson et al., 2006).
Sources of information:
Meekins & McCarthy, 2001, Nuzzo, 1999; Nuzzo, 2000; Fellows, 2006; Stinson et al., 2006.

1.3. Impact on Natural Community Composition

A.	No perceived impact; causes no apparent change in native populations	0
B.	Influences community composition (e.g., reduces the number of individuals in one or more native species in the community)	3
C.	Significantly alters community composition (e.g., produces a significant reduction in the population size of one or more native species in the community)	7
D.	Causes major alteration in community composition (e.g., results in the extirpation of one or several native species, reducing biodiversity or change the community composition towards species exotic to the natural community)	10
U.	Unknown	

Score 10

Documentation:
Identify type of impact or alteration:
Dramatically outcompetes native herb species, especially early in the season. Also inhibits the seed germination of many native species (Prati & Bosdorf, 2004; Stinson et al., 2006). Suppresses the growth of seedlings of sugar maple, red maple and white ash (Stinson et al. 2006). Not browsed by deer or other herbivores (including insects), which places further browsing stress on native species (Szentesi, 1991; Nuzzo, 2000; Blossey et al., 2001; Renwick et al., 2001; Williams and Ward, 2006; Eschtruth and Battles 2008).
Sources of information:
Nuzzo, 1999, 2000; Prati & Bosdorf, 2004; Fellows, 2006; Stinson et al., 2006.

1.4. Impact on other species or species groups (cumulative impact of this species on the animals, fungi, microbes, and other organisms in the community it invades. Examples include reduction in nesting/foraging sites; reduction in habitat connectivity; injurious components such as spines, thorns, burrs, toxins; suppresses

soil/sediment microflora; interferes with native pollinators and/or pollination of a native species; hybridizes with a native species; hosts a non-native disease which impacts a native species)

A.	Negligible perceived impact	0
B.	Minor impact	3
C.	Moderate impact	7
D.	Severe impact on other species or species groups	10
U.	Unknown	

Score 10

Documentation:
Identify type of impact or alteration:
Leaching of garlic mustard's secondary compounds dramtically impacts growth of mycorhizae and other microbes in the soil (Blossey et al., 2001; Prati & Bosdorf, 2004; Stinson et al., 2006; Rodgers et al. 2008. Also there is preliminary evidence that the presence of garlic mustard is decreasing the abundance of the native West Virginia White butterfly Pieris virginiensis (Porter 1994; Courant et al. 1994) and the white mustard butterfly (Pieris napi oleracea) (Renwick et al., 2001; Rodgers et al., 2008).
Sources of information:
Blossey et al. 2001; Prati & Bosdorf, 2004; Stinson et al., 2006; Rodgers et al., 2008.

Total Possible 40
Section One Total 37

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

2.1. Mode and rate of reproduction (provisional thresholds, more investigation needed)

A.	No reproduction by seeds or vegetative propagules (i.e. plant sterile with no sexual or asexual reproduction).	0
B.	Limited reproduction (fewer than 10 viable seeds per plant AND no vegetative reproduction; if viability is not known, then maximum seed production is less than 100 seeds per plant and no vegetative reproduction)	1
C.	Moderate reproduction (fewer than 100 viable seeds per plant - if viability is not known, then maximum seed production is less than 1000 seeds per plant - OR limited successful vegetative spread documented)	2
D.	Abundant reproduction with vegetative asexual spread documented as one of the plants prime reproductive means OR more than 100 viable seeds per plant (if viability is not known, then maximum seed production reported to be greater than 1000 seeds per plant.)	4
U.	Unknown	

Score 4

Documentation:
Describe key reproductive characteristics (including seeds per plant):
Larger plants can produce over 1000 (up to 7900 per plant) seeds per plant with germinations rates between 12% and 100%.
Sources of information:
Cavers et al., 1979; Byers & Quinn, 1988; 1988; Baskin & Baskin, 1992.

2.2. Innate potential for long-distance dispersal (e.g. bird dispersal, sticks to animal hair, buoyant fruits, pappus for wind-dispersal)

A.	Does not occur (no long-distance dispersal mechanisms)	0
B.	Infrequent or inefficient long-distance dispersal (occurs occasionally despite lack of adaptations)	1
C.	Moderate opportunities for long-distance dispersal (adaptations exist for long-distance dispersal, but studies report that 95% of seeds land within 100 meters of the parent plant)	2

D. Numerous opportunities for long-distance dispersal (adaptations exist for long-distance dispersal and evidence that many seeds disperse greater than 100 meters from the parent plant) 4

U. Unknown

Score 4

Documentation:
Identify dispersal mechanisms:
Seeds generally fall within 100 m. of parent plant but there are numerous opportunities for long distance dispersal of these small seeds by water and animals (Lhotska, 1975; Cavers et al., 1979; Nuzzo, 1999, 2000).
Sources of information:
Lhotska, 1975; Cavers et al., 1979; Nuzzo, 1999, 2000; A. Entrup, Dwight Andrews, pers. obs..

2.3. Potential to be spread by human activities (both directly and indirectly – possible mechanisms include: commercial sales, use as forage/revegetation, spread along highways, transport on boats, contaminated compost, land and vegetation management equipment such as mowers and excavators, etc.)

A. Does not occur 0

B. Low (human dispersal to new areas occurs almost exclusively by direct means and is infrequent or inefficient) 1

C. Moderate (human dispersal to new areas occurs by direct and indirect means to a moderate extent) 2

D. High (opportunities for human dispersal to new areas by direct and indirect means are numerous, frequent, and successful) 3

U. Unknown

Score 3

Documentation:
Identify dispersal mechanisms:
Seeds are widely dispersed indirectly by humans through clothing and directly by soil transport, yard waste, earth moving machinery, and snow plows.
Sources of information:
Cavers et al., 1979; Nuzzo, 1999; Nuzzo, 2000; Fellows, 2006.

2.4. Characteristics that increase competitive advantage, such as shade tolerance, ability to grow on infertile soils, perennial habit, fast growth, nitrogen fixation, allelopathy, etc.

A. Possesses no characteristics that increase competitive advantage 0

B. Possesses one characteristic that increases competitive advantage 3

C. Possesses two or more characteristics that increase competitive advantage 6

U. Unknown

Score 6

Documentation:
Evidence of competitive ability:
Shade tolerance; infertile soils, allelopathy; low palatability to white tailed deer.
Sources of information:
Cavers et al., 1979; Fellows, 2006; Eschtruth and Battles, 2008; author's personal observations..

2.5. Growth vigor

A. Does not form thickets or have a climbing or smothering growth habit 0

B. Has climbing or smothering growth habit, forms a dense layer above shorter vegetation, 2

forms dense thickets, or forms a dense floating mat in aquatic systems where it smothers other vegetation or organisms

U. Unknown

Score 0

Documentation:
Describe growth form:
Does not form thickets or a smothering growth habit.
Sources of information:
Cavers et al., 1979; Fellows, 2006; author's personal observations.

2.6. Germination/Regeneration

A. Requires open soil or water and disturbance for seed germination, or regeneration from vegetative propagules. 0
B. Can germinate/regenerate in vegetated areas but in a narrow range or in special conditions 2
C. Can germinate/regenerate in existing vegetation in a wide range of conditions 3
U. Unknown (No studies have been completed)

Score 3

Documentation:
Describe germination requirements:
Germinates in existing vegetation in a wide variety of conditions.
Sources of information:
Roberts & Boddrell, 1983; Baskin & Baskin 1992; author's personal observations.

2.7. Other species in the genus invasive in Indiana or elsewhere

A. No 0
B. Yes 3
U. Unknown

Score 0

Documentation:
Species:
Weldy & Werier, 2005; Brooklyn Botanic Garden, 2008

Total Possible 25
Section Two Total 20

3. ECOLOGICAL AMPLITUDE AND DISTRIBUTION

3.1. Density of stands in natural areas in the northeastern USA and eastern Canada (use same definition as Gleason & Cronquist which is: "The part of the United States covered extends from the Atlantic Ocean west to the western boundaries of Minnesota, Iowa, northern Missouri, and southern Illinois, south to the southern boundaries of Virginia, Kentucky, and Illinois, and south to the Missouri River in Missouri. In Canada the area covered includes Nova Scotia, Prince Edward Island, New Brunswick, and parts of Quebec and Ontario lying south of the 47th parallel of latitude")

A. No large stands (no areas greater than 1/4 acre or 1000 square meters) 0
B. Large dense stands present in areas with numerous invasive species already present or disturbed landscapes 2
C. Large dense stands present in areas with few other invasive species present (i.e. ability to invade relatively pristine natural areas) 4
U. Unknown

Score 4

Documentation:
Identify reason for selection, or evidence of weedy history:
Large dense stands present with few to no other invasives present.
Sources of information:
Fellows, 2006; Rodgers et al, 2008; author's personal observations.

3.2. Number of habitats the species may invade

A.	Not known to invade any natural habitats given at A2.2	0
B.	Known to occur in two or more of the habitats given at A2.2, with at least one a natural habitat.	1
C.	Known to occur in three or more of the habitats given at A2.2, with at least two a natural habitat.	2
D.	Known to occur in four or more of the habitats given at A2.2, with at least three a natural habitat.	4
E.	Known to occur in more than four of the habitats given at A2.2, with at least four a natural habitat.	6
U.	Unknown	

Score 6

Documentation:
Identify type of habitats where it occurs and degree/type of impacts:
See A2.2.
Sources of information:
Cavers et al., 1979; Byers & Quinn, 1987; Nuzzo, 1992a, 1993a; Brooklyn Botanic Garden, 2008, CAPS.

3.3. Role of disturbance in establishment

A.	Requires anthropogenic disturbances to establish.	0
B.	May occasionally establish in undisturbed areas but can readily establish in areas with natural or anthropogenic disturbances.	2
C.	Can establish independent of any known natural or anthropogenic disturbances.	4
U.	Unknown	

Score 4

Documentation:
Identify type of disturbance:
Usually establishes in areas with anthropogenic disturbance but can establish in areas without any recent natural or anthropogenic disturbance.
Sources of information:
Nuzzo, 1999; Nuzzo, 2000, Fellows, 2006; author's personal observations; Jordan pers.obs. Cold Spring Harbor, NY.

3.4. Climate in native range

A.	Native range does not include climates similar to Indiana	0
B.	Native range possibly includes climates similar to at least part of Indiana	1
C.	Native range includes climates similar to those in Indiana	3
U.	Unknown	

Score 3

Documentation:
Describe what part of the native range is similar in climate to Indiana:
Europe.

Sources of information:
U.S.D.A., 2008; Brooklyn Botanic Garden, 2008

3.5. Current introduced distribution in the northeastern USA and eastern Canada (see question 3.1 for definition of geographic scope)

A.	Not known from the northeastern US and adjacent Canada	0
B.	Present as a non-native in one northeastern USA state and/or eastern Canadian province.	1
C.	Present as a non-native in 2 or 3 northeastern USA states and/or eastern Canadian provinces.	2
D.	Present as a non-native in 4–8 northeastern USA states and/or eastern Canadian provinces, and/or categorized as a problem weed (e.g., "Noxious" or "Invasive") in 1 northeastern state or eastern Canadian province.	3
E.	Present as a non-native in >8 northeastern USA states and/or eastern Canadian provinces. and/or categorized as a problem weed (e.g., "Noxious" or "Invasive") in 2 northeastern states or eastern Canadian provinces.	4
U.	Unknown	

Score: 4

Documentation:
Identify states and provinces invaded:
Present in all northeastern states in the U.S and all eastern Canadian provinces.
Sources of information:
See known introduced range in plants.usda.gov, and update with information from states and Canadian provinces.
U.S.D.A., 2008.

3.6. Current distribution of the species outside of cultivation in Indiana

A.	Present in no Indiana counties	0
B.	Present in 1-10 Indiana counties	1
C.	Present in 11-20 Indiana counties	2
D.	Present in 21-50 Indiana counties	3
E.	Present in more than 50 Indiana counties or on Federal noxious weed list	4
U.	Unknown	

Score: 4

Documentation:
Describe distribution:
Documented in 84 counties; see A1.1.
Sources of information:
CAPs map, 2007

Total Possible: 25
Section Three Total: 24

4. DIFFICULTY OF CONTROL

4.1. Seed banks

A.	Seeds (or vegetative propagules) remain viable in soil for less than 1 year, or does not make viable seeds or persistent propagules.	0
B.	Seeds (or vegetative propagules) remain viable in soil for at least 1 to 10 years	2
C.	Seeds (or vegetative propagules) remain viable in soil for more than 10 years	3

U. Unknown

Score 2

Documentation:
Identify longevity of seed bank:
Seeds remain viable for over 1 year; no evidence for 10 years.
Sources of information:
Byers & Quinn, 1998; Fellows, 2006

4.2. Vegetative regeneration

A. No regrowth following removal of aboveground growth 0
B. Regrowth from ground-level meristems 1
C. Regrowth from extensive underground system 2
D. Any plant part is a viable propagule 3
U. Unknown

Score 0

Documentation:
Describe vegetative response:
Biennial; no regrowth following removal of aboveground growth at proper time of year after flowering has begun.
Sources of information:
Byers & Quinn, 1998; Fellows, 2006; author's personal observations.

4.3. Level of effort required

A. Management is not required: e.g., species does not persist without repeated anthropogenic disturbance. 0
B. Management is relatively easy and inexpensive: e.g. 10 or fewer person-hours of manual effort (pulling, cutting and/or digging) can eradicate a 1 acre infestation in 1 year (infestation averages 50% cover or 1 plant/100 ft^2). 2
C. Management requires a major short-term investment: e.g. 100 or fewer person-hours/year of manual effort, or up to 10 person-hours/year using mechanical equipment (chain saws, mowers, etc.) for 2-5 years to suppress a 1 acre infestation. Eradication is difficult, but possible (infestation as above). 3
D. Management requires a major investment: e.g. more than 100 person-hours/year of manual effort, or more than 10 person hours/year using mechanical equipment, or the use of herbicide, grazing animals, fire, etc. for more than 5 years to suppress a 1 acre infestation. Eradication may be impossible (infestation as above). 4
U. Unknown

Score 4

Documentation:
Identify types of control methods and time-term required:
Hand pulling in light infestations, clipping close to the ground but must remove seed heads; herbicide can include Roundup. Very difficult to eradicate once established due to seed bank.
Sources of information:
Rowe & Swearingen, 1997; Nuzzo, 2000; Fellows, 2000; author's personal observations.

Total Possible	10
Section Four Total	6
Total for 4 sections Possible	100
Total for 4 sections	86

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Citation: This IN ranking form may be cited as: Jacquart, E.M. 2012. Invasiveness ranking system for non-native plants of Indiana. Unpublished. Invasive Plant Advisory Committee (IPAC) to the Indiana Invasive Species Council, Indianapolis, IN.

Acknowledgments: The IN form incorporates components and approaches used in several other systems, cited in the references below. The Invasive Plant Advisory Committee was created by the Indiana Invasive Species Council in October 2010, and is made up of the original members of the Indiana Invasive Plant Assessment Working Group (IPSAWG). Original members of IPSAWG included representatives of the The Nature Conservancy; Indiana Native Plant and Wildflower Society; Indiana Nursery and Landscape Association; Indiana Chapter of the American Society of Landscape Architects; Indiana Forage Council; Indiana Wildlife Federation; Indiana State Beekeepers Association; Indiana Beekeeper's Association; Department of Natural Resources; Hoosier National Forest; Indiana Academy of Science; Natural Resources Conservation Service; Indiana Department of Environmental Management;

Indiana Department of Transportation; Purdue Cooperative Extension Service; Seed Administrator, Office of the Indiana State Chemist.

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