INDIANA

NON-NATIVE PLANT INVASIVENESS RANKING FORM

DRAFT ASSESSMENT FOR INVASIVE PLANTS NOT IN TRADE

Form originally created for use in New York; Indiana Form version date: November 1, 2010

Scientific name:	*Perilla frutescens* USDA Plants Code: PEFR4
Common names:	Beefsteak plant, perilla mint, Chinese basil, purple mint, Perilla, rattlesnake weed, shiso
Native distribution:	Southeast Asia
Date assessed:	11/12/19
Assessors:	Will Drews
Reviewers:	Ellen Jacquart & IPAC
Date Approved:	12/6/19 & 12/9/2019

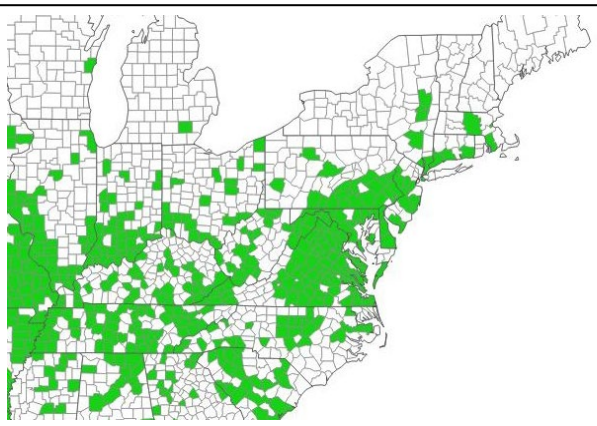
Indiana Invasiveness Rank: Medium

Invasiveness Ranking Summary (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	40 (30)	13
2	Biological characteristic and dispersal ability	25 (25)	16
3	Ecological amplitude and distribution	25 (25)	18
4	Difficulty of control	10 (10)	6
	Outcome score	100 (90)[b]	53[a]
	Relative maximum score †		58.89
	Indiana Invasiveness Rank §	Moderate	

* 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 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
A2What 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 A3
☐	Not likely – stop here. There is no need to assess the species



Documentation:
Sources of information:
EDDMapS (12/6/2019)

A3 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: Glades, Pasturelands*

Documentation:
Sources of information:
Hilty 2019; EDDMapS 12/6/2019)

B. INVASIVENESS RANKING
Questions apply to areas similar in climate and habitats to Indiana unless specified otherwise.

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: U

Documentation:
Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)
No existing research on this.

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: 3

Documentation:
Identify type of impact or alteration:
Forms dense stands along forest edges with higher stem densities than native vegetation
Sources of information:
Drews, personal observation

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: 3

Documentation:
Identify type of impact or alteration:
Forms dense stands along forest edges reducing abundance of native species.
Sources of information:
Drews, personal observation

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: 7

Documentation:
Identify type of impact or alteration:
Contains ‘the toxin "perilla ketone," which causes pulmonary edema (fluid in the lung cavity) in many animal species, although not in pigs or dogs’
“In Japan, 20 to 50% of long-term workers in the perilla industry develop dermatitis on their hands due to contact with perillaldehyde”
Contains 9 allelochemicals compounds (specifically phytotoxic volatile components) and inhibits seedling growth of crop species.
Sources of information:
Brenner 1993
Lim, S. et al. 1994

Total Possible	40
Section One Total	13

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

2.1. Mode and rate of reproduction

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):
Produces abundant amounts of seeds from 1,000 to 1,500 per plant
Sources of information:
Russell, D. and J. Byrd 2018

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:
Can be spread by heavy equipment, birds, or by water movement
Sources of information:
Russell and Byrd 2018

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: Introduced as a culinary crop and occasionally grown for a crop or ornamentally. Easily spreads by heavy equipment during ROW mowing or logging operations.

Sources of information:
Brenner 1993
Drews, personal observation

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 3

Documentation:
Evidence of competitive ability:
Allelopathy – contains 9 allelochemicals compounds (specifically phytotoxic volatile components) and inhibits seedling growth of crop species.
Sources of information:
Lim, S. et al. 1994

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, forms dense thickets, or forms a dense floating mat in aquatic systems where it smothers other vegetation or organisms 2
U. Unknown

Score 0

Documentation:
Describe growth form:

Sources of information:

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 2

Documentation:
Describe germination requirements:
Can germinate readily in disturbed, fertile soil but can germinate and compete with pasture species during periods with limited rainfall
Sources of information:
Russell and Byrd 2018

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

A. No 0

B. Yes 3
U. Unknown

Score 0

Documentation:
Species:

Total Possible 25
Section Two Total 16

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 2

Documentation:
Identify reason for selection, or evidence of weedy history: can form large dense stands along forest edges and trails, generally with other invasive species.

Sources of information:
Drews, personal observation

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 4

Documentation:
Identify type of habitats where it occurs and degree/type of impacts:
See A2.2.
Sources of information:
Hilty 2019, EDDMapS 12/2019), Drews, personal observation

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 2

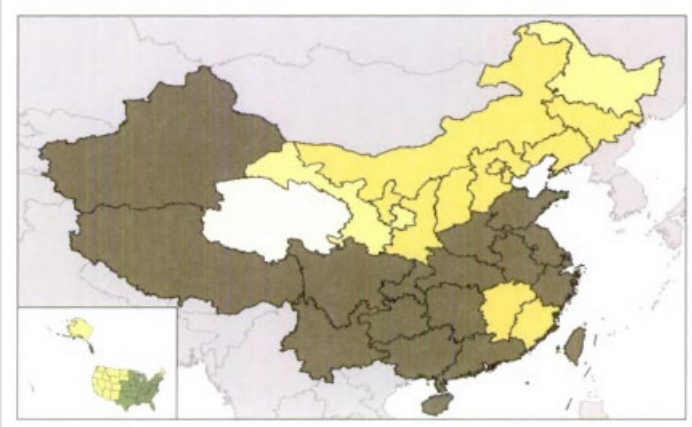
Documentation:
Identify type of disturbance:
In a silvicultural treatment study conducted in Missouri, Perilla established in the treatment plots (thinning and uneven aged mgmt.) as well as the control plots.
Sources of information:
Muzika and Farrington 2013

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:



Occurs in all of China, which shares the same climate zone as all of the E. United States, including Indiana.
Sources of information:
Zheng et al. 2004

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: MN, WI, IA, MO, KY, IL, IN, OH, WV, MD, PA, NY, MA, CT, NJ, DE, VA, etc.

Sources of information:
See known introduced range in plants.usda.gov, and update with information from states and Canadian provinces. See map in Section A above. From EDDMapS

3.6. Current introduced distribution of the species in natural areas 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 3

Documentation:
Describe distribution: Throughout southern Indiana and scattered counties in central and northern IN (36 total).

Sources of information: See map in Section A. From EDDMapS (2019)

Total Possible 25
Section Three Total 18

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: Lasts from 1 year up to 65%-70% germination rate after 5-8 years stored at 4 degrees C, about 0% germination after 9 years.

Sources of information:
Masumoto, N. and M. Ito. 2010

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 1

Documentation:
Describe vegetative response:
Can produce new shoots after being cut
Sources of information:
Drews, personal observation

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 3

Documentation:
Identify types of control methods and time-term required:
Mowing before flowering may reduce seed set and spread but will probably require spot treatments to control fully.
Herbicides such as glyphosate, 2,4-D, Forefront, Milestone, and Weedmaster have been shown to control Beefsteak Plant. Drews has observed areas treated early in the season often have new seedlings germinate later in the summer. So at least two rounds of treatment, whether both chemical or mowing + chemical, will be required
Sources of information:
Nice et al. 2010
Drews, personal observation

Total Possible	10
Section Four Total	6
Total for 4 sections Possible	90
Total for 4 sections	53

References for species assessment:

Brenner, D.M. 1993. Perilla: Botany, uses and genetic resources. *New Crops*. Wiley, NY. pp. 322-328.

EDDMapS. 2019. Early Detection & Distribution Mapping System. The University of Georgia - Center for Invasive Species and Ecosystem Health. Available online at http://www.eddmaps.org/; last accessed November 7, 2019.

Hilty, John. 2019. Beefsteak Plant. Illinois Wildflowers. Available online at http://www.illinoiswildflowers.info/weeds/plants/beefsteak.htm; last accessed November 7, 2019.

Lim, S. et al. 1994. Isolation of Volatile Allelochemicals from Leaves of Perilla frutescens and Artemisia asiatica. *Applied Biological Chemistry* 37(2): 115-123.

Masumoto, N. and M. Ito. 2010. Germination rates of perilla (*Perilla frutescens* (L.) Britton) mericarps stored at 4° C for 1–20 years. *Journal of Natural Medicines* 64(3): 378-382.

Muzika, R.M. and S.J. Farrington. 2013. Effects of silvicultural practices on invasive plant species abundance in the Missouri Ozark forests of the central United States. *Invasive Plant Ecology*. Taylor & Francis Group, LLC. pp. 113-120.

Nice, G.R.W. et al. 2010. Weed Management in Pastures: Beefsteak Plant (Perilla Mint). Purdue Extension. WS-43-W.

Russell, D. and J. Byrd. 2018. Perilla Mint (*Perilla frutescens*). Mississippi State University Extension. Available online at https://extension.msstate.edu/sites/default/files/publications/information-sheets/is2018.pdf; last accessed November 12, 2019.

Zheng, H. et al. 2004 *Invasive Plants of Asian Origin Established in the United States and Their Natural Enemies*. Vol. 1. pp. 129-130.

Citation: This IN ranking form may be cited as: Jacquart, E.M. and P.M.Paulone. 2011. 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 ranking form is an adaptation for Indiana use of the form created for New York by Jordan et al. (2009), cited below. Documentation for species assessed for New York are used for Indiana where they are applicable. 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.

References for the Indiana ranking form:

Jordan, M.J., G. Moore, and T.W. Weldy. 2009. Invasiveness ranking system for non-native plants of New York. Unpublished. The Nature Conservancy, Cold Spring Harbor, NY; Brooklyn Botanic Garden, Brooklyn, NY; The Nature Conservancy, Albany, NY.

References for the New York ranking form:

Carlson, Matthew L., Irina V. Lapina, Michael Shephard, Jeffery S. Conn, Roseann Densmore, Page Spencer, Jeff Heys, Julie Riley, Jamie Nielsen. 2008. Invasiveness ranking system for non-native plants of Alaska. Technical Paper R10-TPXX, USDA Forest Service, Alaska Region, Anchorage, AK XX9. Alaska Weed Ranking Project may be viewed at: http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm.

Heffernan, K.E., P.P. Coulling, J.F. Townsend, and C.J. Hutto. 2001. Ranking Invasive Exotic Plant Species in Virginia. Natural Heritage Technical Report 01-13. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. 27 pp. plus appendices (total 149 p.).

Morse, L.E., J.M. Randall, N. Benton, R. Hiebert, and S. Lu. 2004. An Invasive Species Assessment Protocol: Evaluating Non-Native Plants for Their Impact on Biodiversity. Version 1. NatureServe, Arlington, Virginia. http://www.natureserve.org/getData/plantData.jsp

Randall, J.M., L.E. Morse, N. Benton, R. Hiebert, S. Lu, and T. Killeffer. 2008. The Invasive Species Assessment Protocol: A Tool for Creating Regional and National Lists of Invasive Nonnative Plants that Negatively Impact Biodiversity. Invasive Plant Science and Management 1:36–49

Warner, Peter J., Carla C. Bossard, Matthew L. Brooks, Joseph M. DiTomaso, John A. Hall, Ann M.Howald, Douglas W. Johnson, John M. Randall, Cynthia L. Roye, Maria M. Ryan, and Alison E. Stanton. 2003. Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands. Available online at www.caleppc.org and www.swvma.org. California Exotic Pest Plant Council and Southwest Vegetation Management Association. 24 pp.

Williams, P. A., and M. Newfield. 2002. A weed risk assessment system for new conservation weeds in New Zealand. Science for Conservation 209. New Zealand Department of Conservation. 1-23 pp.