

INDIANA

NON-NATIVE PLANT INVASIVENESS RANKING FORM

ASSESSMENT FOR INVASIVE PLANTS NOT IN TRADE
Form originally created for use in New York. Indiana Form version date: November 1, 2010

Scientific name: Galega officinalis USDA Plants Code: GAOF
 Common names: Professor-weed, common milkpea, goat's-rue
 Native distribution: North Africa, Middle East, and Europe
 Date assessed: July 15, 2012
 Assessors: Pia Marie Paulone and Ellen Jacquart
 Reviewers: Larry Bledsoe
 Date Approved: September 21, 2012

Indiana Invasiveness Rank: Moderate (Relative Maximum Score 50.00-69.99)

Invasiveness Ranking Summary (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	40 (20)	6
2	Biological characteristic and dispersal ability	25 (25)	17
3	Ecological amplitude and distribution	25 (21)	13
4	Difficulty of control	10 (6)	4
	Outcome score	100 (72) ^b	40 ^a
	Relative maximum score [†]		55.55
	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)

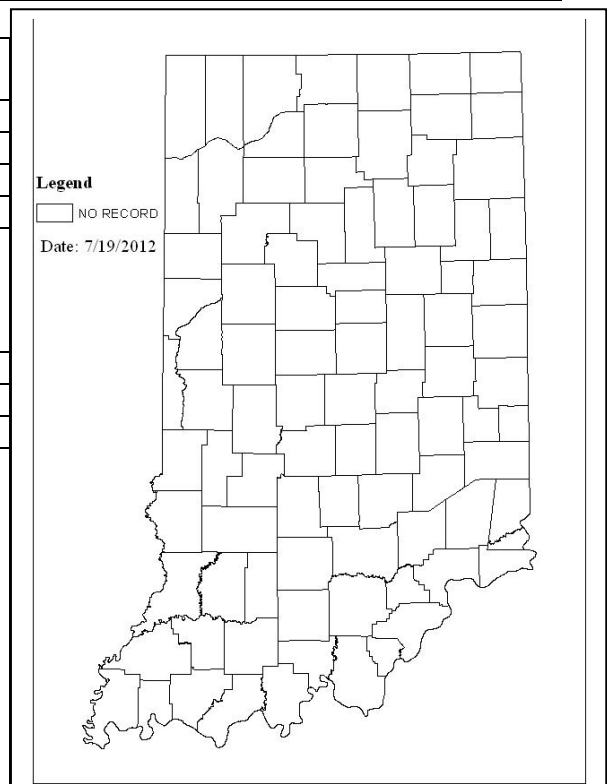
Yes – continue to A2.2

No – continue to A2.1

A2. 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 A3

Not likely



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Documentation: Based on biological characteristics and known range in U.S.
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; Indiana IPSAWG reports (unpublished); and EDDMapS reports, 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/>

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.

<p>Aquatic Habitats</p> <p>Rivers/streams Natural lakes and ponds Reservoirs/impoundments*</p>	<p>Wetland Habitats</p> <p><u>Marshes</u> Fens Bogs Shrub swamps <u>Forested wetlands/riparian</u> Beaches/dunes <u>Ditches*</u></p>	<p>Upland Habitats</p> <p>Forest Savannas Barrens <u>Prairies</u> <u>Cultivated*</u> <u>Old Fields*</u> <u>Roadsides*</u></p>
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Other potential or known suitable habitats within Indiana:
No additional habitats.

Documentation:
Sources of information:
Gravuer, 2006; King [Washington] County Noxious Weed Program, 2007; Brooklyn Botanic Garden, 2008.

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)
Studies on natural ecosystem processes and system wide parameters not known.
Sources of information:
Gravuer, 2006.

1.2. Impact on Natural Community Structure

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- 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

Documentation:

Identify type of impact or alteration:

Can form dense stands increasing the density of the herbaceous layer.

Sources of information:

Gravuer, 2006; King [Washington] County Noxious Weed Program, 2007.

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

Documentation:

Identify type of impact or alteration:

Can form dense stands in wetlands and other habitats thus reducing the number of individuals of native species in these areas. No evidence of significant alteration.

Sources of information:

Gravuer, 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

Documentation:

Identify type of impact or alteration:

Known to be poisonous to livestock but apparently native wildlife, such as deer, avoid it.

More studies needed, though.

Sources of information:

Klugh, 1998; Gravuer, 2006.

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Total Possible	20
Section One Total	6

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 1-9 seeds per pod, and each plant can produce 15,000 pods per plant or more.
Sources of information:
Gravuer, 2006; King [Washington] County Noxious Weed Program, 2007; Evans, 1982

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 2

Documentation:

Identify dispersal mechanisms:
Apparently, the pods of the plant are buoyant for a short time (Gravuer 2006) then become saturated (Klugh 1998), thus providing moderate opportunities for long distance dispersal.
Sources of information:
Klugh, 1998; Gravuer, 2006.

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

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

Score

Documentation:

Identify dispersal mechanisms:

Occasionally available as a horticultural plant, but not widely planted. No known means of indirect human transport.

Sources of information:

Gravuer, 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

Documentation:

Evidence of competitive ability:

Prefers full sun, but can tolerate shade; perennial.

Sources of information:

Gravuer, 2006; King [Washington] County Noxious Weed Program, 2007.

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

Documentation:

Describe growth form:

Grauver (2006) reports it as being able to form dense herbaceous thickets.

Sources of information:

Grauver, 2006.

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

Documentation:

Describe germination requirements:

Seeds can be sown outdoors in situ (Plants for a Future 2008), Morris Arboretum infestation started from neighbor throwing seed into meadow (Stokes 1964). Germination is inversely related to burial depth (Oldham & Ransom 2008).

Sources of information:

Plants for a Future, 2008; Stokes, 1964, Oldham & Ransom, 2008.

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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	17

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 U

Documentation:
Identify reason for selection, or evidence of weedy history:
Fairly large stand at Morris Arboretum (Klugh 1998, Stokes 1964). Recent collection in Bronx, NY. No hard data on size of populations. Grauver (2006): "The largest infestation is in Cache County, UT [38,000 acres]; other establishment sites include King County, WA and a few scattered counties in PA and NY. A few collections have also been made from ME, MA, CT, MD, NE, and CO, but there is doubt that these populations persist."
Sources of information:
Stokes, 1968; Klugh, 1998; Gravuer, 2006; Weldy & Werier, 2008.

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

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U. Unknown

Score

Documentation:

Identify type of habitats where it occurs and degree/type of impacts:
See A2.2.
Sources of information:

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

Documentation:

Identify type of disturbance:
Usually establishes in disturbed areas but also reported to establish in areas lacking recent disturbance.
Sources of information:
Stokes, 1964.

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

Documentation:

Describe what part of the native range is similar in climate to Indiana:
Native to north Africa, Middle East and Europe as far north as Poland and France.
Sources of information:
GRIN 2008; 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
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Documentation:

Identify states and provinces invaded:
ON, ME, MA, CT, NY, PA, MD, NE, WA, and Washington, DC. Oldham, 2008.

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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 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

Documentation:
Describe distribution:
See A1.1.
Sources of information:

Total Possible	21
Section Three Total	13

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

Documentation:
Identify longevity of seed bank:
Seeds remain viable for 5-10 years (Gravuer 2006). Seed germination is reduced but still viable after 26 years (Oldham & Ransom 2008)
Sources of information:
Gravuer, 2006; Oldham & Ransom, 2008.

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

Documentation:
Describe vegetative response:
Reprouts from a dense crown.

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Sources of information:
 Gravuer, 2006; Oldham, 2008.

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 ft²). 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

U

Documentation:

Identify types of control methods and time-term required:
 Local populations have not been large and management has not been needed. However, the species unlike others (e.g., *Spiraea japonica*, *Tanacetum vulgare*) does not have a long history of establishment in the state. In other parts of the U.S. entrenched populations are very difficult to control but caught early chemicals can be used. Grauver (2006): "less-entrenched infestations, good control has been achieved in as little as 2 years using the herbicides dicamba, 2,4-D, or their combination (Evans 1996)." Wetland habitats complicate removal of plant.
 Sources of information:
 Evans, 1996; Grauver, 2006.

Total Possible	6
Section Four Total	4

Total for 4 sections Possible	72
Total for 4 sections	39

References for species assessment:

Brooklyn Botanic Garden. 2008. AILANTHUS database. [Accessed Oct. 30, 2008].

Clemants, S. & G. Moore. 2008. Invasiveness ranking system for non-native plants of New York: *Galega officinalis*. Unpublished. The Nature Conservancy, Cold Spring Harbor, NY; Brooklyn Botanic Garden, Brooklyn, NY; The Nature Conservancy, Albany, NY.

Evans, J.O. 1996. GOATSRUE (*Galega officinalis*). Utah Agricultural Experiment Station Research Report 79.

Gravuer, K. 2006. *Galega officinalis*. U.S. Invasive Species Impact Rank (I-Rank). NatureServe Explorer. <www.natureserve.org>. [Accessed Oct. 30, 2008].

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Klugh, K. 1998. Goatsrue, *Galega officinalis*, in Pennsylvania. Regulatory Horticulture 24(2): 25-28. Weed Circular No. 22, Pennsylvania Department of Agriculture, Bureau of Plant Industry. <http://www.invasive.org/eastern/other/vol24_10.pdf>.

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United States Department of Agriculture, National Resources Conservation Service. 2008. The PLANTS Database. National Plant Data Center, Baton Rouge, Louisiana. <plants.usda.gov>. [Accessed Oct. 30, 2008].

Weldy, T. and D. Werier. 2005. New York Flora Atlas. [S.M. Landry, K.N. Campbell, and L.D. Mabe (original application development), Florida Center for Community Design and Research. University of South Florida]. New York Flora Association, Albany, New York. <atlas.nyflora.org>.

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 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:

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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

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