INDIANA
NON-NATIVE PLANT INVASIVENESS RANKING FORM
ASSESSMENT FOR INVASIVE PLANTS NOT IN TRADE
Form version date: March 3, 2009

Scientific name:	Centaurea stoebe ssp. micranthos s.l. (including C. biebersteinii, C. diffusa, C. maculosa misapplied, C. xpsammogena)USDA Plants Code: CESTM, CEDI3, CEPS
Common names:	Spotted knapweed, spotted star-thistle
Native distribution:	Southeastern Europe
Date assessed:	July 16, 2012
Assessors:	Ellen Jacquart, Alison Clements
Reviewers:	Stuart Orr
Date Approved:	September 21, 2012

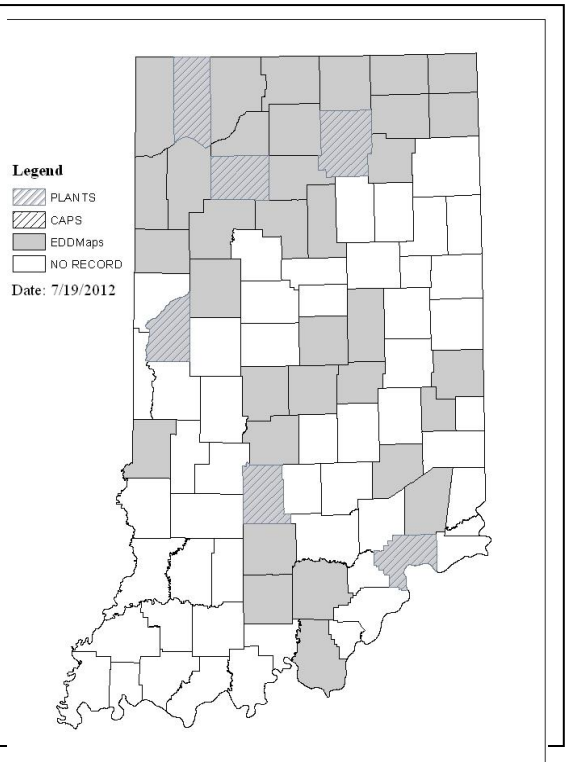
Indiana Invasiveness Rank: High (Relative Maximum Score 70.00-80.00)

Invasiveness Ranking Summary (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	40 (37)	28
2	Biological characteristic and dispersal ability	25 (25)	19
3	Ecological amplitude and distribution	25 (25)	22
4	Difficulty of control	10 (10)	8
	Outcome score	100 (97)[b]	77[a]
	Relative maximum score †		79.38
	Indiana Invasiveness Rank §	High (Relative Maximum Score 70.00-80.00)	

* 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): Summarized from individual PRISM forms

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Indiana CAPS database, http://extension.entm.purdue.edu/CAPS/index.html; Indiana IPSAWG reports (unpublished); and EDDMapS reports, http://eddmaps.org/
The taxonomy here and nomenclature of this group is most difficult. Keil & Ochsmann (2006) note that the material introduced in the U.S. is the C.stoebe subsp micranthos, which is a tetraploid perennial that is distinct from the diploid biennials (C. stoebe subsp. stoebe, C. maculosa, C. rhenana) found in Europe. They also note that another closely related species, C. diffusa, has been reported from the Northeast (e.g., CT, MA, NJ) and that it hybridizes with C. stoebe subsp. micranthos producing C. xpsammogena. More collection and study is needed to determine if the material in New York is straight C. stoebe subsp. stoebe or a mixture of this C. diffusa and the hybrid, C. xpsammogena. Should also confirm that the diploid taxa reported from Europe are not present. Preliminary review of the material in this complex from New York shows it to be quite diverse morphologically. Keil & Ochsmann, 2006; Brooklyn Botanic Garden, 2009; Weldy & Werier, 2009.

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:

Documentation:
Sources of information:
Keil & Ochsmann, 2006; Brooklyn Botanic Garden, 2009.

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 7

Documentation:
Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)
Oliver (2004): "This species easily extracts moisture and nutrients from the soil, and is better adapted than the native species inhabiting the area, of extracting nutrients. As this species invades, it alters the ecology of the ecosystem. Specifically, native species in areas where this non-native occurs tend to have network root systems and as the native species decline, their network root systems are replaced by the knapweed's taproot system. This taproot system alters the soil by lowering its water holding capability and increasing soil erosion (Maurer et al., 2002)." No evidence of major irreversible impacts to natural ecosystem processes or system-wide parameters. The spotted knapweed has also been reported to be allelopathic, secreting phyotoxins (catechin) that inhibits growth of other plant species (Calloway et al., 2005a, Calloway et al., 2005b; Perry et al., 2005).
Sources of information:
Oliver, 2004; Maurer et al., 2002; Calloway, 2005.

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:
Species can significantly impacts the herb layer by increasing its height and density. this species often occurs in areas (open dry sandy areas) where the herb layer is low and/or sparse.
Sources of information:
Oliver, 2004; Maurer et al., 2002..

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 7

Documentation:
Identify type of impact or alteration:
Causes significant reduction in native species. Oliver (2004): "Once established in undisturbed areas, it displaces native species by altering the soil's water storage capacity and

increasing erosion (Maurer et al. 2002). It's able to alter the soil in this way because of its taproot system which is better at extracting soil than the root systems of native plants (Maurer et al. 2002)." No evidence of major alteration in community composition.
Sources of information:
Mauer et al., 2002; Oliver, 2004.

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:
Studies on species' impacts on other species not known. Presumably the phytotoxin production impacts the soil microflora but specific studies on this not done. It has been noted to reduce the amount of Lupinus perennis in Karner Blue butterfly habitat in Michigan oak-pine barrens and prairies; reported by Michigan TNC staff and personal observation by Orr.
Sources of information:
Oliver, 2004.

Total Possible: 37
Section One Total: 28

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):
Plants can produce up to 600 seeds or more with high viability; plants are self-compatible.
Sources of information:

Mauer et al, 2002; Wilson & Randall 2003; Oliver, 2004..

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:
Achenes are small, and long distance dispersal can either be passive (wind) or active (birds, rodents).
Sources of information:
Mauer et al., 2002; Oliver, 2004.

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:
Readily spread via vehicles and contaminated seed and hay supplies.
Sources of information:
Mauer, 2004; Oliver 2004.

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:
Perennial, able to grow on poor soils, allelopathic.
Sources of information:

Calloway et al, 2005a; Calloway et al., 2005b, Keil & Ochsman, 2005; Perry et al., 2005.

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 2

Documentation:
Describe growth form:
Readily forms a dense layer above shorter vegetation, especially on low nutrient soils that generally support a low, sparse herb layer of native plant species.
Sources of information:
Mauer, 2002; Oliver, 2004..

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:
Will germinate in existing vegetation, but the phytotoxin catechin produced by the plant inhibits germination of its own seeds. The seeds will thus germinate in areas that lack mature plants.
Sources of information:
Calloway et al, 2005a; Calloway et al., 2005b, Keil & Ochsman, 2005; Perry et al., 2005.

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

A. No 0
B. Yes 3
U. Unknown

Score 0

Documentation:
Species:
Centaurea benedicta, C. calcitrapa, C. cyanus, C. diluta, C. jacea s.l., C. melitensis, C. montana, C. phrygia, C. scabiosa, C. solstitialis. Centaurea iberica, C. macrocephala, C. sulphurea and C. virgata (none reported from eastern U.S.) and C. calcitrapa, C. jacea s.l., C. melitensis, and C. solstitialis (reported from eastern U.S., including N.Y.) are considered to be noxious weeds in various western states. Keil & Ochsmann, 2006; U.S.D.A., 2009.

Total Possible 25
Section Two Total 19

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 stands can occur in areas with few other invasive species already present.
Sources of information:
Authors' pers. obs.

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:
Keil & Ochsmann, 2006; Brooklyn Botanic Garden, 2009.

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:
Readily establishes in disturbed areas; does not require anthropogenic disturbance to become established.
Sources of information:
Keil & Ochsmann, 2006; Brooklyn Botanic Garden, 2009.

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:
Keil & Ochsmann, 2006; Brooklyn Botanic Garden, 2009.

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:
All northeastern states and provinces.
Sources of information: See known introduced range in plants.usda.gov, and update with information from states and Canadian provinces.
Keil & Ochsmann, 2006; Brooklyn Botanic Garden, 2009; U.S.D.A., 2009.

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 3

Documentation:
Describe distribution:
Documented in 84 counties; see A1.1.
Sources of information:
Weldy & Werier, 2009; Brooklyn Botanic Garden, 2009.

Total Possible	25
Section Three Total	22

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 up to eight years. No evidence for more than 10 years.
Sources of information:
Mauer et al, 2002; Oliver, 2004.

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 2

Documentation:
Describe vegetative response:
Regrowth from extensive underground root system.
Sources of information:
Mauer et al., 2002, Oliver 2004.

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:
Oliver (2004): "This species is moderately difficult to control. There are several methods that are somewhat effective. Mowing if done 10 days after flowering reduces the seed output, but doesn't eradicate populations. Herbicides are also effective, however, they don't prevent germination or reinfestation and can be expensive over large areas. Several biological control methods are available, including insects which either attack the flowers by laying eggs in them or eating the plant's roots. Biological control using insects does reduce populations, is inexpensive, and doesn't disturb the soil or surrounding

vegetation, however, this method is slower than the others (Mauer et al. 2002)." The inhibition of seed germination by the phytoxin catechin allows the seed bank to remain intact until needed (i.e., when mature plants are removed).
Sources of information:
Mauer, 2002; Oliver, 2004; Calloway et al., 2005a; Calloway et al., 2005b; Perry et al., 2005. .

Total Possible	10
Section Four Total	8
Total for 4 sections Possible	90
Total for 4 sections	70

References for species assessment:

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Calloway, R. M., H.P. Bias, T. L. Wier, L. Perry, W. M. Ridenour, J. M. Vivanco. 2005. Allelopathy and exotic plant invasion: from genes to communities: synopsis,updates, and implications. Pp. 33-38 in Proceedings of the 4th World 38 Congress on Allelopathy (J.D.I. Harper, M. An, H. Wu, J.H. Kent, eds.) August 2005, Wagga Wagga, Australia.

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Wilson, L. M. and C. B. Randall. 2003. Biology and Biological Control of Knapweed. USDA-Forest Service Forest Health Technology Enterprise Team (FHTET)-2001-07. 2nd Edition.<invasive.org/weeds/knapweed/chapter1.html>. [Accessed April 6, 2009.]

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.

References for 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.

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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

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