NAME OF SPECIES: *Phalaris arundinacea* L.		
Synonyms: Over 22 synonyms including: *Phalaroides arundinacea* (L.) Raeusch.; *P. arundinacea* var. *picta* L.; *P. arundinacea* forma *variegata*; *Phalaroides arundinacea* (L.) Raeusch. var. *picta* (L.) Tzvelev (sterile ornamental variety) (1)(2)		
Common Name: Reed canarygrass, reed canary grass, ribbon grass, gardener's gaiters (1) (2).	**Cultivars?** YES ☒ NO ☐	
A. CURRENT STATUS AND DISTRIBUTION		
I. In Wisconsin?	1. YES ☒	NO ☐
	2. Abundance: Widely distributed throughout Wisconsin (3) Herbarium vouchers in all but three Wisconsin counties (4).	
	3. Geographic Range: Ubiquitous across temperate N America.	
	4. Habitat Invaded: Open and semi-open areas, particularly wetlands. Invasions are concordant with disturbances, particularly nutrient enrichment, sedimentation, and hydrological alterations. Curtis (5) documented its presence in 11 different plant community types, with maximum presence in shrub carr. Increasingly invasive in floodplain forests, especially after timber harvest. Disturbed Areas ☒ Undisturbed Areas ☒	
	5. Historical Status and Rate of Spread in Wisconsin: Repeated introductions of reed canary grass cultivars for forage and erosion control began in the 1830s.	
	6. Proportion of potential range occupied: Reed canary grass is found in densities exceeding 50% in 1 out of 4 Wisconsin wetlands (3). In total, it is dominant in over 40,000 ha of wetlands in WI.	
II. Invasive in Similar Climate Zones	1. YES ☒ NO ☐ Where (include trends): Temperate Eurasia and Russia. Aggressive stands are usually naturalized cultivars. Wild populations in Eurasia are not as aggressive as cultivated varieties or introgressive hybrids.	
III. Invasive in Which Habitat Types	1. Upland ☒ Wetland ☒ Dune ☐ Prairie ☒ Aquatic ☐ Forest ☒ Grassland ☒ Bog ☐ Fen ☒ Swamp ☒ Marsh ☒ Lake ☐ Stream ☒ Other: Shrub carr, lowland forests, oak savanna, upland sites with clay soils, seasonally moist pastures, margins of lakes and ponds, floodplains, riverbanks, shores, irrigation ditches, overflow channels, roadsides, fencerows, disturbed sites and especially nutrient rich sites.	
IV. Habitat Affected	1. Soil types favored or tolerated: Reed canary grass has wide ecological can tolerate a wide variety of soil and environmental conditions. Some genotypes may not tolerate low soil pH, but conflicting results are reported in the literature.	
	2. Conservation significance of threatened habitats: Many invaded habitats are of conservation concern, particularly wet prairie and sedge meadows, which filter nutrients and sink carbon dioxide.	
V. Native Range and Habitat	1. List countries and native habitat types: Origin of diversity is believed to be Asia Minor (6), where it occurs in wet open habitats and along riparian corridors. Certain sources also suggest that reed canary grass may be native to the northwestern United States (19). A study by Merigliano and Lesica in 1998 using herbarium specimens collected prior to 1900 determined that reed canary grass was native to certain river systems in MT, ID, and WY(20).	

VI. Legal Classification	1. Listed by government entities? Yes. Washington lists reed canary grass as a Class C Noxious Weed; Connecticut lists it as invasive, but not banned; Massachusetts lists it as prohibited (7). It is classified as a pest species in 9 different states (15).
	2. Illegal to sell? YES ☐ NO ☒ Notes: In Wisconsin, reed canary grass is actively promoted for erosion control and forage by some agricultural interests and Land Grant universities. Widespread use as forage was previously limited by high concentrations of indole alkaloids (particularly chemical derivatives of tryptamin), which made it unpalatable. Newly developed breeding lines possess gramine, a palatable alkaloid, and this species' use as forage may become more commonplace.
B. ESTABLISHMENT POTENTIAL AND LIFE HISTORY TRAITS	
I. Life History	1. Type of plant: Annual ☐ Biennial ☐ Monocarpic Perennial ☐ Herbaceous Perennial ☒ Vine ☐ Shrub ☐ Tree ☐ **Grass**
	2. Time to Maturity: Plants grown from seed can potentially flower during the second growing season. Vernalization is required for panicle development (8). However, rhizomatous perennial grasses have the capacity to remain in the vegetative growth state for several growing seasons without flowering.
	3. Length of Seed Viability: Not clear. Seed germination percentage was zero after 24 months of inundation (9), but selective breeding and seed multiplication of cultivated varieties may have indirectly resulted in enhanced seed traits and seed production characteristics (10) (11).
	4. Methods of Reproduction: Asexual ☒ Sexual ☒ Notes: Can colonize bare ground from rhizome fragments. Approximately 15% of culm fragments (from mowing) can develop adventitious roots and establish new stands. See bank densities of 437 seeds per square meter have been reported. Large numbers of dormant rhizome buds allow the plant to resprout after seemingly successful herbicide application (26).
	5. Hybridization potential: High. Hybrids between different Phalaris species can develop in areas of sympatry. One hybrid, P. monspeliensis [P. arundinacea x P. aquatica] is grown for forage (1). Introgressive hybrids between native genotypes and cultivated varieties are also suspected to exist (12).
II. Climate	1. Climate restrictions: Generally restricted to temperate climates. Northernmost range is limited by daylight because light is a factor in florogenesis. This grass can tolerate inundation or drought. It is also highly salt tolerant.
	2. Effects of potential climate change: Preliminary results suggest that carbon accumulation in reed canary grass monotypes may not be greater than diverse wet prairie stands, and it appears that reed canary grass stands, even with their high productivity, are not a better substitute for the diverse native communities they replace in terms of carbon sequestration.

III. Dispersal Potential	1. <u>Pathways - Please check all that apply</u>: <u>Unintentional</u>: Bird ☒ Animal ☒ Vehicles/Human ☒ Wind ☒ Water ☒ Other: Riparian corridors, drainage ditches and stormwater systems are major dispersal vectors. Reed canary grass seeds, rhizomes, and culm fragments will float on water. Seeds can also lodge in bird feathers and animal fur. <u>Intentional</u>: Ornamental ☒ Forage/Erosion control ☒ Medicine/Food: Other: Biofuel, reclamation, wastewater treatment, phytoremediation of hazardous substances and metals, phytoremediation of heavy (deuterium) water used in nuclear fuel technology.
	2. <u>Distinguishing characteristics that aid in its survival and/or inhibit its control</u>: Has wide ecological amplitude and high genetic and morphological plasticity. Attains maximum productivity well before native herbaceous competitors (13). Tolerates a variety of growing conditions and environmental stresses. Possesses a persistent dormant rhizome bud bank that must be depleted through repeated herbicide applications.
IV. Ability to go Undetected	1. HIGH ☐ MEDIUM ☒ LOW ☐
C. DAMAGE POTENTIAL	
I. Competitive Ability	1. <u>Presence of Natural Enemies</u>: Yes. Several fungal infections, fruit flies, terrestrial caterpillars, meadow voles.
	2. <u>Competition with native species</u>: Superior competitor when gross nutrient supply and light availability is high. Highly competitive with native species and can outcompete other invasive species, such as purple loosestrife. Reed canary grass is able to rapidly exploit disturbances due to its genetic and morphological plasticity.
	2. Rate of Spread: -changes in relative dominance over time: -change in acreage over time: HIGH(1-3 yrs) ☒ MEDIUM (4-6 yrs) ☒ LOW (7-10 yrs) ☐ Notes: Rate of spread is proportional to disturbance levels; expansions are synergized by many interacting disturbances (14).
II. Environmental Effects	1. <u>Alteration of ecosystem/community composition?</u> YES ☒ NO ☐ Notes: Declines in species density, richness, and diversity have been extensively documented. Tree regeneration and tree planting efforts are severely limited when reed canary grass is present.
	2. <u>Alteration of ecosystem/community structure?</u> YES ☒ NO ☐ Notes: Very low soil insect diversity and fewer trophic groups of insencts have been reported in reed canary grass monocultures (15). Reed canary grass stands offer only half as many bird perches than wet meadow communities (Annen et. al., unpublished data from an in-progress study).
	3. <u>Alteration of ecosystem/community functions and processes?</u> YES ☒ NO ☐ Notes: Carbon and nitrogen sequestration services are lower in

	monospecific reed canary grass stands than in diverse wet prairie communities (16).
	4. Allelopathic properties? YES ☐ NO ☒ Notes: Reed canary grass litter has a mulching effect on native species, but no specific allelochemical mechanisms have been identified.
D. SOCIO-ECONOMIC EFFECTS	
I. Positive aspects of the species to the economy/society:	Notes: Stabilize soil and prevents erosion. Phytoremediation and wastewater treatment. Tolerant of adverse environmental conditions. Newer cultivars useful as forage crop, especially for horses, and especially when weather conditions are severe and other crops fail (18). Potential feedstock for pelletized biofuel and cellulosic ethanol production. Used occassionally in pulp, paper, and fiber programs (15). Use as a biofuel: if reed canary grass is baled before senescence it has acceptable standability. We generally recommend baling warm season grasses after senescence since it helps maintian plant strength. Since we don't care if we weaken RCG from early harvest it would be an acceptable practice. The biggest problem with any grass is that it must be densified to work in current coal plant material handling systems (25). Based on the 2011 WNA Economic Impact Survey, the following information was reported for this plant. Out of the 204 nurseries responding, 6 reported selling this plant. 5 reported it comprised <1% of their gross plant sales. 1 reported it comprised 1 – 2.9% of their gross plant sales. The estimated total dollar amount contributed to Wisconsin's economy by this plant is $27,338. It ranks 31st among the 63 taxa surveyed. The estimated wholesale value of plants in production is $2,000. The majority of respondents said it took <6 months to produce this plant. The trend for the 2011 season was to remain unchanged or to decrease slightly (27).
II. Potential Socio-Economic Effects of Requiring Controls:	Positive: Phalaris is too ubiquitous to require controls. Negative: Native species alternatives may be more expensive to plant. ½ million acres are harvested for hay in WI, 4 tons at $80/T=$320/a. At 500,000 acres, this is $160 million income to the farmers of WI (18). Primarily planted to restore hay fields and to convert crop fields to hay fields, farmers are generally not planting in wetlands. Important crop for dairy industry. Potent for cellulosic ethanol. Important forage for horses.
III. Direct and indirect Socio-Economic Effects of Plant :	Notes: As probably the most abundant invasive plant in the state, it prevents forest regeneration, impacts all invaded wetlands and other natural areas.
IV. Increased Costs to Sectors Caused by the Plant::	Notes: Increase costs to forestry, wildlife management, natural areas management and to private landowners.
V. Effects on human health:	Notes: Pollen from dense monospecific stands can inflare allergies and asthma.
VI. Potential socio-economic effects of restricting use:	Positive: Restricting use of RCG hay as mulch or seeding in or adjacent to wetlands would be beneficial to protecting the biodiversity of uninvaded wetlands.

	Negative: Native species alternatives may be more expensive to plant. ½ million acres are harvested for hay in WI, 4 tons at $80/T=$320/a. At 500,000 acres, this is $160 million income to the farmers of WI (18). Primarily planted to restore hay fields and to convert crop fields to hay fields, farmers are generally not planting in wetlands. Important crop for dairy industry. Potential for cellulosic ethanol. Important forage for horses.
E. CONTROL AND PREVENTION	
I. Costs of Prevention (please be as specific as possible):	Notes: Preventing spread into uninfested wetlands will require not allowing it to be purchased or planted for "wildlife use" and will require that RCG hay be used only in sites that are not vulnerable to invasion.
II. Responsiveness to prevention efforts:	Notes: Control appears to be most effective when background disturbances (nutrient and stormwater inputs, sedimentation, hydrological alterations) are abated prior to administering treatments. When levels of certain soil nutrients, mainly nitrogen, are reduced via carbon enrichment, a native sedge is able to outcompete RCG (20). Eradication is enhanced by using an integrated, multiple-treatment approach rather than relying exclusively on herbicides; control might be synergized by multiple treatment effects interacting. RCG seed germination is inhibited by a complex native species canopy (17).
III. Effective Control tactics: (provide only basic info)	Mechanical ☒ Biological ☐ Chemical ☒ Times and uses: Broad-spectrum herbicides (glyphosate and imazapyr) are effective, but these treatments often hinder native species reestablishment. Short-term suppression can be achieved by application of grass-specific herbicides in mixed stands of RCG and native species. Spring or late-summer/early-autumn treatments are usually recommended, but more research is needed to narrow timing windows. Mowing is also used extensively, but RCG is tolerant of a variety of harvesting schedules. Prescribed burning is effective in low density, mixed stands but not in stands where RCG is dominant. Coupling tillage to broad-spectrum or grass-specific herbicide application accelerates control and reduces this species' ability to recover from treatments. Tillage can also be coupled with flooding for effective control, but this also assumes that there are no native species of concern in the area (20). Tarping or hand-pulling is effective on small populations. Excavation of topsoil is effective, but soils are a source of propagules wherever they are deposited. Managed grazing may or may not be effective. Prolonged flooding is also effective where water levels can be manipulated by land managers.
IV. Costs of Control:	Notes: Variable. Multiple-year treatments are usually required to suppress RCG and release native species. Black plastic used in solarization costs $40/2,000 square feet, equaling $2,150/ha. This method is 100% effective for small, incidental invasions when sued after mowing (21). Due to the ubiquity of this species in WI, some level of monitoring and management may be required indefinitely. With current techniques, large scale eradication or control is not feasible.
V. Cost of prevention or control	Notes: Loss of wetland ecosystem services, particularly carbon and

vs. Cost of allowing invasion to occur:	nitrogen sequestration.
VI. Non-Target Effects of Control:	Notes: Control often requires the use of herbicides and additives. Mowing can have negative effects on nesting grassland birds.
VII. Efficacy of monitoring:	Notes: Suppression and control of immature infestations is most effective.
VIII. Legal and landowner issues:	Notes: Extant RCG fields are harvested for hay which is transported and sold for forage and mulch.
F. HYBRIDS AND CULTIVARS AND VARIETIES	
I. Known hybrids? YES ☒ NO ☐	Name of hybrid: Notes: Hybrids between non-native European strains and native strains of RCG are known to exist (15).
	Names of hybrid cultivars:
II. Species cultivars and varieties	Names of cultivars, varieties and any information about the invasive behaviors of each: var. picta 'Picta' is the variegated 'Ribbon Grass' var. picta 'Feesey' is similar but shorted and with pink tinges 'Strawberry and Cream Ribbon Grass' is a multi-colored cultivar 'Dwarf Garters' is a dwarf variegated ribbon grass var. arundinacea has a pale green midrib All varieties and cultivars are described as rapid spreaders, mat-formers, and rhizomatous by gardening websites. Of the six nursery survey respondents growing reed canary grass, one each reported growing Freezy's Form, Dwarf Garters, and Strawberries. None commented on invasiveness. (27)
	Notes: RCG has been bred for cultivation and at least 11 cultivars have been developed (24). Many low alkaloid cultivars have been bred and introduced for the forage industry in North America (15). Additionally, as listed above, certain cultivars are sold in the landscaping industry (22). Industry attitudes: There is significant opposition to prohibiting reed canary grass from the forage industry. Due to its tolerance of wet conditions as well as drought, RCG is widely regarded as a beneficial forage grass and would likely cause economic losses if the different low-alkaloid cultivars were prohibited (18). There is less opposition from the landscaping industry, as profits from different cultivars of RCG are considered to be minimal in Wisconsin (23).

G. REFERENCES USED:

☒ UW Herbarium (Madison or Stevens Point)
☒ WI DNR
☒ Bugwood (Element Stewardship Abstracts
☐ Native Plant Conservation Alliance
☒ IPANE
☒ USDA Plants

Number	Reference
1	Flora of North America (2007) Volume 24, Poaceae, part 1.
2	Wisconsin State Herbarium. 2007. WISFLORA: Wisconsin Vascular Plant Species (http://www.botany.wisc.edu/wisflora). Dept. Botany, Univ. Wisconsin, Madison, WI 53706-1381 USA.
3	Bernthal et al. unpublished data.
4	Robert W. Freckmann Herbarium. 2010. Plants of Wisconsin. University of Wisconsin-Stevens Point, WI 54481. Accessed 9-13-10. http://wisplants.uwsp.edu/
5	Curtis, J.T. (1959). The Vegetation of Wisconsin. University of Wisconsin Press. Madison, WI.
6	Anderson, D. E. 1961. Taxonomy and Distribution of the Genus Phalaris. Iowa State Journal of Science, Vol. 36 (1); 1-96
7	USDA, NRCS. 2007. The PLANTS Database (http://plants.usda.gov, 16 March 2007). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.
8	Heide, O.M. 1994. Control of Flowering and Reproduction in Temperate Grasses. New Phytologist, Vol. 128 (2): 347-362.
9	Comes, R.D.; V.F. Bruns; and A.D. Kelley. 1978. Longevity of Certain Weed and Crop Seeds in Fresh Water. Weed Science, Vol. 26 (4): 336-344.
10	Sahramaa, M.; L. Hommo; andL. Jauhianieu. 2004. Variation in Seed Production Traits of Reed Canarygrass Germplasm. Crop Science Vol. 44: 988-996.
11	Ostrem, L. 1988. Studies on Genetic Variation in Reed Canarygrass, Phalaris arundinacea L. Hereditas Vol. 108: 159-168.
12	Galatowitsch, S.M.; N.O. Anderson, and P.D. Ascher. 1999. Invasiveness of Wetland Plants in Temperate North America. Wetlands, Vol. 19(4): 733-755.
13	Klopatek, J.M.; and F.W. Stearns. 1978. Primary Productivity of Emergent Macrophytes in a Wisconsin Freshwater Marsh Ecosystem. The American Midland Naturalist, Vol. 100(2): 320-332.
14	Kercher, S.M., A. Herr-Turoff, and J.B. Zedler. In Press. Understanding Invasion as a Process. The Case of Phalaris arundinacea in Wet Prairies. Biological Invasions.
15	Lavergne, S. and J. Molofsky. 2004. Reed Canary Grass (Phalaris arundinacea) as a Biological Model in the Study of Plant Invasions. Critical Reviews in the Plant Sciences, Vol. 23(5): 415-429.
16	Herr-Turoff, A., and J.B. Zedler. 2005. Does Wet Prairie Vegetation Retain more Nitrogen with or without Phalaris arundinacea Invasion? Plant and Soil, Vol. 277: 19-34.
17	Linding-Cisneros, R, and J.B. Zedler. 2002. Relationships Between Canopy Complexity and Germination Microsites for Phalaris arundinacea L. Oecologia, Vol. 133:159-167
18	Dan Undersander. Forage Specialist- Department of Agronomy, University of Wisconsin-Madison. Rough estimates
19	Invasive Plant Atlas of New England. 2010. Reed Canarygrass. Accessed online 09/17/2010. http://www.invasiveplantatlas.org/subject.html?sub=6170.
20	Tu, M. 2004. Reed Canarygrass: Control and Management in the Pacific Northwest. The Nature Conservancy. Accessed online 09/17/2010. http://www.invasive.org/gist/moredocs/phaaru01.pdf.
21	Johnson, M. 2005. Investigating Alternatives for Control of Phalaris arundinacea (reed canarygrass) in Urban Wetlands. Master's Thesis, Portland State University, January 4th, 2005. 25 p.
22	Suddha. Winter Greenhouse; Winter, WI. Email interview. 10/01/2010.
23	Chad McGrath. President-ClearView Nursery Corp. Email interview. 10/01/2010.
24	Waggy, Melissa, A. 2010. Phalaris arundinacea. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Accessed online 10/15/2010. http://www.fs.fed.us/database/feis/
25	Bill Johnson, Biomass Consulting Services, personal communication, Sept. 1, 2011 billjohnson@biomassconsultingservices.com
26	Reyes, C. M. 2004. The feasibility of using prescribed burning to control reed canarygrass (*Phalaris arundinacea* L.) populations in Wisconsin wetlands. M.S. thesis. University of Wisconsin. Madison.
27	Wiegrefe, Susan. 2011. Wisconsin Nursery Association Survey of the Economic impact of potentially invasive species in Wisconsin

Author(s), Draft number, and date completed: Craig Annen, First Draft, March 21, 2007

Reviewer(s) and date reviewed: Michael Healy, July 31, 2007. Jerry Doll, September 27, 2007. Kelly Kearns, October 24, 2011.

Approved and Completed Date: 12/20/2011