NAME OF SPECIES: *Berberis thunbergii* DC		
Synonyms: *Berberis thunbergii* var. atropurpurea (Chenault), *Berberis thunbergii* var. maximowiczii, *Berberis thunbergii* var. minor (2)		
Common Name: Japanese barberry	**Cultivars?** YES ☒ NO ☐	
A. CURRENT STATUS AND DISTRIBUTION		
I. In Wisconsin?	1. YES ☒	NO ☐
	2. Abundance: Over 150 occurrences of Japanese barberry have been reported in the state of WI since 1938. While this number does include some cultivated plants, many of the occurrences have been reported from naturalized settings including state natural areas. Furthermore, this species is probably underreported. (18)	
	3. Geographic Range: *B. thunbergii* is now reported throughout southern WI, parts of central WI, in the eastern portion of the state along Lake Michigan, and in northwestern WI along Lake Superior. (18)	
	4. Habitat Invaded: Lowland hardwood forests, oak woodlands and oak savannas. (20) Low-density invasions of *B. thunbergii* have been reported in silver maple dominated lowland forests in southeastern WI. (10) Disturbed Areas ☒ Undisturbed Areas ☒	
	5. Historical Status and Rate of Spread in Wisconsin: Japanese barberry was introduced as an ornamental to North America via Massachusetts in 1875. By 1920 it was being promoted as a substitute for the common barberry, which was used by early settlers for hedgerows, dyes and jams but was eradicated when it was discovered to be a host for black stem rust. (2,4,10) The earliest known reports of *B. thunbergii* in the state of WI are from the 1930s. (18, 19)	
	6. Proportion of potential range occupied: This species occupies only a portion of its potential range in WI.	
II. Invasive in Similar Climate Zones	1. YES ☒	NO ☐
	Where (include trends): Reports of the escape of isolated Japanese barberry plants began around 1910 in the Northeastern states. During the early 20th century, this shrub colonized recently abandoned agricultural lands in that region. It was able to persist and spread locally during reforestation. (16) Today *B. thunbergii* is naturalized in 31 states throughout the Northeast, Southeast, and Midwest, and adjacent Canadian provinces. It is less common west of the Mississippi and south of North Carolina. (5, 10) Currently it has spread as far west as WY. (5) Japanese barberry is considered invasive in climatic regions with maximum and minimum temperatures between -11 and 24.6˚C and average annual precipitation between 1,129 and 1,219mm. This species is well-documented as a problem invasive in New England and the upper Midwest. (3)	
III. Invasive in Which Habitat Types	1. Upland ☒ Wetland ☒ Dune ☐ Prairie ☐ Aquatic ☐ Forest ☒ Grassland ☒ Bog ☐ Fen ☐ Swamp ☐ Marsh ☐ Lake ☐ Stream ☒ Other: Urban green space ☒ Notes: In the eastern U.S. Japanese barberry invasions occur mostly in upland and riparian zones, wetlands, pastures, meadows	

	and woodlands. *B. thunbergii* occurs in the Northeast in early-successional to late-successional mixed hardwood forests, and is found in hemlock and pine dominated communities. (10) In the Northeast, this species is more likely to be found in secondary forests (following agriculture or timber harvest) than in continuously wooded sites. Although invasion often occurs in the second-growth forests, Japanese barberry populations have also been reported from relatively undisturbed forest. The plant forms dense thickets in mature forest communities. Generally, this species invades areas that rarely burn.
IV. Habitat Affected	1. Soil types favored or tolerated: Prefers well-drained soils but has been found in wet, calcareous soils (1). Tolerates wet, moist or dry soils but prefers mesic conditions. (2) Can thrive on sandy, loam, or clay soils with a pH of 3.7 to 6.2. This species is not salt tolerant. (10)
	2. Conservation significance of threatened habitats: *B. thunbergii* prefers partial sunlight and is often found along roadsides, fences, old fields and open woods, but it can also invade closed canopy forests. (2, 3) This species is a known invasive in upland deciduous forest and woodland especially in the Northeast and Midwest; as well as floodplain deciduous forest and shrub or meadow wetlands. Forest patches with high edge to area ratios are especially vulnerable to invasion. (10) *B. thunbergii* is a dominate understory species at invaded sites in oak and sugar maple forests of the Northeast and Midwest. (10) In the Northeast, *B. thunbergii* has invaded or displaced native forest understory communities dominated by chokecherry (*Prunus virginiana*), ostrich fern (*Matteucchia struthiopteris*), Christmas fern (*Polystichum acrostichoides*), huckleberries (*Gaylussacia* spp.), mountain-laurel (*Kalmia latifola*), pink azalea (*Rhododendron periclymenoides),* and blueberries (*Vaccinum* spp.). (10)
V. Native Range and Habitat	1. List countries and native habitat types: Japan (1)
VI. Legal Classification	1. Listed by government entities? Connecticut – Invasive, not banned Massachusetts – Prohibited (5)
	2. Illegal to sell? YES ☒ NO ☐ Notes: Illegal to sell in Canada as well as MA. (4, 5)
B. ESTABLISHMENT POTENTIAL AND LIFE HISTORY TRAITS	
I. Life History	1. Type of plant: Annual ☐ Biennial ☐ Monocarpic Perennial ☐ Herbaceous Perennial ☐ Vine ☐ Shrub ☒ Tree ☐
	2. Time to Maturity: Starts producing fruits at 5 years. It is likely that individuals can live 20-50 years. (7)
	3. Length of Seed Viability: This species does not seem to form a large or persistent seed bank. (10)
	4. Methods of Reproduction: Asexual ☒ Sexual ☒ Notes: Reproduces by seed and by sprouting from the root crown and rhizomes. (1) Long stems touching the ground will also root. (10) The many forms of reproduction can result in large swarms of stems, which make it difficult to determine the limits of an

	individual plant. (10)
	5. Hybridization potential: Known to hybridize with common barberry (*Berberis vulgaris*) and produce viable offspring, *Berberis* x *ottawensis*. (4) This species is often used in hybrid cultivars.
II. Climate	1. Climate restrictions: Zones 4-8. The current northern limits of the distribution of *B. thunbergii* are likely defined by low temperatures, the southern limits by cold stratification requirements for germination, and the western limits by drought tolerance. (10)
	2. Effects of potential climate change: There is potential for the species distribution to shift north as average temperatures rise. Increased regional nitrogen deposition along with warming winter temperatures may enhance carbon gain in Japanese barberry relative to native shrubs, contribuing to the invasiveness of this species. However this remains to be studied. (10)
III. Dispersal Potential	1. Pathways - Please check all that apply: Unintentional: Bird ☒ Animal ☒ Vehicles/Human ☒ Wind ☐ Water ☐ Other: Intentional: Ornamental ☒ Forage/Erosion control ☐ Medicine/Food: Other: Notes: Spreads along roads and invades forest edges. (10)
	2. Distinguishing characteristics that aid in its survival and/or inhibit its control: *B. thunbergii* populations grow rapidly due to low mortality rates of the stems. This species may occur under almost any shade level and at all stages of forest succession. As shoot density increases, larger numbers of seeds fall near the plant. (10) Seeds can be dispersed long distances by birds, especially ground birds, and small mammals. However most seedlings are found under or adjacent to adult plants. (2) Leafing out early in the spring may give *B. thunbergii* an advantage over native species by allowing the plant to photosynthesize when high light is available. (10)
IV. Ability to go Undetected	1. HIGH ☐ MEDIUM ☐ LOW ☒ In most habitats, Japanese barberry is recognizable because of its distinctive coloration. (9) It is easily identifiable in the spring, since it is one of the first shrubs to leaf out. (10)
C. DAMAGE POTENTIAL	
I. Competitive Ability	1. Presence of Natural Enemies: Seeds collected from *B. thunbergii* in one naturalized setting showed high rates of predation by an unknown seed weevil. (11) Japanese barberry is unpalatable to many species of wildlife including white-tailed deer (although it may be preferred by mule deer). (10) In northern hardwood forests, deer herbivory of palatable native species probably gives a competitve advantage to *B. thunbergii*. (13)

	Extensive defoliation of *B. thunbergii* by the barberry geometer (*Coryphista meadii*), a lepidopteran native to all of N. America, was documented in *B. thunbergii* populations in New Jersey. It is unknown if herbivory by this species occurs elsewhere, and what the effect is on *B. thunbergii* populations. (15) Grasses can inhibit the growth of *B. thunbergii* (1).
	2. Competition with native species: Forms dense stands and shades out understory species. (1) Can displace herbs and shrubs. (2) Aside from displacing native understory species, dense infestations restrict regeneration of forest trees. (14) This species may occur under almost any shade level and at all stages of forest succession. (10) The presence of earthworms may alter the soil environment to favor growth of *B. thunbergii* over native shrubs. (10)
	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: Since light appears to be a common limiting resource for establishment of *B. thunbergii*, populations tend not to expand rapidly into oak-dominant forests or on extreme north-facing slopes. (2)
II. Environmental Effects	1. Alteration of ecosystem/community composition? YES ☒ NO ☐ Notes: Replaces native understory herbs and shrubs, such as *Vaccinium* spp. (10) May replace bird habitat. (3)
	2. Alteration of ecosystem/community structure? YES ☒ NO ☐ Notes: Japanese barberry populations range from small plants occurring at low densities to dense stands with up to 40 stems per individual, or 36 stems per square meter. (10) This species can replace native understory layers, though it may not significantly alter community structure. (3)
	3. Alteration of ecosystem/community functions and processes? YES ☒ NO ☐ Notes: Japanese barberry may alter the soil microbial community and associated soil processes such as nitrogen mineralization, therefore altering plant-available nitrogen and soil pH. (10) One study found that *B. thunbergii* leaf litter is higher in nitrogen and decomposes more rapidly than the native tree and shrub species in northern New Jersey sites. In this setting *B. thunbergii* may increase the rate of net nitrification and the amount of available nitrate, thereby favoring its own growth. Such changes in soil fertility can facilitate invasions by other nonnatives, or hinder restoration of native flora. (3)
	4. Allelopathic properties? YES ☐ NO ☒ Notes:

D. SOCIO-ECONOMIC EFFECTS	
I. Positive aspects of the species to the economy/society:	Notes: This species can tolerate harsh site conditions such as high acidity, low fertility and shallow soil. It is recommended for reclamation of highly disturbed sites such as former strip mining sites. (10)
II. Potential Socio-Economic Effects of Requiring Controls:	Positive: Negative: Banning Japanese barberry would mean the loss of an important landscaping plant. Landscaping alternatives that are native to North America include: Common winterberry *(Ilex verticillata*), lowbush blueberry *(Vaccinium angustifolium*), American cranberry bush *(Viburnum opulus var. Americanum),* bladdernut (*Staphylea trifolia*), buttonbush (*Cephalanthus occidentalis*), dogwoods (*Cornus. alternifolia, C. amomum, C. racemosa, C. stolonifera*), American elder (*Sambucus canadensis*), spicebush (*Lindera benzoin*), and witch hazel (*Hamamelis virginiana*). (20) Based on the 2011 WNA Economic Impact Survey, the following information was reported for this plant. Out of the 204 nurseries responding, 49 reported selling this plant. 22 reported it comprised <1% of their gross plant sales. 18 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 $653,885. It ranks 4th among the 63 taxa surveyed. The estimated wholesale value of plants in production is $98,750. The majority of respondents said it took 2 to 3 years to produce this plant. The trend for the 2011 season was to remain unchanged (24).
III. Direct and indirect Socio-Economic Effects of Plant :	Notes:
IV. Increased Costs to Sectors Caused by the Plant:	Notes: If Japanese barberry continues to spread and becomes problematic in the state's natural areas, the costs of eradication will fall on land managers in the public sector.
V. Effects on human health:	Notes: Forest sites invaded by Japanese barberry may become more favorable tick habitat, thereby increasing the risk of Lyme's disease. (10) Dense Japanese barberry infestations in mixed hardwood forests in Connecticut had high densities of blacklegged ticks feeding on white-footed mice. The ticks are vectors for *Borrelia burgdorferia*, which causes Lyme's disease in humans. Areas where Japanese barberry invasions were controlled had reduced numbers of the *Borrelia burgdorferia*-infested blacklegged ticks, indicating that management of Japanese barberry infestations can help slow the spread of Lyme's disease. (13) Japansese barberry is a potential substitute for goldenseal (*Hydrastis canadensis*). This plant is overharvested from its native habitats for medicinal use (the roots are rich in alkaloids and have antibacterial properties). (10)
VI. Potential socio-economic effects of restricting use:	Positive: Negative:

E. CONTROL AND PREVENTION	
I. Costs of Prevention (please be as specific as possible):	Notes:
II. Responsiveness to prevention efforts:	Notes: The Conneticut Nursery & Landscape Association and its members are voluntarily imposing an industry ban state wide on the following 25 *Berberis thunbergii* cultivars and parent species (wild type): Angel Wings, Antares, var. atropurpurea, 'Bailtwo' Burgundy Carousel®, 'Monomb' Cherry Bomb™, Crimson Velvet, Erecta, Gold Ring, 'Bailsel' Golden Carousel® *B. koreana x B. thunbergii* hybrid, Inermis, 'Bailgreen' Jade Carousel®, 'JN Redleaf 'Ruby Jewel™, 'JN Variegated' Stardust™, Kelleris, Kobold, 'Anderson' Lustre Green™, Marshall Upright, Painter's Palette, Pow Wow, Red Rocket, Rose Glow, 'Bailone' Ruby Carousel®, Silver Mile Sparkle, 'Tara' Emerald Carousel® *B. koreana x B. thunbergii* hybrid, and Wild Type (parent species – green barberry). (21)
III. Effective Control tactics:	Mechanical ☒ Biological ☐ Chemical ☒ Times and uses: <u>Mechanical:</u> Cutting, pulling and digging are effective at very low-density infestations. (1) All roots should be removed. Hand-cutting of established clumps is difficult due to the long arching stems and prolific thorns. (9) Mowing or cutting is appropriate for initial small populations. Repeated mowing or cutting will control the spread but will not eradicate the population. (9) Following the removal of aboveground stems, Japanese barberry can re-sprout from stumps, root crowns and underground organs. (10) <u>Chemical:</u> Triclopyr has been used successfully as a cut-stump treatment for individual plants and may be effective for basal bark treatment. (1, 12) Cut-stump treatment with glyphosate may be effective. Cut plants at base in winter or spring, and spray re-sprouts with glyphosate. (12) In areas where herbicide use should be avoided, Japanese barberry can be effectively controlled mechanically. The following 2-step process is recommended: an initial pre- or early-season cutting, prescribed fire, or direct flame treatment (propane torch) followed by a mid-to-late season treatment of targeted herbicide applications OR direct flame. Foliar application of herbicides on new sprouts was the most effective follow-up. For large, dense infestations, a drumchopper or bulldozer is recommended for the initial cutting. (14) Prescribed fire may successfully reduce Japanese barberry populations in ☐olumbia☐n oak savannas. (10)

IV. Costs of Control:	Notes: The Indiana DNR estimated contractual costs of control of *B. thunbergii* at greater than $2000/acre/year in the first year, for a 50% infestation. (7)
V. Cost of prevention or control vs. Cost of allowing invasion to occur:	Notes:
VI. Non-Target Effects of Control:	Notes: In *B. thunbergii* infestations the plants may be scattered, in which case foliar or dormant stem spraying results in significant non-target damage. (7) Propane torches provide a non-chemical alternative. (14)
VII. Efficacy of monitoring:	Notes: *B. thunbergii* is one of the first shrubs to leaf out in northeastern habitats, which aids in identification and monitoring. (1)
VIII. Legal and landowner issues:	Notes: *B. thunbergii* has been used for decades on private property as an ornamental species. Eradication would involve collaboration with private landowners.
F. HYBRIDS AND CULTIVARS	
I. Known hybrids? YES ☒ NO ☐	Notes: Japanese barberry is commonly used to breed ornamental hybrids. (10)
	Names of hybrid cultivars: Known hybrids include: *Berberis* x *ottawensis* (hybrid of *B. thunbergii* and *B. vulgaris*); 'B. tara' (hybrid of *B. thunbergii* and *B. koreana*). (10) Saujoy Pillar, x intermedia was grown by a nursery survey respondent. (24) A nursery survey respondent reported that "no viable seeds are produced by korean x japanese hybrids." (24)
II. Species cultivars	Names of cultivars: Aurea, Bogozam, Crimson Pygmy, Crimson Velvet, Golden Devine, Kobold, Monlers, Rose Glow, Sparkle, Tara. A nursery survey respondent reported Emerald Carousel as being spread by birds especially well, another grower has "seen Crimson Pygmy reseed in landscape areas with no to very little management." (24) One respondent reported that all cultivars produce seed. Three respondents reported having never seen seedlings; one of which provided no cultivar/species data. The other two both reported growing Crimson Pygmy, and other varieties grown by them include Bailsel, Moretti, and Carousel. (24) 34 responses with following frequencies: Crimson Pygmy 22, Rose Glow 18, Concorde 8, Helmond Pillar 7, Golden Carousel/Bailsel 5, Marshall Upright 2, red leaf/ atropurpurea 4, species 2, Royal Burgundy 2, Gold Ruby 2, Emerald Carousel 2; 1 each – Bailgreen, Bailone, Golden Nugget, Burgundy Carousel, Pigmy Concord, Golden Nugget, Bagatelle, Kobald, Sunjoy Golden Pillar, Gold Beret, Gold Ruby, Cabarret, Ruby Carousel, Gold Ring, green, other, thornless.(24) "50 -100 cultivars in commerce with variable seed fertility. Some work done on this at U of Conn. Seems more commonly to invade

	open sandy areas probably where there is little competition. Very common landscape plant, must review at cultivar level, use study by Dr. Mark Brands at Univ. of CT." (25)
	Notes: Cultivars of Japanese barberry vary in foliage color, growth habit (size and shape), fruit production, germination, and seedling establishment. (10) As of 1998 there were an estimated 450 cultivars worldwide. (6) Many are based on var. *atropurpureus*, all of which are purple-leaved, but the purple-leaved cultivars often produce green progeny. The Indiana DNR has noted a mix of green and purple invaders at their sites. (7) A study found that while seed production varies widely between cultivars, almost all cultivars have the ability to produce seeds. (8) Some cultivars produce over 1000 seeds per plant. At the time of the publication, only Crimson Ruby and Golden Devine had not produced any seed, and four other cultivars produced less than 10 seeds per plant. However, plants in the study were three years old, which is relatively young for fruit production, and the results are based on just one year's observations. Longer-term studies are needed to determine the invasive potential of cultivars. (7) The smaller, less "vigorous" cultivars 'Aurea' and 'Crimson Pygmy', may be less competitive than *B. thunbergii*. (10) In one study seedlings of *B.* t. var. *atropurpurea* and 'Rose Glow' attained greater heights and widths, greater numbers of branches, and a heavier canopies than the smaller forms 'Aurea' and 'Crimson Pygmy.' In comparison, the wild type *B. thunbergii* had similar or smaller dimensions compared to *B.* t. var. *atropurpea* and 'Rose Glow.' 'Bogozam', 'Kobold', and 'Monlers', produce on average no more than 1 fruit per 2 inches of stem length. (10) In contrast, 'Golden Ring', 'Rose Glow', 'Crimson Velvet', 'Sparkle', and B. 'Tara' (a hybrid of *B. thunbergii* and *B. koreana*) can produce more than 3 fruits per stem inch. (10) *B. thunbergii* cultivars 'Crimson Pygmy', 'Crimson Dwarf', and 'Monomb' Cherry Bomb ™ appear to be the same genotype. Cultivars 'Concorde' and 'Criruzam' Crimson Ruby ™ are most likely genotypes of *B.* X *ottawensis*. (15) Lubell et al. (2008) developed a dichotomous key for 42 *B. thunbergii* cultivars and hybrids and *B. vulgaris* 'Atropurpurea,' which can be used to insure that only legal cultivars are sold, if cultivar-specific bans are enacted. (16) A team of scientists at the University of Connecticut identified 7 cultivars of Japanese barberry which were determined to be less invasive than other cultivars because of lower seed production. The following cultivars were determined to be the lowest seed-producing: Lime Glow, Sunsation, Helmond Pillar, Royal Burgundy, Gold Nugget, Aurea, and Bagatelle. (22)

	B. tara ('Emerald Carousel') , hybrid of B thunbergii and B. koreana, 'Golden Ring', 'Rose Glow', 'Crimson Velvet' ans 'Sparkle' all produce many seeds. (23)

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