Maryland Department of Agriculture

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Version 2

Weed Risk Assessment for *Wisteria sinensis* (Sims) DC., *W. floribunda* (Willd.) DC., *and W.* x *formosa* Rehder (Fabaceae) – Chinese and Japanese wisteria and hybrids

Top: Wisteria in a natural area, Bottom: twining wisteria vines; Right: Wisteria seed pods. (source: Sylvan Kaufman).

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Introduction The Maryland Department of Agriculture regulates terrestrial ornamental invasive plants under the authority of Md. AGRICULTURE Code Ann. § 9.5-101 et seq. Invasive Plant Prevention and Control. An invasive plant is defined as a terrestrial plant species that a) did not evolve in the State, and b) if introduced within the State, will cause or is likely to cause, as determined by the Secretary: economic, ecological, environmental harm or harm to human health.

Maryland's Invasive Plant Advisory Committee (IPAC) was established by legislative mandate in October 2011. The IPAC's primary responsibility is to advise the Secretary of Agriculture on regulating the sale of invasive plants, and on preventing them from entering Maryland or from spreading further in the state. IPAC evaluates the risk potential of plants already present in Maryland, newly detected in the Maryland or the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

IPAC evaluates the potential invasiveness of plants using the weed risk assessment (WRA) process developed by the Plant Protection and Quarantine (PPQ) Program of the US Department of Agriculture's Animal and Plant Health Inspection Service (Koop et al. 2012). PPQ's risk model uses information about a species' biological traits and behavior to evaluate its risk potential (Koop et al. 2012).

Because the PPQ WRA model is geographically and climatically neutral, it can be used to evaluate the baseline invasive/weed potential of any plant species for the entire United States, or for any specific region in the United States. In the PPQ process, the geographic potential of the species is evaluated separately so that risk managers can make decisions appropriate for their regions. With respect to Maryland's evaluation process, we use PPQ's Geographic Information System overlays of climate to evaluate the potential for a plant to establish and grow in Maryland. The PPQ weed risk assessment also uses a stochastic simulation to evaluate how the uncertainty associated with the assessments affects the model's predictions. Detailed information on the PPQ WRA process is available in the document, *Guidelines for the USDA-APHIS-PPQ Weed Risk Assessment Process* (APHIS PP, 2015), which is available upon request.

IPAC uses a second tool, the Maryland Filter, to assign plant species that score as highly invasive either Tier 1 or Tier 2 status. Maryland regulations define Tier 1 plants as "invasive plant species that cause or are likely to cause severe harm within the State" and Tier 2 plants as "invasive plant species that cause or are likely to cause substantial negative impact within the State." The Maryland Filter considers the actual and potential distribution of the species in Maryland, its threat to threatened and endangered ecosystems and species in the state, the difficulty of control of the species, and whether added propagule pressure would be likely to increase its persistence and spread significantly. IPAC then recommends regulations to reduce the risk of the Tiered invasive plants in Maryland.

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Wisteria sinensis* (Sims) DC., *W. floribunda* (Willd.) DC., and *W.* x *formosa* Rehder– Japanese and Chinese wisterias and hybrids

Species Information

Family: Fabaceae

Synonyms: Old synonyms for *Wisteria* are *Glycine* and *Kraunhia*. *Wisteria floribunda* has sometimes been listed as *W. chinensis* (ISSG 2014).

Common names: Japanese and Chinese wisteria

Botanical description: Wisterias are twining, woody vines that grow in temperate areas in sun and part shade. They send out long runners and climb into trees. A full botanical description can be found in the Flora of China (Flora of China Editorial Committee 2014), Woody Plants of Maryland (Brown and Brown 1972), and Plants of Pennsylvania (Rhoads and Block 2007). Hybrids have resulted from plants grown for horticultural purposes (Trusty et al. 2007).

Initiation: This plant is listed on the MD Department of Natural Resources Do Not Plant List, a policy document available from MD DNR. We evaluated both species and their hybrids in one assessment because all are widely used as ornamental plants and all have naturalized in Maryland, and most of the literature does not distinguish among them. In this document, “wisteria” refers to the two species and their hybrids.

Foreign distribution: Chinese wisteria is native to eastern Asia. Japanese wisteria is native to Japan. Hybrids have probably resulted from plants grown for horticultural purposes (Trusty et al. 2007). The two species and their hybrids have been widely introduced to other countries for cultivation (GBIF 2015; Randall 2007).

U.S. distribution and status: In the United States wisterias have naturalized from Florida to Maine and west to Texas and Iowa. Due to their close taxonomic relationship and the occurrence of naturalized hybrids between the two species we assess the species and their hybrids in this assessment.

WRA area[1]: Entire United States, including territories.

Summary Statement

Wisteria sinensis, *W. floribunda*, and *W.* x *formosa* assessed together received a ranking of high risk under the PPQ weed risk assessment because these wisterias are climbing woody vines that can invade natural areas and forest plantations forming dense thickets, smothering and girdling large and small trees. These wisterias received a Tier 2 ranking in the Maryland Filter

[1] “WRA area” is the area in relation to which the weed risk assessment is conducted [definition modified from that for “PRA area”] (IPPC, 2012).

assessment because the species are already widespread in Maryland and they are not documented as threatening endangered species or ecosystems in the state.

1. *Wisteria* analysis

Establishment/Spread Potential Wisteria naturalizes in many areas, particularly in the southeastern United States (Stone 2009). The climbing vines can rapidly form dense thickets (Miller et al. 2010). Although wisteria seems to mainly spread from cultivated plants, it sends out long runners and does have viable seeds (ISSG, 2014). Little information is available on rates of seed production or on seed dispersal.

Risk score = 10 Uncertainty index = 0.14

Impact Potential Wisteria impacts natural areas changing soil nitrogen levels, toppling tall trees, girdling small trees, and (Smith et al. 2010). There are numerous publications on control of wisteria in natural areas in the United States (MacDonald et al., 2008; Langeland et al. 2008). Wisteria is also reported to impact forest plantations (Miller 1998), but there is less evidence for its effects on forestry. Wisteria vines damage buildings and other structures because of its twining, climbing nature and is controlled in gardens (Dave's Garden 2014).

Risk score = 3.6 Uncertainty index = 0.22

Geographic Potential Based on three climatic variables, we estimate that about 57 percent of the United States is suitable for the establishment of Wisteria including all physiographic provinces of Maryland (Fig. 1). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map for Wisteria represents the joint distribution of Plant Hardiness Zones 4-13, areas with 20-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: Tropical Rainforest, Steppe, Mediterranean, Humid subtropical, Marine west coast, Humid continental warm summer, Humid continental cool summer, and Subarctic.

The area of the United States shown to be climatically suitable (Fig. 1) is likely overestimated since our analysis considered only three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. Wisteria grows on wet to dry sites and tolerates a range of soil types. It prefers deep, loamy soils. It is often found along roadsides, forest edges, ditches and rights-of-ways as well as by old house sites (Swearingen et al. 2010).

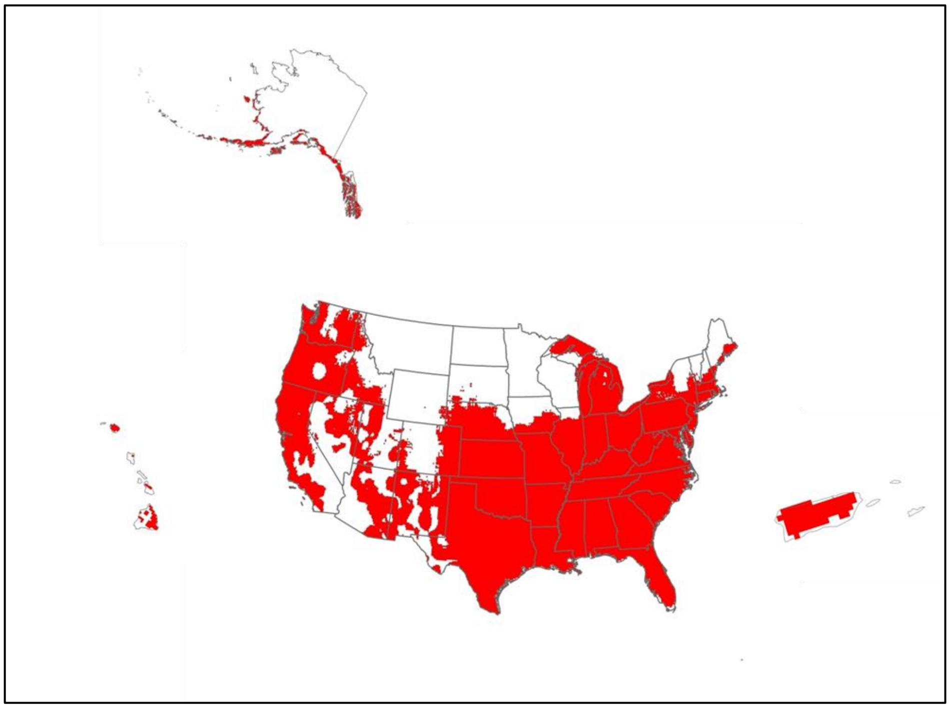

Figure 1. Predicted distribution of Wisteria in the United States. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.

2. Results

Model Probabilities: P(Major Invader) = 59.6%
P(Minor Invader) = 38.4%
P(Non-Invader) = 2.0%

Risk Result = High Risk

Secondary Screening = Not Applicable

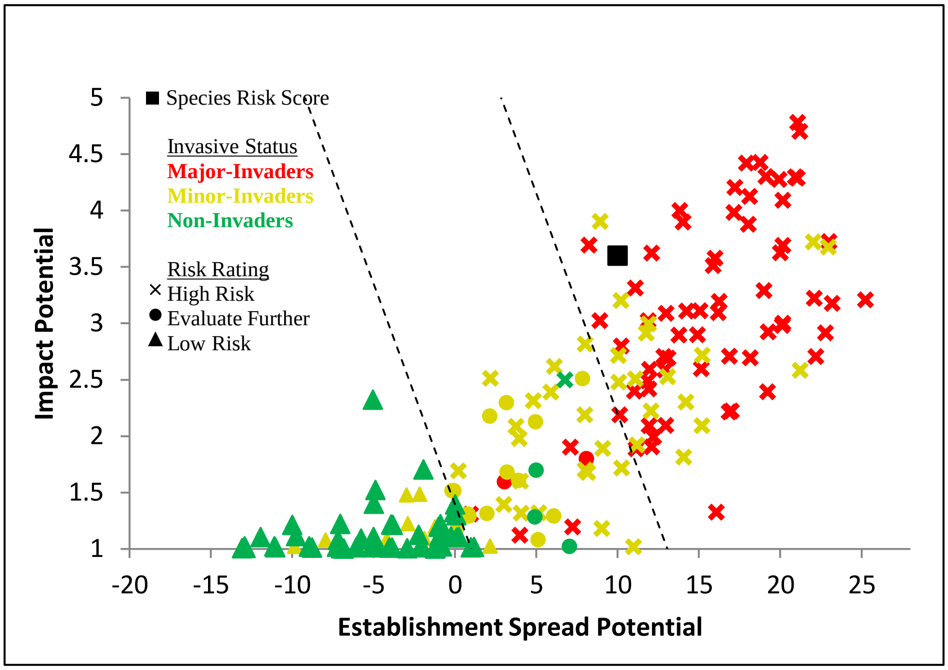

Figure 2. Wisteria risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

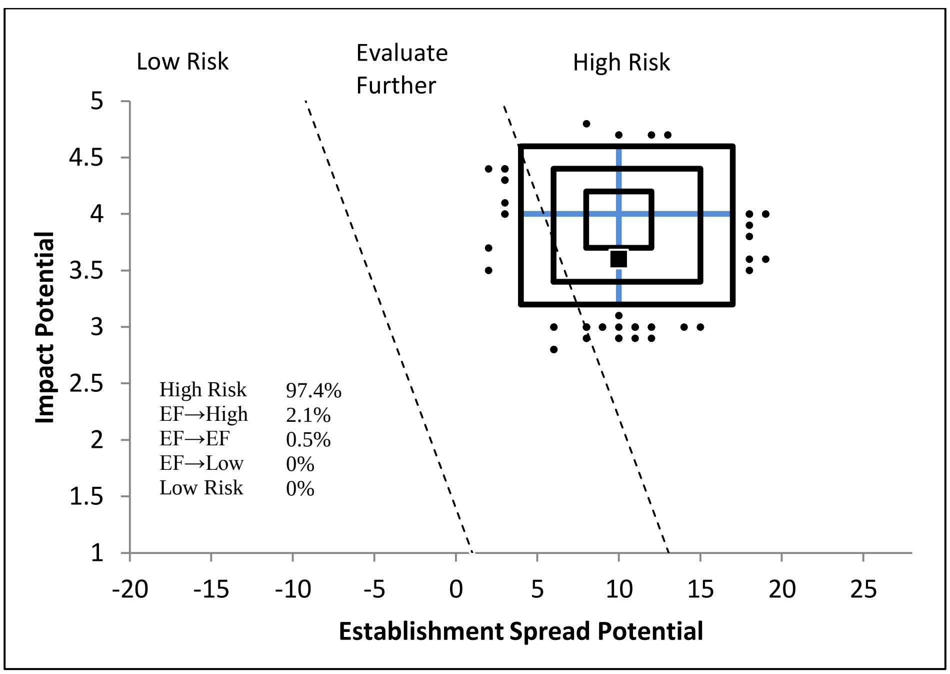

Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for wisteria. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the combined weed risk assessment for *Wisteria sinensis, W. floribunda*, and their hybrid *W.* x *formosa* is High Risk (Fig. 2). Our uncertainty analysis supports this because 97 percent of the simulated risk scores were located in the High Risk region (Fig. 3). Our model indicates that this species complex has a 60 percent chance of being a major invader and this result is supported by reports of wisterias' invasiveness in the southeast and mid-Atlantic (Stone 2009). Once established, wisteria forms dense infestations (Miller et al. 2010). As a twining vine it causes significant damage to trees, shrubs, and built structures (Smith et al. 2010, Miller et al. 2010, Dave's Garden 2014). Once established it is difficult to control because of extensive runners and the ability to resprout (MacDonald et al. 2008; Langeland et al. 2008).

Wisteria ranks as a Tier 2 plant (Appendix B). Wisteria has a wide distribution in Maryland and has been sold and naturalized in the state for at least twenty years (EDDMapS 2015, Norton Brown Herbarium 2015). We found no documentation of its effect on threatened and endangered species or ecosystems in the state, but it does seem likely that it could affect species and ecosystems based on its wide distribution and community level impacts. Because the species is already widely distributed and has been in Maryland for a long time period (an herbarium specimen of a cultivated plant from Baltimore dates to 1909 (Norton Brown Herbarium 2015) additional sales are unlikely to increase wisteria's potential to persist and spread.

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Appendix A. Weed risk assessment *Wisteria sinensis* (Sims) DC., *W. floribunda* (Willd.) DC., and *W.* x *formosa* Rehder – Japanese and Chinese wisterias and hybrids (Fabaceae). The following information came from the original risk assessment, which is available upon request (full responses and all guidance). We modified the information to fit on the page.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 (Status/invasiveness outside its native range)	f - low	5	*Wisteria sinensis* and *W. floribunda* are native to Asia. These two species and their hybrid, *W.* x *formosa*, are listed as naturalized and spreading in the southeastern and mid-Atlantic US (Trusty et al. 2007a, Swearingen et al. 2010). Naturalized in Europe in the British Isles (Clement 2004) and Italy (Celesti-Grapow 2009) but generally listed as a casual species in Europe. Also naturalized in New Zealand but usually spreads vegetatively from planted plants (Webb 1988). *Wisteria floribunda* is listed as naturalized and spreading into forests in Korea (KeeDae K. 2012). Based on the invasiveness in the United States we chose "f" but with low uncertainty since plants are generally considered casual escapes in other countries. Alternate answers were both "e", naturalized.
ES-2 (Is the species highly domesticated)	n - low	0	Wisteria is an ornamental plant with more than 25 cultivars selected for flower color, double blossoms, fall coloration, and dwarf (bonsai) stature (Trusty 2008). There is no evidence that selection for ornamental traits has reduced the weedy potential of this species or its hybrids; in fact, domestication has mixed the genetic makeup of these two species, possibly increasing its invasive potential (Trusty 2007a; Trusty 2007b; Trusty 2008). Wisteria is cultivated in many countries (Randall 2007).
ES-3 (Weedy congeners)	n - mod	0	There are about 4-8 species of *Wisteria* in the world (Trusty et al. 2007b; Kew 2014; ITIS, 2014). *Wisteria brachybotrys* is listed as a weed in Japan (Randall 2007) but no detail could be found on its effects.
ES-4 (Shade tolerant at some stage of its life cycle)	n - high	0	Wisteria is often described as shade tolerant, but plants seldom establish or thrive in full shade (Stone 2009; Kaufman and Kaufman 2013). Established plants can send out long runners into fully shaded areas and shoots can then climb trees (assessor, personal observation). Since plants generally tolerate part shade, we are answering "no" with high uncertainty.
ES-5 (Climbing or smothering growth form)	y - negl	1	Wisteria is a twining climbing vine that grows into tree canopies (Sakai 2002, ISSG 2009, Smith 2008).
ES-6 (Forms dense thickets)	y - negl	2	Wisteria forms dense thickets where it establishes (Stone 2009; Miller et al. 2010). Stolons spread from the parent plant (Sakai 2002).
ES-7 (Aquatic)	n - negl	0	Wisterias are terrestrial vines (Kaufman and Kaufman 2013; Miller et al. 2010). They grow along streams (Burrows 2001; Sakai 2002).
ES-8 (Grass)	n - negl	0	Wisterias are not grasses. Wisterias are in the Fabaceae family (ARS 2009).

ES-9 (Nitrogen-fixing woody plant)	y - negl	1	Wisterias produce root nodules that contain N-fixing bacteria (Liu 2005).
ES-10 (Does it produce viable seeds or spores)	y - low	1	Both species set viable seed, and plants appear to produce hybrids in nature (Trusty 2007). We found numerous reports on Dave's Garden (2014) about successful seed germination but not outdoors.
ES-11 (Self-compatible or apomictic)	? - max	0	No information was found on whether Wisteria is self-compatible.
ES-12 (Requires special pollinators)	n - low	0	Wisteria is visited by bumblebees and honey bees (Vididomini 1998; Frankie et al. 2009). The congener, *W. brachybotrys*, is pollinated by several insect species (PFAF 2009). Plants set seed in their introduced range (Trusty 2007).
ES-13 (Minimum generation time)	d - mod	-1	Cultivated wisteria may take 20 years to begin flowering when grown from seed (Foley 1995). Wisterias also reproduce vegetatively from runners (stolons) that periodically root along their nodes to create ramets (Valder 1995; Smith 2008; Sakai 2002). It seems reasonable to assume that vegetative reproduction will have a lower generative time, but it is not precisely known by how much. It is not unreasonable that it may be around 5 years, especially because new ramets may not be entirely self-sufficient for a year or two. Alternate answers for the Monte Carlo simulation were both "c."
ES-14 (Prolific reproduction)	? - max	0	Unknown. A list of characters that have contributed to the invasiveness of Wisterias (*W. sinensis* and *W. floribunda*), mentions fecundity (Trusty 2007), suggesting that it may be a prolific seeder . Each seed pod contains 1-8 seeds, but no reports of numbers of pods/plant (Trusty et al. 2007).
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - high	1	Because wisteria reproduces vegetatively, cuttings in garden waste can lead to new infestations (ISSG 2009).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - mod	-1	We found no evidence.
ES-17 (Number of natural dispersal vectors)	1	-2	Fruit and seed traits for ES-17a - ES17e. *Wisteria sinensis* and *W. floribunda* produce large pods that are 2.5 to 6 inches long by about an inch wide (Miller et al. 2010). They split open to release 1-8 round, flat seeds that are 0.5 to 1 inch in diameter (Miller et al. 2010). Wisteria spp. pods open violently, flinging the seeds away (Valder 1995).
ES-17a (Wind dispersal)	n - low		We found no evidence of wind dispersal. *Wisteria sinensis* and *W. floribunda* pods and seeds are large and heavy (Stone 2009), which would limit wind dispersal.
ES-17b (Water dispersal)	y - mod		Several references report that seeds may be carried downstream in water great distances (Miller et al, 2010; ISSG 2009; Smith 2008), but the references are mostly fact sheets and information summaries that sometimes refer to each other and not to the primary literature. Pods and seeds are large and would likely float. Wisterias do grow along riparian areas sometimes (Miller et al. 2010). Using moderate uncertainty

			because evidence for water dispersal seems to be indirect.
ES-17c (Bird dispersal)	n - low		We found no evidence of bird dispersal. *Wisteria sinensis* and *W. floribunda* pods and seeds are large and heavy which limits dispersal by birds and animals (Stone 2009).
ES-17d (Animal external dispersal)	n - low		There are no structures on wisteria pods or seeds that would stick to animal fur and we found no evidence of animal external dispersal (Stone 2009).
ES-17e (Animal internal dispersal)	n - low		Because of the large seed size, it is thought that animals would be discouraged from dispersing the seeds (Miller et al. 2010; Smith 2008). *Wisteria sinensis* and *W. floribunda* pods and seeds are large and heavy which limits dispersal by birds and animals (Stone 2009).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	n - mod	-1	*Wisteria floribunda* does not form a soil seed bank; seeds lose viability before a year (Sakai 2002). We use moderate uncertainty because this was based on a personal observation by Sakai.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - negl	1	Wisterias resprout after cutting, and control recommendations state to reduce suckers every two weeks during the growing seasons (ISSG 2009). *W. floribunda* produces a web of stolons - with emerging ramets - around its base that extends for dozens of meters (Sakai 2002); assuming resources are not limiting, incomplete removal of the parent plant will likely release many younger stolons and ramets that remain in the soil.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	Wisteria is not listed in as herbicide resistant in the Weed Science Society database (Heap 2014).
ES-21 (Number of cold hardiness zones suitable for its survival)	9	0	
ES-22 (Number of climate types suitable for its survival)	8	2	
ES-23 (Number of precipitation bands suitable for its survival)	10	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	We found no evidence that wisteria is allelopathic. The wisteria taxa evaluated here are relatively well known and a search at the genus level in Web of Science, CABI, and other databases did not yield any results for allelopathy.
Imp-G2 (Parasitic)	n - negl	0	This species is not a member of a plant family known to contain parasitic plants (Nickrent 2014; Heide-Jorgensen 2008).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	? - max		Climbing wisteria vines strangle and kill mature trees, opening the forest canopy and making conditions more favorable to their own aggressive growth by increasing sunlight. (Stone 2009; ISSG 2014; Smith 2008). Plants are nitrogen-fixing and have high leaf nitrogen content potentially increasing soil nitrogen levels (Wang et al. 2011). However, we feel there is not enough direct evidence in the literature yet to state that wisteria

			changes ecosystem processes.
Imp-N2 (Change community structure)	y - negl	0.2	Can overtop and kill trees (ISSG 2014; Langeland 2001). Will create vine thickets (Stone 2009).
Imp-N3 (Change community composition)	y - negl	0.2	"Forms dense thickets allowing little else to grow" (ISSG 2014). Eliminates other species (Stone 2009). "Sizable trees have been killed by vining wisteria. When these large trees are killed, it opens the forest floor to sunlight, which allows seedlings to grow and flourish." (MacDonald et al. 2008).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - mod	0.1	Because wisteria changes ecosystem processes and spreads into natural areas (Stone 2009) it is likely to affect threatened and endangered species.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	y - mod	0.1	Wisteria has been found in rare longleaf pine forests (Stone 2009) where it could change community composition (Stone 2009) and increase soil nitrogen levels (Wang et al. 2011).
Imp-N6 (Weed status in natural systems)	c - negl	0.6	Wisteria is listed as negatively impacting native vegetation in multiple references (Langeland 2001, Smith et al. 2010; ISSG 2014). It is controlled using herbicides and mechanical methods in natural areas (MacDonald et al. 2008, Langeland 2001). Alternate answers for the Monte Carlo simulation are both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	y - low	0.1	Climbs and dislocates gutters, sends suckers under houses and sheds, distorts chain link fencing (assessor's personal observations). One report on Dave's Garden said wisteria crushed their front porch (Dave's Garden 2014). In Australia, one vine was reported to send a sucker underneath the house that grew between the floor and the wall seeking light (GardenWeb 2009).
Imp-A2 (Changes or limits recreational use of an area)	y - mod	0.1	Forests infested with *W. sinensis* lose aesthetic and recreational value (ISSG 2014).
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	y - low	0.1	Aggressive roots disrupt nearby gardens (Gilman 1999). Outcompetes desirable plants in gardens according to numerous postings on Dave's Garden (Dave's Garden 2014).
Imp-A4 (Weed status in anthropogenic systems)	c - negl	0.4	Some homeowners in Australia who have wisteria planted say the plants sucker and they have to pull the suckers out. One homeowner in particular was wondering whether she should pull out her plant entirely (GardenWeb 2009). *Wisteria floribunda* is listed as a weed in Japan where it is native (Enomoto 2003). Numerous reports of control in gardens on Dave's Garden (Dave's Garden 2014). Alternative answers for the Monte Carlo simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	? - max		Wisteria is considered a weed in forestry systems – "Chinese wisteria occurs as severe, dense isolated infestations in forest stands." (Miller 1998), because it girdles small trees and climbs into tree canopies (Miller et al. 2010). However, since no evidence is available on whether wisteria reduces yields in forestry systems we

			are answering "unknown."
Imp-P2 (Lowers commodity value)	n - low	0	We found no evidence that wisteria lowers commodity values.
Imp-P3 (Is it likely to impact trade)	n - low	0	We found no evidence that wisteria is likely to impact trade.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - low	0	We found no evidence that wisteria impacts irrigation or competes for water in production systems.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - low	0.1	Poisonous to mammals (Wiesner 2002; ARS 2014). Wisteria seeds are poisonous to people (Hill 1986; Rondeau 1993).
Imp-P6 (Weed status in production systems)	c - low	0.6	Wisteria is not a weed in agricultural systems, but it is considered a weed with evidence of control in forest plantations in the southeastern United States (Miller 1998). We chose "b" for both alternative answers for the Monte Carlo simulation.
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically-referenced points obtained from the Global Biodiversity Information Facility (GBIF), accessed in 2014. Geo-referenced points from sources other than GBIF are noted as (pt.) Non-geo-referenced locations from GBIF and other sources are noted as occurrences (occ.) that in, present in a region. Data from previous USDA PERAL searches are incorporated here.
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that the plants occur in this zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that the plants occur in this zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that the plants occur in this zone.
Geo-Z4 (Zone 4)	n - negl	N/A	Hebei, China (ARS 2014, occ.). May be suitable for this zone (Dirr 1998)
Geo-Z5 (Zone 5)	y - high	N/A	Hebei, China (Occurrence data: ARS 2014, occ.). Recommended for this zone (Dirr 1998 ; Gilman 1999)
Geo-Z6 (Zone 6)	y - negl	N/A	Hebei, China (ARS 2014. occ.). Switzerland, Japan (GBIF 2009). Recommended for this zone (Dirr 1998; Gilman 1999) Italy, China, Germany, Korea, Japan, NY, MI, CT, NH (GBIF 2014, pt and occ.).
Geo-Z7 (Zone 7)	y - negl	N/A	Recommended for this zone (Dirr 1998; Gilman 1999) Sweden, China, Korea, Japan; TN, CD, MD, NJ, MI, CT (GBIF 2014, pt. and occ.).
Geo-Z8 (Zone 8)	y - negl	N/A	Recommended for this zone (Dirr 1998; Gilman 1999) Netherlands, Germany, Sweden, Croatia, China, Korea, Japan, Australia, AL, SC, MI (GBIF 2014, pt. and occ. data)
Geo-Z9 (Zone 9)	y - negl	N/A	Recommended for this zone (Dirr 1998; Gilman 1999); Spain, France, England, China, Korea, Japan, Australia, New Zealand, CA, LA, FL, GA, MI, NY (GBIF 2014, pt. and occ.).
Geo-Z10 (Zone 10)	y - mod	N/A	Taiwan, Australia, New Zealand, Turkey (GBIF 2014, pt. and occ.).
Geo-Z11 (Zone 11)	y - negl	N/A	Portugal, Spain, Australia, Taiwan (GBIF 2014, pt. and occ.).
Geo-Z12 (Zone 12)	y - low	N/A	We found no evidence that the plants occur in this zone.

Geo-Z13 (Zone 13)	y - low	N/A	Panama, Equitorial Guinea (GBIF 2014, occ.)
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - negl	N/A	Able to grow in humid subtropical, marine west coast, Mediterranean, and possibly humid continental warm summer in China (Espenshade 1995).
Geo-C2 (Tropical savanna)	n - negl	N/A	We found no evidence that the plants occur in this climate class.
Geo-C3 (Steppe)	y - low	N/A	Spain, China, Australia, CA
Geo-C4 (Desert)	n - negl	N/A	We found no evidence that the plants occur in this climate class.
Geo-C5 (Mediterranean)	y - negl	N/A	Portugal, Spain, France, Turkey, CA
Geo-C6 (Humid subtropical)	y - negl	N/A	Croatia, China, Taiwan, Australia, LA, MI, AL, FL, GA, SC, MD, DC
Geo-C7 (Marine west coast)	y - negl	N/A	France, England, China, Japan, Australia, New Zealand
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	China, Japan, NJ, PA, NY, CT
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Sweden, Germany, Italy, Japan, China, MI,NH, NY, RI, CT
Geo-C10 (Subarctic)	y - low	N/A	Germany, France
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that the plants occur in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that the plants occur in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - negl	N/A	45-80 inches in Japan/Korea; 15-65 China. At one site in its native range it receives on average 47 inches (1200mm) per year (Sakai, 2002)
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Spain, France, Sweden, Turkey, Australia, New Zealand
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Spain, France, Sweden, Belgium, China (GBIF 2014, occ.).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Spain, France, Germany, Netherlands, England, Italy, Australia, New Zealand
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	France, Croatia, Australia, New Zealand, SC, MD, DC, NJ, NH, CT, NY
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Spain, New Zealand, AL, TN, NY
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	Spain, LA, AL, FL
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Equatorial Guinea, Japan
Geo-R9 (80-90 inches; 203-229 cm)	y - low	N/A	Taiwan
Geo-R10 (90-100 inches; 229-254 cm)	y - low	N/A	Panama
Geo-R11 (100+ inches; 254+ cm)	y - low	N/A	Taiwan
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Wisteria is widely cultivated in the United States (Dave's Garden 2014) and naturalized in many areas (Kartesz 2014; NRCS 2014; EDDMapS 2014).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	

Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	-	N/A	
Ent-4b (Contaminant of plant propagative material (except seeds))	-	N/A	
Ent-4c (Contaminant of seeds for planting)	-	N/A	
Ent-4d (Contaminant of ballast water)	-	N/A	
Ent-4e (Contaminant of aquarium plants or other aquarium products)	-	N/A	
Ent-4f (Contaminant of landscape products)	-	N/A	
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	-	N/A	
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	-	N/A	
Ent-4i (Contaminant of some other pathway)	-	N/A	
Ent-5 (Likely to enter through natural dispersal)	-	N/A	

Appendix B. Maryland Filter assessment for *Wisteria sinensis* (Sims) DC., *W. floribunda* (Willd.) DC., and *W.* x *formosa* Rehder (Fabaceae).

Maryland Filter questions	Answer	Instructions/Result	Notes
1. Is the plant a sterile cultivar or used only for root stock? yes OR no	no	Go to question 2	Each seed pod contains 1-8 seeds (Trusty et al. 2007)
2. What is the species' potential distribution in Maryland? wide OR narrow	wide	Go to question 3	WRA Geographic analysis - all provinces of Maryland. Observation reports of wisteria naturalized from Ridge and Valley, Blue Ridge, Piedmont, Upper Coastal Plain, Lower Coastal Plain (EDDMapS 2014; personal observation).
3. Does or could the species harm threatened or endangered Maryland species or community types or CITES listed species occurring in MD? yes OR no	?		? - no information available
4. How feasible is control of the species? easy OR difficult	difficult	Go to question 5	vegetative reproduction
5. Is added propagule pressure from sales significantly increasing potential of the species to persist and spread? yes OR no	no	Tier 2	Present in Maryland more than 20 years and present at more than 20 sites.