Weed Risk Assessment for *Iris pseudacorus* L. (Iridaceae) – Yellow flag iris

Maryland Department of Agriculture

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Version 1

Left: *Iris pseudacorus* flower. Right: A colony of *Iris pseudacorus* (source: Bugwood, 2013).

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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 PPQ 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.

	***Iris pseudacorus* L. – Yellow flag iris**
Species Information	Family: Iridaceae
	Synonyms: None.
	Common Names: yellow flag iris, yellow iris, flag iris, yellow water iris, pale-yellow iris
	Botanical Description: Yellow flag iris' stout rhizomes grow in moist to wet soils. Its sword-like leaves grow 3 – 4 ft. tall. Yellow flowers bloom in early summer. Capsules hold many flattened seeds (Ramey and Peichel 2001).
	Initiation: This plant is listed on the MD Department of Natural Resources Do Not Plant List, a policy document available from MD DNR. This plant was initially assessed by APHIS because on July 3, 2013, Mike Reed, Weed Superintendent of Douglas County Environmental Services in Omaha, Nebraska, requested a weed risk assessment after detection of a dense patch of *Iris pseudacorus* in northeast Nebraska (Reed 2013).
	Foreign distribution: *Iris pseudacorus* is native to Europe, the United Kingdom, North Africa, and the Mediterranean (NGRP 2013; Sutherland 1990) and has been introduced into Canada, Argentina, Chile, Uruguay, Australia, New Zealand (NGRP 2013), and South Africa (ARC 2011).
	U.S. distribution and status: *Iris pseudacorus* has been present in the United States as early as 1771 (Stone 2009). The Biota of North America Program (BONAP) database lists it as present in every state in the continental United States except for North Dakota, South Dakota, Wyoming, Colorado, and Arizona (Kartesz 2013). *Iris pseudacorus* is listed as a noxious weed in several states, including Connecticut, Massachusetts, Montana, New Hampshire, Oregon, Washington, and Vermont (Jacobs et al. 2011; NWCB 2011; Ramey and Peichel 2001), and it is listed as a prohibited aquatic plant species in Michigan (Morgan et al. 2012). This plant is widely cultivated and several cultivars exist that have variegated leaves and flowers in different colors (Ramey and Peichel 2001; Sutherland 1990).
	WRA area[1]: Entire United States, including territories.

[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).

Iris pseudacorus L. – Yellow flag iris
Family: Iridaceae

Summary Statement

Yellow flag iris received a "High Risk" potential because of its rapid spread in wetlands and riparian areas. Its dense growth displaces native vegetation and clogs irrigation channels, drainage pipes and flood control ditches. It is ranked as Tier 1 because of its threat to Maryland threatened and endangered species in wetlands and riparian areas.

1. *Iris pseudacorus* analysis

Establishment/Spread Potential

Iris pseudacorus is a fast-growing plant that has naturalized and spread after introduction in New Zealand, North America, and South America (NGRP 2013). *Iris pseudacorus* forms dense thickets in wetlands and riparian areas (ISSG 2013; Ramey and Peichel 2001) as well as in shady areas such as forested wetlands (Stone 2009). This plant spreads by seeds and rhizome fragments that are dispersed in moving water (Sutherland 1990; Weber 2003). Manually removing the plants from rivers can dislodge rhizome pieces that establish new populations downstream (DNRP 2009; Evergreen 2007). We had an average amount of uncertainty for this risk element.
Risk score = 13 Uncertainty index = 0.16

Impact Potential

Iris pseudacorus is controlled in natural environments, urban and suburban settings, and production systems (DNRP 2009; Morgan et al. 2012; Stone 2009). In natural environments, *I. pseudacorus* displaces native vegetation (DNRP 2009; Stone 2009; Weber 2003) and alters river areas by trapping sediment, which creates drier habitats (DNRP 2009; Morgan et al. 2012). In production systems, *I. pseudacorus* is toxic to livestock and clogs irrigation channels (Morgan et al. 2012). *Iris pseudacorus* also has negative impacts in urban and suburban settings, where this plant clogs drainage pipes and flood control ditches (DNRP 2009; Evergreen 2007; Stone 2009), and outcompetes desirable plants in gardens (Dave's Garden 2013; Murrain 2011). We had low uncertainty for this risk element.
Risk score = 4.2 Uncertainty index = 0.07

Geographic Potential

Based on three climatic variables, we estimate that about 89 percent of the United States is suitable for the establishment of *Iris pseudacorus* (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 *I. pseudacorus* represents the joint distribution of Plant Hardiness Zones 3-10, areas with 0-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: Steppe, Desert (likely within protected habitats in this climate class), Mediterranean, Humid subtropical, Marine west coast, Humid continental warm summers, Humid continental cool summers, 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. *Iris pseudacorus* grows in both freshwater and saltwater environments, including fresh- and saltwater marshes, swamp forests, and riparian habitats (Coops and Van Der Velde 1995; Evergreen 2007; Ramey and Peichel 2001; Weber 2003).

Entry Potential We did not assess the entry potential of *Iris pseudacorus* because this species is already present in the United States (ISSG, 2013; Kartesz, 2013; Stone, 2009).

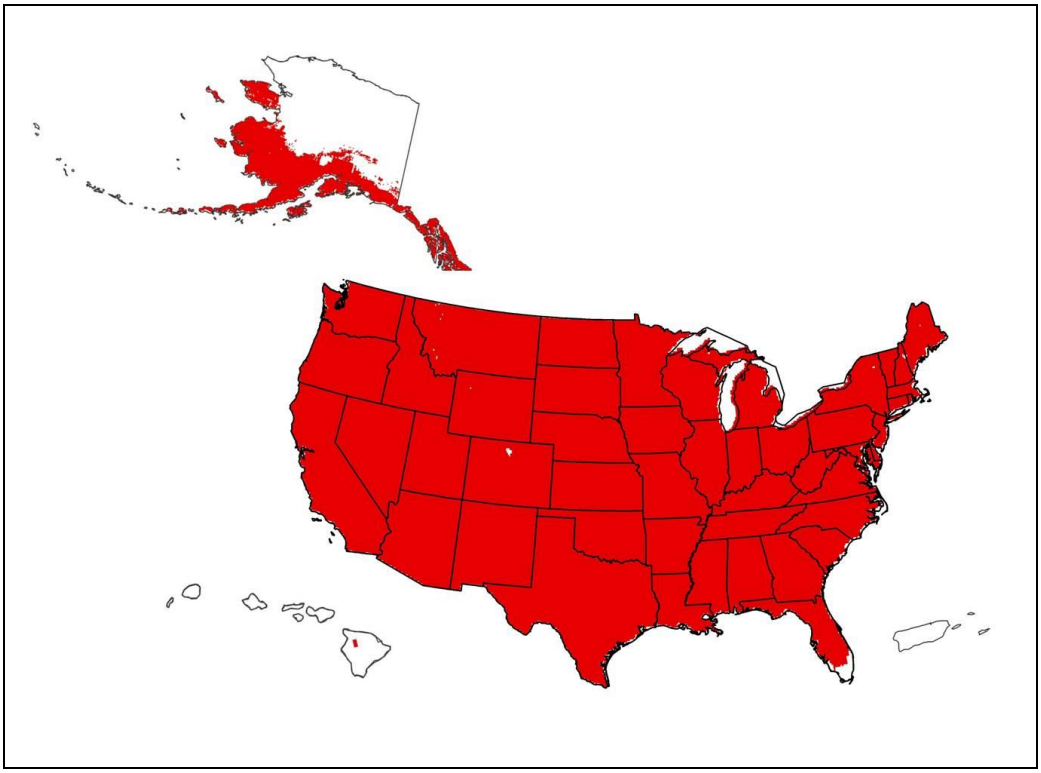

Figure 1. Predicted distribution of *Iris pseudacorus* in the United States. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.

2. Results and Conclusion

Model Probabilities: P(Major Invader) = 81.1%
P(Minor Invader) = 18.2%
P(Non-Invader) = 0.7%

Risk Result = High Risk
Secondary Screening = Not Applicable

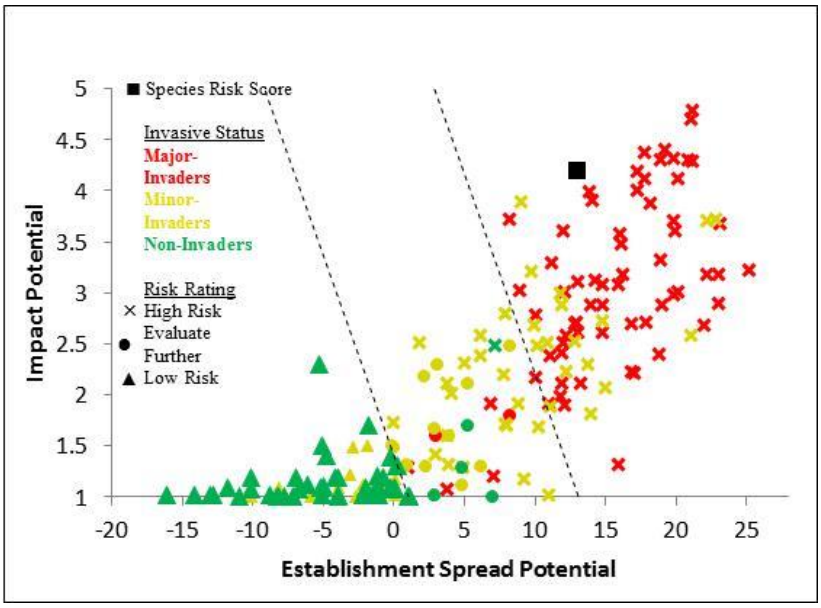

Figure 2. *Iris pseudacorus* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

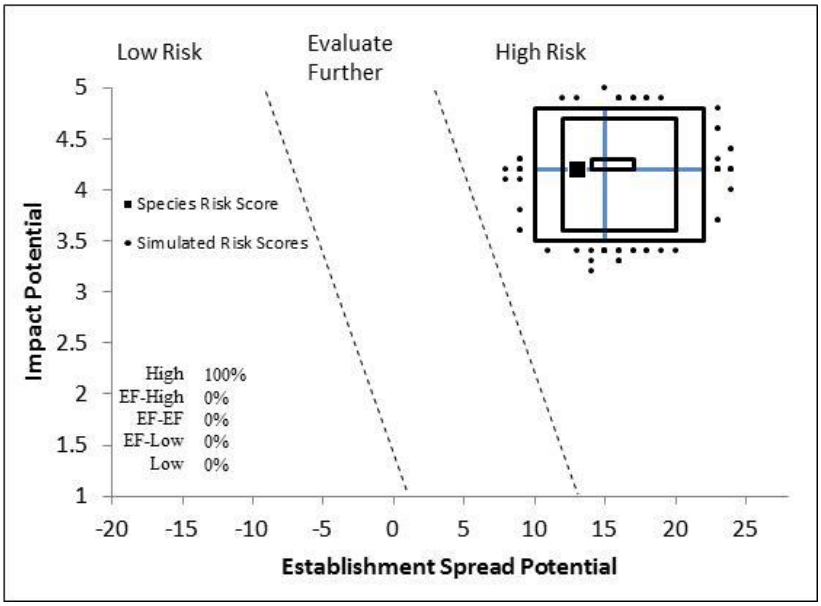

Figure 3. Monte Carlo simulation results (N = 5,000) for uncertainty around the risk scores for *Iris pseudacorus*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *Iris pseudacorus* is High Risk. One hundred percent of the simulated risk scores were in the "High Risk" category in the uncertainty analysis, so our result seems robust (Fig. 3). The risk score for *I. pseudacorus* is similar to that of other major U.S. invaders tested during model development (Fig. 2). *I. pseudacorus* spreads quickly, forms dense stands, is dispersed by water, and is controlled in natural environments, urban and suburban settings, and production systems (ISSG 2013; Morgan et al. 2012; Ramey and Peichel 2001; Stone 2009; Sutherland 1990). It has been said that *I. pseudacorus* will be "one of the few plants flourishing after a nuclear holocaust" (Sutherland 1990). Additionally, *I. pseudacorus* is toxic to animals; the sap from its plants can irritate and blister human skin (ISSG 2013; Morgan et al. 2012), and the plant especially poses a risk to dogs that consume the rhizomes (Burrows and Tyrl 2001). Land managers should be careful when manually removing the plants from rivers, because rhizome pieces can become dislodged and establish new populations downstream (DNRP 2009; Evergreen 2007). Composting rhizome pieces is not recommended, because the plants can grow for months without water (DNRP 2009).

The results of the Maryland Filter rank *Iris pseudacorus* as Tier 1. Iris grows in the same habitat as several Maryland threatened and endangered plants including *Eleocharis rostellata and Bidens mitis.*

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Appendix A. Weed risk assessment for *Iris pseudacorus* L. (Iridaceae). 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 - negl	5	Native to Europe, the United Kingdom, North Africa, and the Mediterranean (NGRP 2013; Sutherland 1990). Introduced into the United States, Canada, Argentina, Chile, Uruguay, Australia, New Zealand (NGRP 2013), and South Africa (ARC 2011). Naturalized in the United States (Burrows and Tyrl 2001). Naturalized in New Zealand, North America, and South America (NGRP 2013). "*Iris pseudacorus* is a fast-growing and fast-spreading invasive plant" (Ramey and Peichel 2001). In Jericho Park in Canada, 1,000 stems of yellow flag were counted in 2004 (Evergreen 2007). During the next survey there were 5,000 stems, a five-fold increase in less than two years. "Yellow flag… is spreading throughout the country...[it] has widely escaped" (Ramey and Peichel 2001). *Iris pseudacorus* was recorded as being "especially abundant" in northeast Tennessee (James 1956). "[Y]ellow flag was reported to be so plentiful in Canadian swamps as to 'have the appearance of a native plant'" (Cody 1961, cited by Ramey and Peichel 2001). Alternate answers for the Monte Carlo simulation were both "e."
ES-2 (Is the species highly domesticated)	n - low	0	Cultivars have been bred to have variegated leaves and flowers in different colors (Ramey and Peichel 2001; Sutherland 1990), and sterile hybrids exist that have been suggested as an alternative to growing *I. pseudacorus* (Hobden and Scott 2013), but we found no evidence that it has been bred for reduced weed potential.
ES-3 (Weedy congeners)	y - low	1	Holm et al. (1979) list *I. foetidissima* as a principal weed in New Zealand, where *I. foetidissima* prevents the growth of native plants and is toxic to livestock (Weedbusters 2013).
ES-4 (Shade tolerant at some stage of its life cycle)	y - low	1	"During the growing season, it can survive at least 28 days of dark" (Morgan et al. 2012). "In wooded or shaded habitats, less flowering occurs and plants tend to spread linearly. Shaded plants tend to have fewer and longer leaves than plants in open areas....low light may limit seedling establishment but not growth of mature pale-yellow iris plants" (Stone 2009). Seeds germinate regardless of light conditions, but the percentage of germination is greater and occurs more rapidly after exposure to light (Gedebo and Froud-Williams 1998).
ES-5 (Climbing or smothering growth form)	n - negl	0	*Iris pseudacorus* is a herbaceous plant with erect leaves and is not a vine (NGRP 2013; Sutherland 1990).
ES-6 (Forms dense thickets)	y - negl	2	"[Y]ellow iris colonizes into large numbers, forming very dense monotypic stands…grow[s] in thickets" (Ramey and Peichel 2001). Grows in "dense clumps" (Sutherland and Walton, 1990). "Form[s] almost impenetrable thickets" in wetlands (Ramey and Peichel 2001). "[M]ay form firm mats" (Weber 2003). "These populations form dense, underwater mats of vegetation" (Morgan et al. 2012).
ES-7 (Aquatic)	n - mod	0	"*Iris pseudacorus* usually grows in sites with a continuously high soil-water content but the soil does not need to be submerged and the plant is capable of growth in dry sandy soil" (Sutherland 1990). "Pale-yellow iris generally establishes in areas that are

			moist but not waterlogged" (Stone 2009). *Iris pseudacorus* occurs at higher positions along the shore of riparian zones and seeds germinate on exposed soil (Coops and Van Der Velde 1995). "[U]sually found near streams" (James 1956). Grows in wet meadows (Coops and Van Der Velde 1995), grasslands, woodlands (Ramey and Peichel 2001), and wetlands (Ramey and Peichel 2001). "In Ireland it was often abundant on waterlogged lower hill-slopes and valleys but rare on wet upper slopes and crests of hills" (Sutherland 1990). The rhizomes can grow when submerged in water 25 cm deep (Sutherland and Walton 1990). During laboratory studies, submerged seeds failed to germinate (Gedebo and Froud-Williams 1998). Rhizomes continue to grow even after three months without water (Ramey and Peichel 2001; Sutherland 1990). "[C]onsidered as [an] emergent aquatic [weed]" (Gedebo and Froud-Williams 1998). Because this plant is able to grow in dry soil, we answered ”no” but used moderate uncertainty.
ES-8 (Grass)	n - negl	0	*Iris pseudacorus* is not a grass; it is a herbaceous plant in the family Iridaceae (NGRP 2013).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	Iridaceae is not a family known to contain nitrogen-fixing species (Martin and Dowd 1990).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Reproduces by seed (Coops and Van Der Velde 1995; Sutherland and Walton 1990).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown. "Pale-yellow iris is a cross-fertilizing species" (Stone 2009).
ES-12 (Requires special pollinators)	n - negl	0	Pollinated by bumblebees (*Bombus* spp.) (Dieringer 1982; Ramey and Peichel 2001; Sutherland 1990), long-tongued flies (Ramey and Peichel 2001; Sutherland 1990), and the hoverfly *Rhingia rostrata* (Sutherland 1990). Also attracts butterflies and hummingbirds (Stone 2009).
ES-13 (Minimum generation time)	b - high	1	In Norfolk, *Iris pseudacorus* flowers in May-July and produces seeds between July and November (Sutherland 1990). Flowers in early spring in warm climates such as Florida, and flowers in the summer in cooler areas such as Canada (Ramey and Peichel 2001). "Plants take three years to mature before flowering" (DNRP 2009). It is a perennial species (Gedebo and Froud-Williams 1998). In Jericho Park in Canada, plants increased five-fold in less than two years (Evergreen 2007). "When plants reach about 10 years of age...rhizomes fragment and contribute to new plant establishment" (Stone 2009). This plant can rapidly multiply over an area through rhizome production (Evergreen 2007). Although it may take several years before ramets connected by rhizomes break apart, we assumed, based on the evidence of 5-fold plant increase, that each ramet produces several new ramets annually, and thus we answered "b" with high uncertainty. The alternate answers for the Monte Carlo simulation were "c" and "a."
ES-14 (Prolific reproduction)	n - mod	-1	"[S]tudies in Poland showed that the density of seedlings was 5-32 m2 but that most of the fragments arose from vegetative growth rather than from seedlings" (Sutherland 1990). Each flowering shoot produces an average of 47 seeds (Coops and Van Der Velde 1995). Each plant produces 5-6 seed-yielding pods per plant. Each fruit contains an average of 120 seeds, about 30 of which will fail (Sutherland 1990). "Each capsule may release up to 120...seeds” but only a small fraction of those were viable (Morgan et al. 2012). Seed germination rates can range from 48

			to 62 percent (Morgan et al. 2012). Based on this evidence, we answered “no” with moderate uncertainty.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - low	1	Manually digging out plants along rivers can dislodge rhizomes that can then be carried downstream (DNRP 2009; Evergreen 2007). During eradication efforts, equipment should be cleaned to avoid spreading seeds and rhizomes (Jacobs et al. 2011).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - mod	-1	We found no evidence that this is true, so we concluded “no” with moderate uncertainty.
ES-17 (Number of natural dispersal vectors)	1	-2	Fruit and seed description used to answer ES-17a through ES-17e: "The capsules are 4-8 cm, elliptic, apiculate; the seeds are dark brown, smooth and very variable in size. The seeds are closely packed in three rows and the majority are disc-like in form" (Sutherland 1990). "Seeds have a hard seed coat beneath which there is a gas space, allowing seeds to float in water" (Stone 2009).
ES-17a (Wind dispersal)	n - low		We found no evidence for this. The seeds do not have any adaptations for wind dispersal.
ES-17b (Water dispersal)	y - negl		Seeds are released onto water surface and can float for over 1000 hours due to the gas space inside seeds and their hard seed coat (Coops and Van Der Velde 1995). Seeds can germinate after being in seawater for 31 days (Ramey and Peichel 2001). Spreads downstream by rhizomes (Ramey and Peichel 2001; Sutherland 1990). Rhizomes and seeds are dispersed by water (Weber 2003). Seeds and rhizomes can also be transported during flood events (Stone 2009).
ES-17c (Bird dispersal)	? - max		"The seeds are not mentioned in the recorded diet of any bird" (Sutherland 1990). "[I]t is suggested that the arrival of *I. pseudacorus* at the island of Vorso, Jutland, was due to seaborne seeds" (Sutherland 1990). Because the seeds do not seem to have any adaptations for wind dispersal, birds may have brought *I. pseudacorus* to the island. However, because this is speculation, we answered “unknown.”
ES-17d (Animal external dispersal)	n - mod		We found no evidence for this, and seeds do not have any adaptations that allow them to adhere to animals.
ES-17e (Animal internal dispersal)	n - mod		*Iris pseudacorus* is toxic and many animals avoid eating this plant (Morgan et al. 2012).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	"The considerable viable seed bank in the soil has meant that areas disturbed in the process of removing yellow flag iris corms are often re-colonized with yellow flag seedlings from the seed bank....thousands of yellow flag iris seedlings...sprouted from the ever-present seed bank. From 2002-2005, 11,996 kg of *Iris pseudacorus* were removed [from the Courtenay River area in Canada]" (Evergreen 2007). About 20 percent of the seeds produced in the fall will germinate in the spring, while another 20 percent of the seeds will germinate the following year (Sutherland 1990). Laboratory tests demonstrated that the best way to store seeds was to bury them underground in fall to early spring (Nakashima and Oki 2005). "In Poland, there are 3 bursts of seed germination; the majority of germination occurs in spring, followed by limited summer and autumn germination" (Stone 2009).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - mod	1	Using a mowing-basket to clean ditches in the Netherlands significantly favored the growth of *I. pseudacorus* plants (Beltman 1987). Manual control can dislodge and spread

			rhizome fragments (DNRP 2009). Broken rhizome pieces reroot (Evergreen 2007). However, several years of intensive mowing can deplete the energy reserves of rhizomes and kill plants (DNRP 2009). Seeds germinate and seedlings grow well in marshes that have been burned (Ramey and Peichel 2001). "Burning is not recommended...plants have a strong tendency to resprout from rhizomes after burning" (DNRP 2009). "Like many wetland plants, pale-yellow iris is not specifically adapted to survive fire. Its tendency to grow at or near the ground surface suggests that fire would likely kill plants and seedlings" (Stone 2009). Based on this evidence, it appears that cultivation and mutilation can dislodge *I. pseudacorus* rhizome fragments and aid in plant dispersal. *Iris pseudacorus* does not appear to be tolerant to fire, but the seedlings are able to rapidly establish in burned areas. Thus, we answered "yes," but used moderate uncertainty due to the conflicting information.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	? - max		"It is susceptible to many herbicides but resistant to Terbutryne" (Sutherland 1990). Not listed by Heap (2013). Effectively controlled by herbicides (ISSG 2013). We answered "unknown" because it is not clear if *Iris pseudacorus* is truly resistant to Terbutryne or merely tolerant.
ES-21 (Number of cold hardiness zones suitable for its survival)	8	0	
ES-22 (Number of climate types suitable for its survival)	8	2	
ES-23 (Number of precipitation bands suitable for its survival)	11	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	We found no evidence for this.
Imp-G2 (Parasitic)	n - negl	0	We found no evidence for this. *Iris pseudacorus* is in the family Iridaceae (NGRP 2013), which is not a family known to contain parasitic plants (Heide-Jørgensen 2008; Nickrent 2009).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	y - negl	0.4	"[Rhizome] mats also alter the habitat…by compacting the soil as well as increasing elevation by trapping sediments.... Studies in Montana show that yellow-flag iris can reduce stream width by up to 10 inches per year by trapping sediment, creating a new bank and then dominating the new substrate with its seedlings, creating still more sediment retention" (DNRP 2009). "Populations...create a positive feedback loop: once established, the roots trap sediment, which enables growth of new seedlings, which in turn trap more sediment....This increase in sedimentation also creates new habitat for shrubs and trees, thereby altering it to a drier ecosystem" (Morgan et al. 2012).
Imp-N2 (Change community structure)	y - low	0.2	"By suppressing willows and providing a raised surface, pale-yellow iris promoted the spread of species not needing a mineral surface for establishment (e.g., green ash). In turn, this change in species composition facilitated the succession from marsh to swamp" (Stone 2009). Forms dense thickets that displace sedges and rushes, which alters animal habitat (Evergreen 2007).
Imp-N3 (Change	y - negl	0.2	"[D]ominates shallow wetlands…rhizome mats can prevent the

community composition)			germination and seedling growth of other plant species" (DNRP 2009). "Established stands of this herb completely eliminate the native vegetation" (Weber 2003). Outcompetes other wetland plants (Ramey and Peichel 2001). "[P]ale-yellow iris may alter historical patterns of plant succession...by displacing native vegetation" (Stone 2009). "*Iris pseudacorus* can also out-compete neighboring plants for pollinators" (Morgan et al. 2012).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - low	0.1	"*Iris pseudacorus* may be a competitive threat to native irises, including *I. brevicaulis*...[and] *I. verna* ([both] listed as threatened in Ohio)" (Morgan et al. 2012). In Washington, "yellow-flag iris displaces native vegetation along streambanks, wetlands, ponds and shorelines and reduces habitat needed by waterfowl and fish, including several important salmon species" (DNRP 2009). On Theodore Roosevelt Island near Washington, DC, *I. pseudacorus* replaced the native green arrow arum, an important food source for native wood ducks (Stone 2009). "[R]educes the food supply and nesting habitat of many fish and waterfowl that depend on wetlands" (Morgan et al. 2012).
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	y - low	0.1	"[P]otential threat to Louisiana wetlands" (Pathikonda et al. 2009). *Iris pseudacorus* grows in freshwater wetlands, salt marshes, and riparian habitats (Coops and Van Der Velde 1995; Ramey and Peichel 2001; Weber 2003) and based on the impacts listed in Imp-N1 through Imp-N3, this plant could alter globally outstanding wetland and riparian habitats in the United States where it does not yet occur, such as the Florida Everglades (Ricketts et al. 1999).
Imp-N6 (Weed status in natural systems)	c - negl	0.6	Controlled in natural systems by herbicides and manually digging out plants (DNRP 2009; Stone 2009; Weber 2003). Alternate answers for the Monte Carlo simulation were both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	y - negl	0.1	*Iris pseudacorus* thickets restrict water flows and affect flood control ditches (Evergreen 2007). Clogs water control structures and pipes (DNRP 2009; Stone 2009).
Imp-A2 (Changes or limits recreational use of an area)	n - mod	0	We found no evidence for this. "Leaves are brittle and susceptible to damage by trampling; thus, the species is absent from areas of pronounced human or animal activity" (Sutherland 1990).
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	y - low	0.1	One gardener wrote, "When it is in its prime habitat of shallow water it becomes a thug. It can seed over an immense area crowding out nearly every other plant" (Murrain 2011). Another gardener says, "[this plant] was planted by the previous owner around our fish pond....it's dominating and crowding out or hiding other plants I'd like to show off" (Dave's Garden 2013). Yet another gardener writes, "I, like an idiot, put this in a small pond in our deck without checking it out first. It has a root mass from Hell and literally took up every square inch of pond space....I am surprised there are any bodies of water in existence with this monster around" (Dave's Garden 2013).
Imp-A4 (Weed status in anthropogenic systems)	c - negl	0.4	Removed from water control structures, pipes, and ditches by herbicides and excavation equipment (Morgan et al. 2012). Controlled manually and with herbicides on roadsides (DNRP 2009). Anecdotal evidence that many gardeners have had to remove this plant from ponds and gardens in their yards (Dave's Garden 2013). Out of the 23 comments about this plant on

			Dave's Garden, 7 comments were positive, 7 were neutral, and 9 were negative (Dave's Garden 2013). Alternate 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)	n - mod	0	We found no evidence for this, so we answered "no."
Imp-P2 (Lowers commodity value)	y - low	0.2	Occurs in meadows and wet pastures and may reduce available forage for livestock (Stone 2009). "Because palatable species go relatively untouched when intermingled with *I. pseudacorus*, the quality of pastureland can be reduced" (Morgan et al. 2012).
Imp-P3 (Is it likely to impact trade)	n - mod	0	Listed as a noxious weed in several states, including Connecticut, Massachusetts, Montana, New Hampshire, Oregon, Washington, and Vermont (Jacobs et al. 2011; NWCB 2011; Ramey and Peichel 2001). Listed as a prohibited aquatic plant species in Michigan (Morgan et al. 2012). However, because this plant is unlikely to be a contaminant in trade, we answered "no" with moderate uncertainty.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	y - negl	0.1	*Iris pseudacorus* thickets restrict water flow in irrigation canals (Evergreen 2007). Clogs irrigation systems (DNRP 2009; Stone 2009).
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - negl	0.1	Toxic to all animal species, causing burn-like sores on lips, abdominal pain, and diarrhea that can result in dehydration. Dogs are especially at risk because they may find and consume the rhizomes (Burrows and Tyrl 2001). "Hay containing the plant fed to animals commonly causes gastroenteritis, and an outbreak of acute diarrhea in cattle occurred in the West Highlands of Scotland due to cattle eating the rhizomes" (Sutherland 1990). "*Iris pseudacorus* is usually ignored by cattle, sheep, ponies, goats and rabbits" (Sutherland 1990), but cattle may eat the foliage down to rhizomes when other foliage is unavailable (Stone 2009). Poisonous (Morgan et al. 2012).
Imp-P6 (Weed status in production systems)	c - mod	0.6	Controlled in irrigation systems by herbicides and excavation equipment (DNRP 2009; Morgan et al. 2012). Alternate answers for the Monte Carlo simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically-referenced points obtained from the Global Biodiversity Information Facility (GBIF), accessed in 2013. 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 is, presence in a region. Data from earlier USDA PERAL searches are incorporated here.
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - low	N/A	We found no evidence it occurs in this zone.
Geo-Z2 (Zone 2)	n - high	N/A	We found no evidence it occurs in this zone.
Geo-Z3 (Zone 3)	y - low	N/A	USA (Minnesota) (Kartesz 2013, occ.).
Geo-Z4 (Zone 4)	y - negl	N/A	USA (Vermont), Canada (Quebec) (GBIF 2013).
Geo-Z5 (Zone 5)	y - negl	N/A	USA (New York, Vermont) (GBIF 2013).
Geo-Z6 (Zone 6)	y - negl	N/A	USA (Kansas, Missouri, Ohio) (GBIF 2013).
Geo-Z7 (Zone 7)	y - negl	N/A	USA (Washington, Oregon, New Jersey), Germany (GBIF 2013).
Geo-Z8 (Zone 8)	y - negl	N/A	USA (Alabama, Oregon), Chile, France (GBIF 2013).
Geo-Z9 (Zone 9)	y - negl	N/A	USA (Louisiana, California), France (GBIF 2013).
Geo-Z10 (Zone 10)	y - negl	N/A	USA (California) (GBIF 2013).

Geo-Z11 (Zone 11)	n - mod	N/A	We found no evidence that the plant occurs in this zone.
Geo-Z12 (Zone 12)	n - low	N/A	We found no evidence that the plant occurs in this zone.
Geo-Z13 (Zone 13)	n - low	N/A	We found no evidence that the plant occurs in this zone.
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - mod	N/A	We found no evidence that the plant occurs in this zone.
Geo-C2 (Tropical savanna)	n - mod	N/A	We found no evidence that the plant occurs in this zone.
Geo-C3 (Steppe)	y - negl	N/A	USA (California, Washington), Spain (GBIF 2013).
Geo-C4 (Desert)	y - mod	N/A	One point in the United States (Washington), and one point in Spain (GBIF 2013).
Geo-C5 (Mediterranean)	y - negl	N/A	USA (California), Spain (GBIF 2013).
Geo-C6 (Humid subtropical)	y - negl	N/A	USA (Maryland, Louisiana, Alabama) (GBIF 2013).
Geo-C7 (Marine west coast)	y - negl	N/A	France, UK (GBIF 2013).
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	USA (Connecticut, Missouri, Kansas) (GBIF 2013).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Canada (Quebec), USA (New York) (GBIF 2013).
Geo-C10 (Subarctic)	y - low	N/A	USA (New Hampshire) (GBIF 2013).
Geo-C11 (Tundra)	n - mod	N/A	We found no evidence that the plant occurs in this zone.
Geo-C12 (Icecap)	n - low	N/A	We found no evidence that the plant occurs in this zone.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - mod	N/A	USA (Washington) (GBIF 2013; Kartesz 2013, occ.).
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Spain (GBIF 2013).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	France, Germany (GBIF 2013).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Portugal, France (GBIF 2013).
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Ireland (GBIF 2013).
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Ireland (GBIF 2013).
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	UK, USA (Louisiana) (GBIF 2013).
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	UK, USA (Washington) (GBIF 2013).
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Japan (GBIF 2013).
Geo-R10 (90-100 inches; 229-254 cm)	y - low	N/A	USA (Washington) (Kartesz 2013, occ.).
Geo-R11 (100+ inches; 254+ cm)	y - low	N/A	USA (Washington (Kartesz 2013, occ.).
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	*Iris pseudacorus* has been in the United States from as early as 1771 (Stone 2009). The BONAP database lists it as present in every state in the continental United States except for North Dakota, South Dakota, Wyoming, Colorado, and Arizona (Kartesz 2013).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value &	-	N/A	

cultivation/trade status)		
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 *Iris pseudacorus* L. (Iridaceae).

Maryland Filter questions	Answer	Instructions/Result	Notes
1. Is the plant a sterile cultivar or used for root stock only? yes OR no	no	Go to question 2	Cultivars have been bred to have variegated leaves and flowers in different colors such as 'Alba,' 'Gigantea,' 'Golden Fleece,' 'Holden Clough,' 'Mandschurica' (Ramey and Peichel 2001; Sutherland 1990), and sterile hybrids exist that have been suggested as an alternative to growing *I. pseudacorus* (Hobden and Scott 2013), but we found no evidence that it has been bred for reduced weed potential.
2. Is the plant currently cultivated in Maryland? Yes OR no	yes	Go to Question 3	
3. What is the species' potential distribution in Maryland? wide OR narrow	wide	Go to question 4	Present in the Coastal Plain, Piedmont, and Blue Ridge physiographic provinces (EDDMapS 2015).
4. Does or could the species harm threatened or endangered Maryland species or community types or CITES listed species occurring in MD? yes OR no	yes	**Tier 1**	In Maryland, pale-yellow iris was found in marshes dominated by calamus (*Acorus calamus*) and in swamps with longbeak arrowhead (*Sagittaria australis*), Gray's sedge (*Carex grayi*), shallow sedge (*C. lurida*), golden ragwort (*Packera aurea*), marsh blue violet (*Viola cucullata*), sweet woodreed (*Cinna arundinacea*), goldenclub (*Orontium aquaticum*), common winterberry (*Ilex verticillata*), hazel alder (*Alnus serrulata*), southern arrowwood (*Viburnum dentatum*), Virginia sweetspire (*Itea virginica*), sweetbay (*Magnolia virginiana*), green ash, and

			buttonbush (*Cephalanthus occidentalis*) (MD DNR 2015). Communities of these types often contain Maryland threatened and endangered species. "*Iris pseudacorus* may be a competitive threat to native irises, including *I. brevicaulis*...[and] *I. verna* ([both] listed as threatened in Ohio)" (Morgan et al. 2012). In Washington, "yellow-flag iris displaces native vegetation along streambanks, wetlands, ponds and shorelines and reduces habitat needed by waterfowl and fish, including several important salmon species" (DNRP 2009). On Theodore Roosevelt Island near Washington, DC, *I. pseudacorus* replaced the native green arrow arum, an important food source for native wood ducks (Stone 2009). "[R]educes the food supply and nesting habitat of many fish and waterfowl that depend on wetlands" (Morgan et al. 2012). In Massachusetts *I. pseuda-corus* grows in forest seep communities that harbor state listed threatened and endangered species (Swain and Kearsley 2001).
5. How feasible is control of the species? easy OR difficult			Questions 5 and 6 are not answered because question 4 resulted in a ranking of Tier 1.
6. Is added propagule pressure from sales significantly increasing potential of the species to persist and spread? yes OR no			