United States Department of Agriculture

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

United States Department of Agriculture

Animal and Plant Health Inspection Service

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Version 1

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

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Introduction Plant Protection and Quarantine (PPQ) regulates noxious weeds under the authority of the Plant Protection Act (7 U.S.C. § 7701-7786, 2000) and the Federal Seed Act (7 U.S.C. § 1581-1610, 1939). A noxious weed is defined as "any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment" (7 U.S.C. § 7701-7786, 2000). We use weed risk assessment (WRA)—specifically, the PPQ WRA model (Koop et al., 2012)—to evaluate the risk potential of plants, including those newly detected in the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

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 area within it. As part of this analysis, we use a stochastic simulation to evaluate how much the uncertainty associated with the analysis affects the model outcomes. We also use GIS overlays to evaluate those areas of the United States that may be suitable for the establishment of the plant. For more information on the PPQ WRA process, please refer to the document, *Background information on the PPQ Weed Risk Assessment*, which is available upon request.

Iris pseudacorus L. – Yellow flag iris

Species Information

Family: Iridaceae

Synonyms: None.

Initiation: 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. This WRA is intended to assist the Nebraska Weed Control Association in making a management decision regarding this weed (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. *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.

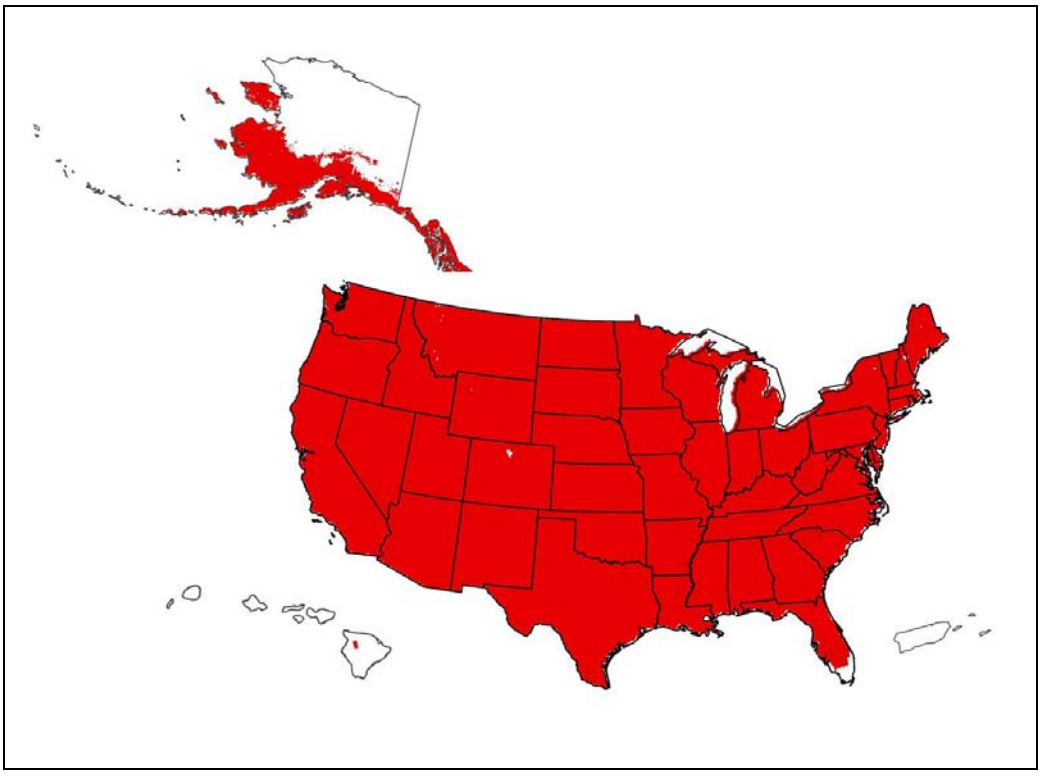
The area estimated likely represents a conservative estimate as it only uses three climatic variables. Other environmental variables, such as soil and

[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).

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 salt water 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.

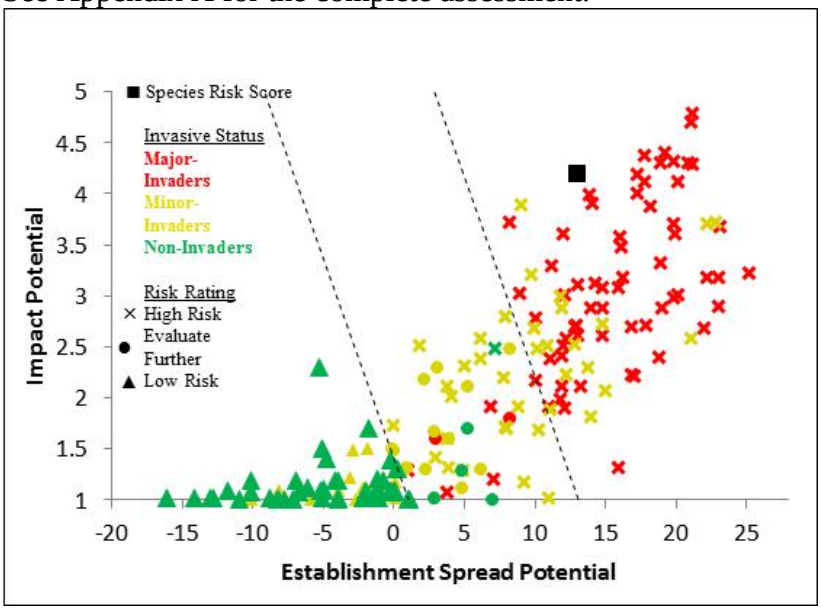
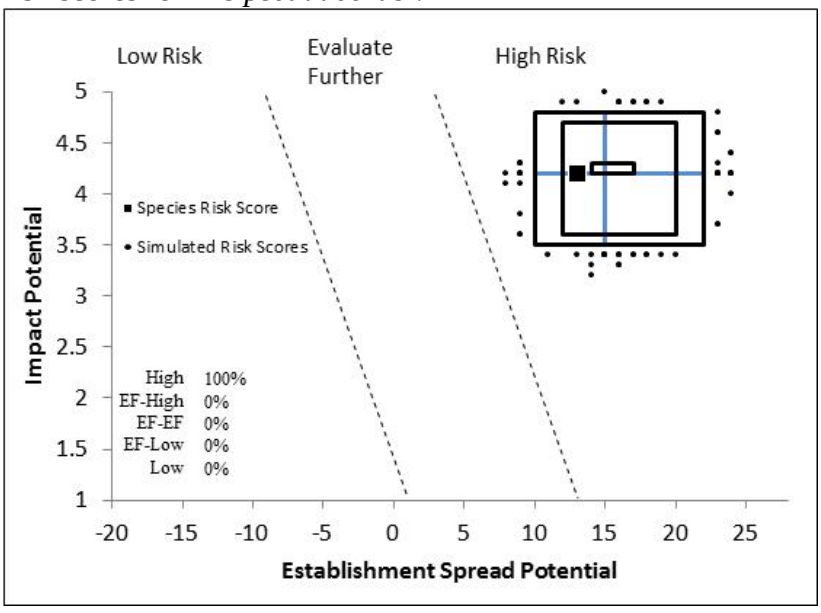


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Iris pseudacorus*[a].



[a] 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 *Iris pseudacorus* is similar to that of other major U.S. invaders tested during model development (Fig. 2). *Iris pseudacorus* spreads quickly, forms dense thickets, 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).

4. Literature Cited

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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* 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 moderate 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, answering 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 re-root (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, answering 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 diarrhoea 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			Below, p.s. refers to Point Source data (i.e., geo-referenced data points) and occur. refers to occurrence-only data (i.e., presence in a region).
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	The United States (Minnesota) (Kartesz, 2013, occur.).
Geo-Z4 (Zone 4)	y - negl	N/A	The United States (Vermont), Canada (Quebec) (GBIF, 2013, p.s.).
Geo-Z5 (Zone 5)	y - negl	N/A	The United States (New York, Vermont) (GBIF, 2013, p.s.).
Geo-Z6 (Zone 6)	y - negl	N/A	The United States (Kansas, Missouri, Ohio) (GBIF, 2013, p.s.).
Geo-Z7 (Zone 7)	y - negl	N/A	The United States (Washington, Oregon, New Jersey), Germany (GBIF, 2013, p.s.).
Geo-Z8 (Zone 8)	y - negl	N/A	The United States (Alabama, Oregon), Chile, France (GBIF, 2013, p.s.).
Geo-Z9 (Zone 9)	y - negl	N/A	The United States (Louisiana, California), France (GBIF, 2013, p.s.).
Geo-Z10 (Zone 10)	y - negl	N/A	The United States (California) (GBIF, 2013, p.s.).
Geo-Z11 (Zone 11)	n - mod	N/A	We found no evidence it occurs in this zone.

Geo-Z12 (Zone 12)	n - low	N/A	We found no evidence it occurs in this zone.
Geo-Z13 (Zone 13)	n - low	N/A	We found no evidence it occurs in this zone.
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - mod	N/A	We found no evidence it occurs in this zone.
Geo-C2 (Tropical savanna)	n - mod	N/A	We found no evidence it occurs in this zone.
Geo-C3 (Steppe)	y - negl	N/A	The United States (California, Washington), Spain (GBIF, 2013, p.s.).
Geo-C4 (Desert)	y - mod	N/A	One point in the United States (Washington), and one point in Spain (GBIF, 2013, p.s.).
Geo-C5 (Mediterranean)	y - negl	N/A	The United States (California), Spain (GBIF, 2013, p.s.).
Geo-C6 (Humid subtropical)	y - negl	N/A	The United States (Maryland, Louisiana, Alabama) (GBIF, 2013, p.s.).
Geo-C7 (Marine west coast)	y - negl	N/A	France, the United Kingdom (GBIF, 2013, p.s.).
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	The United States (Connecticut, Missouri, Kansas) (GBIF, 2013, p.s.).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Canada (Quebec), The United States (New York) (GBIF, 2013, p.s.).
Geo-C10 (Subarctic)	y - low	N/A	The United States (New Hampshire) (GBIF, 2013, p.s.).
Geo-C11 (Tundra)	n - mod	N/A	We found no evidence it occurs in this zone.
Geo-C12 (Icecap)	n - low	N/A	We found no evidence it occurs in this zone.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - mod	N/A	The United States (Washington) (GBIF, 2013, p.s.; Kartesz, 2013, occur.).
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Spain (GBIF, 2013, p.s.).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	France, Germany (GBIF, 2013, p.s.).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Portugal, France (GBIF, 2013, p.s.).
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Ireland (GBIF, 2013, p.s.).
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Ireland (GBIF, 2013, p.s.).
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	The United Kingdom, the United States (Louisiana) (GBIF, 2013, p.s.).
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	The United Kingdom, the United States (Washington) (GBIF, 2013, p.s.).
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Japan (GBIF, 2013, p.s.).
Geo-R10 (90-100 inches; 229-254 cm)	y - low	N/A	The United States (Washington) (Kartesz, 2013, occur.).
Geo-R11 (100+ inches; 254+ cm)	y - low	N/A	The United States (Washington (Kartesz, 2013, occur.).
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