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Version 1

Weed Risk Assessment for *Hygrophila difformis* (L. f.) Blume (Acanthaceae) – Water wisteria

Left: Emerged form of *Hygrophila difformis* (source: UF Herbarium, 2009). Right: Submerged *H. difformis* plant (source: Tsunamicarlos, 2006).

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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.

Hygrophila difformis (L. f.) Blume – Water wisteria

Species Information

Family: Acanthaceae

Synonyms: *Hygrophila difformis* Blume. May also be a synonym of *H. triflora* (Roxb.) Fosberg & Sachet (The Plant List, 2010).

Common names: Water wisteria (NGRP, 2014).

Botanical description: *Hygrophila difformis* is a herbaceous aquatic plant that can grow emerged or fully submerged. It can grow 20-50 cm tall and has slender, lacy leaves when grown submerged. When *H. difformis* is grown out of water, its leaves become smaller, serrated, and covered in glandular hairs (Krishanu, 2012; von Blume, 1826).

Initiation: PPQ received a market access request for *Hygrophila corymbosa*, *H. difformis*, *H. pinnatifida*, and *H. polysperma* aquatic plants for propagation from the Ministry of Food, Agriculture and Fisheries of the Danish Plant Directorate (MFAF, 2009). These *Hygrophila* species are not native to the United States (NGRP, 2014), and may pose a threat to the United States. For example, *H. polysperma* is a Federal Noxious Weed (NRCS, 2014). Thus, the PERAL weed team initiated a weed risk assessment for *H. difformis*.

Foreign distribution: This species is native to India, Thailand (Bailey and Bailey, 1976), Bangladesh, Bhutan, and Nepal (NGRP, 2014). It has been introduced to and naturalized in Taiwan (Wu et al., 2010).

U.S. distribution and status: *Hygrophila difformis* has been cultivated as an aquarium plant in the United States since the 1970s (Bailey and Bailey, 1976; Rataj and Horeman, 1977). It is widely available in the United States from several large, big-box pet supply retailers (PetCo, 2013; PetSmart, 2013). More recently, *H. difformis* is naturalized in Hillsborough County in Florida (Kartesz, 2014; NRCS, 2014).

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

1. *Hygrophila difformis* analysis

Establishment/Spread Potential   *Hygrophila difformis* is an aquatic plant that can grow emerged or fully submerged (Mukherjee, 2011). It has been introduced to and become naturalized in Taiwan (Wu et al., 2010) and Florida (NRCS, 2014; USF Herbarium, 2014). Like other *Hygrophila* species, *H. difformis* easily re-roots from side-shoots and vegetative pieces (Paghat, 2013; Wilson, 2006). We had very high uncertainty in this risk element due to the lack of information on the biology of this species; we answered several questions based on general information about the genus *Hygrophila*.

Risk score = 16   Uncertainty index = 0.37

Impact Potential   *Hygrophila difformis* can quickly crowd out other plants in aquariums (Paghat, 2013; The Planted Tank, 2014) and has been reported to be a weed of rice fields in its native range (Bailey and Bailey, 1976; Moody, 1989). We found no evidence that *H. difformis* causes negative impacts in its introduced range, but that may be because those range expansions occurred only very recently (see above). Because we do not know if *H. difformis* will cause impacts in the future, we answered many of the questions in the impact section as unknown, which gave very high uncertainty for this risk element.

Risk score = 1.6   Uncertainty index = 0.54

Geographic Potential   Based on three climatic variables, we estimate that about 21 percent of the United States is suitable for the establishment of *H. difformis* (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 *H. difformis* represents the joint distribution of Plant Hardiness Zones 8-13, areas with 0-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savanna, steppe, humid subtropical, and marine west coast. If grown submerged, *H. difformis* may be suitable for areas with less than 20 inches of rainfall, but we had high uncertainty about this. Because we found very little geo-referenced point source data for this species, we had greater than

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[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).

average uncertainty for this section.

The area estimated likely represents a conservative estimate as it only uses 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. *Hygrophila difformis* is an aquatic plant that can grow submerged or straggling over the water surface (Mukherjee, 2011). It occurs in marshy habitats in its native range in India (Kasselmann, 2003; Krishanu, 2012).

Entry Potential We did not assess the entry potential of *H. difformis* because it is already present in the United States in Florida (Kartesz, 2014; NRCS, 2014; USF Herbarium, 2014).
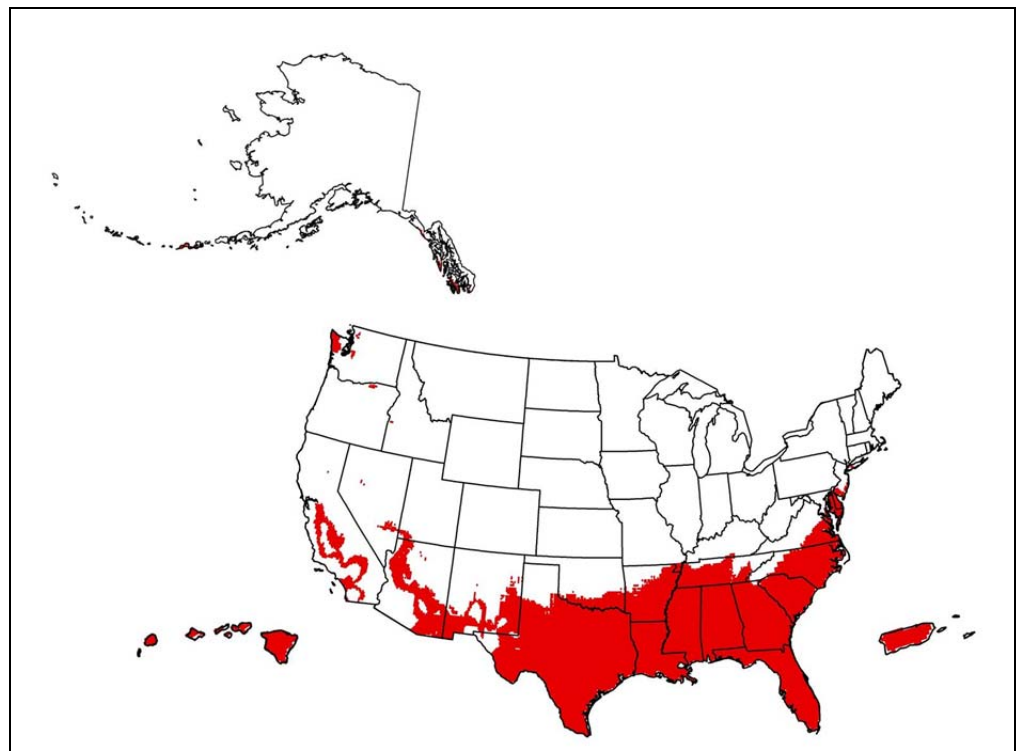

Figure 1. Predicted distribution of *H. difformis* in the United States. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.

2. Results

Model Probabilities: P(Major Invader) = 64.5%
P(Minor Invader) = 33.9%
P(Non-Invader) = 1.6%

Risk Result = High Risk
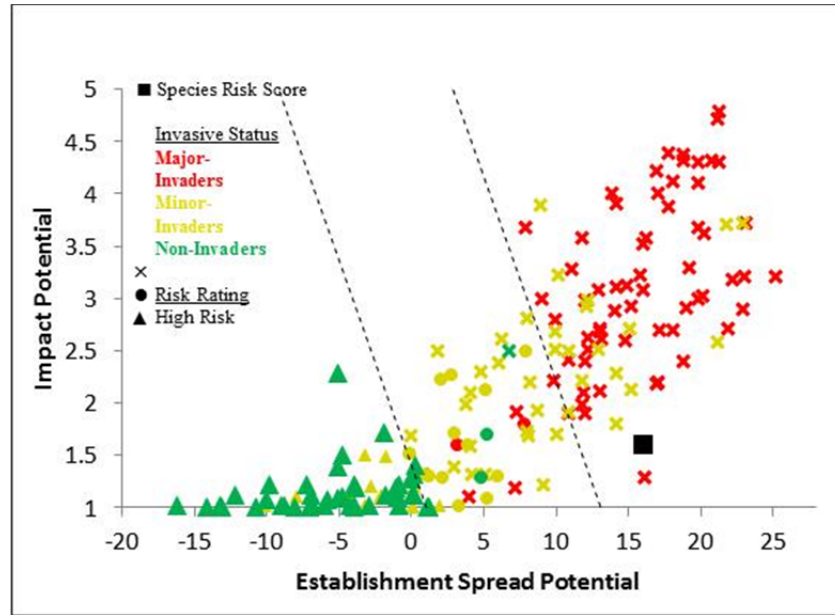Secondary Screening = Not Applicable

Figure 2. *Hygrophila difformis* 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.
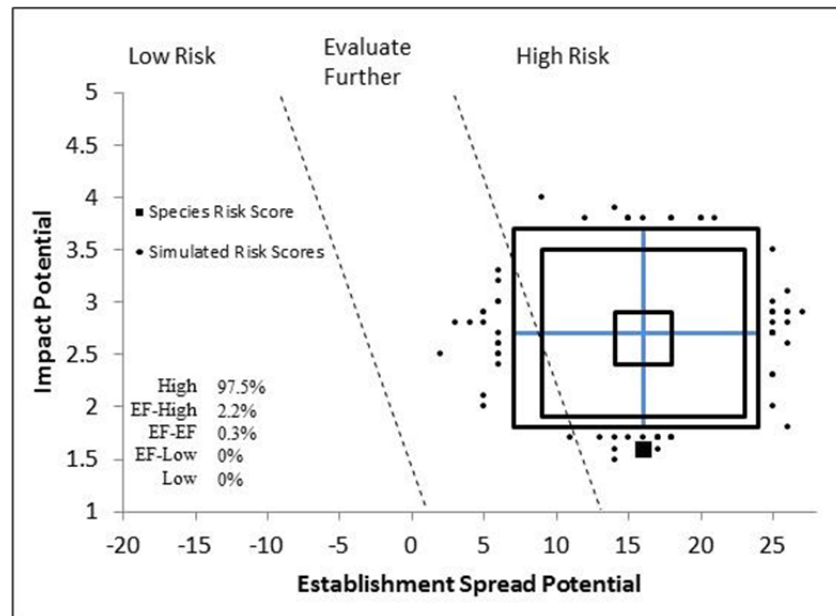

Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *Hygrophila difformis*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *H. difformis* is High Risk. It received this result because this plant species has many establishment and spread traits in common with other U.S. major invaders (Fig. 2). Our overall uncertainty for this risk assessment was very high, but 64.5 percent of our simulated risk scores received a score of High Risk (Fig. 3). The Texas Parks and Wildlife Department used a version of the Australian Weed Risk Assessment (Pheloung et al., 1999) modified for aquatic plants and conducted weed risk assessments for several *Hygrophila* species (Chilton, 2014). *Hygrophila difformis* received a score of 9 (Cook-Hildreth, 2014), greater than the "Reject" threshold score of 6, which corroborates our rating.

We found no evidence of *H. difformis* having any negative impacts, but that may be because this species has only very recently naturalized outside its native range (see above). Compared to the other three *Hygrophila* species we assessed (*H. corymbosa*, *H. pinnatifida*, and *H. polysperma*) *H. difformis* is more widely available for retail sale (see above).

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Appendix A. Weed risk assessment for *Hygrophila difformis* (L. f.) Blume (Acanthaceae). 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 - mod	5	Native to India, Thailand (Bailey and Bailey, 1976), Bangladesh, Bhutan, and Nepal (NGRP, 2014). Introduced to and naturalized in Taiwan (Wu et al., 2010). Naturalized in Hillsborough County in Florida (Kartesz, 2014; NRCS, 2014), where it was described as "spreading" (USF Herbarium, 2014). Based on this evidence, we answered "f." The alternate answers for the Monte Carlo simulation were both "e."
ES-2 (Is the species highly domesticated)	n - mod	0	Pink (Windeløv, 2004), white (Kasselmann, 2003), and bi-color varieties are available for sale (Wilson, 2006), but we found no evidence of breeding efforts for reduced weediness.
ES-3 (Weedy congeners)	y - negl	1	*Hygrophila costata*, which is native to North and South America, is a Class 2 Regionally Prohibited Weed in New South Wales, Australia (all outbreaks must be reported within 24 hours, eradicated from any sites where it is present, and the plant is prohibited from sale) because *H. costata* displaces native species and interferes with boating and recreational water activities (Gorham and Hosking, 2013). Holm et al. (1979) list *Hygrophila pobeguini* as a significant weed in Nigeria, *H. angustifolia* as a principal weed in Cambodia, and *H. phlomoides* as a principal weed in India and Cambodia.
ES-4 (Shade tolerant at some stage of its life cycle)	y - high	1	Occurs in shady places along the banks of rice fields in India (Pandey and Tripathi, 2010). Grows in a range of light conditions in aquariums, from low light to high light (The Planted Tank, 2014). Medium to very high light is recommended for growth in aquariums (Wilson, 2006; Windeløv, 2004). Requires high light for good growth in aquariums (Pal and Samanta, 2011). The related species *H. polysperma* has "low light compensation and saturation points for photosynthesis" and is a "shaded-adapted...able to show net CO_2 uptake under very low light conditions" (Spencer and Bowes, 1985). Based on this evidence, we answered yes, but with high uncertainty.
ES-5 (Climbing or smothering growth form)	n - low	0	*Hygrophila difformis* is not a vine; it is an aquatic plant with decumbent or upright shoots, 30-80 cm long (Kasselmann, 2003).
ES-6 (Forms dense thickets)	? - max	0	When grown in aquaria, "in the long run there will be so much wisteria floating on the surface that big nets of it can be removed....If fish or aquatic amphibians live with it, it will need no fertilizing at all to reach its potential foot-tall very thick bushiness, & in general grows...fast" (Paghat, 2013). Described as "bushy" by several aquarists posting online (PetSmart, 2013). Based on this evidence, we answered unknown because our answer was based on the plant's behavior in aquariums, not in the wild.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-7 (Aquatic)	y - negl	1	Submerged aquatic plant (Bailey and Bailey, 1976). "May be bottom-rooted or straggling over [the water] surface" (Mukherjee, 2011).
ES-8 (Grass)	n - negl	0	Not a grass; aquatic plant in the family Acanthaceae (NGRP, 2014).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	Herbaceous plant in the family Acanthaceae (Bailey and Bailey, 1976; NRCS, 2014).which is not known to contain nitrogen-fixing species (Martin and Dowd, 1990).
ES-10 (Does it produce viable seeds or spores)	? - max	0	Representative drawing of seeds (Gunn and Ritchie, 1988). The specimen from Hillsborough County in Florida was flowering (USF Herbarium, 2014). Seeds rarely develop in cultivation (Kasselmann, 2003). Other species of *Hygrophila* produce viable seeds (Amritphale et al., 1993; Gorham and Hosking, 2013; Les and Wunderlin, 1981). We answered unknown because we do not know if the seeds produced by *H. difformis* are viable.
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown.
ES-12 (Requires special pollinators)	n - mod	0	We found no information for *Hygrophila difformis*. Other species of *Hygrophila* do not require specialist pollinators: *Hygrophila pogonocalyx* is pollinated by bees (Huang et al., 2001) and *H. polysperma* is thought to be self-pollinated (Les and Wunderlin, 1981). Based on this information, we answered no, but with high uncertainty.
ES-13 (Minimum generation time)	b - high	1	*Hygrophila difformis* is a perennial plant (Mukherjee, 2011; NRCS, 2014). Flowers and fruits from August to March in its native habitat in India (Pandey and Tripathi, 2010), but we found no information on how long it takes to begin producing seeds after germinating. With respect to vegetative reproduction, *H. difformis* grows rapidly in in aquariums (Windeløv, 2004). Adventitious plants form on floating leaves (Kasselmann, 2003). "A gravel-rooted wisteria will grow larger & larger for several months, but eventually it starts producing young plants on its leaves, & the whole specimen begins to fall apart to float to the surface as numerous young plants" (Paghat, 2013). Based on the rapid vegetative reproduction of this plant, we answered "b" but used high uncertainty because the generative time is not explicitly stated in the literature. The alternate answers for the Monte Carlo simulation were both "a."
ES-14 (Prolific reproduction)	? - max	0	Unknown.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - mod	1	We found no evidence for *H. difformis*. The related species *H. costata* is spread by machinery and watercraft (Gorham and Hosking, 2013), and *H. polysperma* was likely introduced into Texas "directly through cultivation by local aquatic plant nurseries...or indirectly through careless dumping by aquarists" (Angerstein and Lemke, 1994). Based on this evidence, we answered yes, but with moderate uncertainty because this information is based on congeners.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - high	2	We did not find any information specific to *H. difformis*, but the related species *H. polysperma* can move as a "hitchhiker" plant with other species ordered through water garden catalogs (Nault and Mikulyuk, 2009), and aquatic plants in general are easily moved with aquatic organisms in the horticultural trade though (Maki and Galatowitsch, 2004). Based on this evidence, we answered yes, but with high uncertainty.
ES-17 (Number of natural dispersal vectors)	2	0	Genus-level seed description used to answer ES-17a through ES-17e: "Seeds discoid, covered with long mucilaginous trichomes" (Zhengyi et al., 2014).
ES-17a (Wind dispersal)	n - mod		We found no evidence for this species. The related species *H. costata* is described as spreading by wind and water (Gorham and Hosking, 2013) but this may mean wind moves plant stems along the water surface.
ES-17b (Water dispersal)	y - low		Species of *Hygrophila* "...have adpressed seed hairs, which are erected in water to form a slimy mass" which enlarges the surface area of the seeds and allows the seeds to float on water (van der Pijl, 1982). Other species of *Hygrophila* are dispersed by water (Gorham and Hosking, 2013; Sutton, 1995).
ES-17c (Bird dispersal)	? - max		Aquatic plants in general are frequently dispersed by waterfowl (Figuerola and Green, 2002) but we found no direct evidence that this occurs for *Hygrophila*. Thus, we answered unknown.
ES-17d (Animal external dispersal)	y - high		The related species *H. costata* spreads to new areas "when seeds and plant fragments attach to animals" (Gorham and Hosking, 2013) and *H. polysperma* is transported "by wildlife moving between water bodies" (Nault and Mikulyuk, 2009). Based on this evidence and the genus-level seed description, we answered yes, but with high uncertainty because our answer was based on congeneric information.
ES-17e (Animal internal dispersal)	n - mod		We found no evidence that *Hygrophila* species are dispersed this way.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	? - max	0	Unknown. We found no evidence about seed dormancy in *H. difformis*. However, secondary dormancy (when seeds become dormant under certain unfavorable environmental conditions) can be triggered in the related species *H. auriculata* by storing seeds in the dark for 5-20 days (Amritphale et al., 1993).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - negl	1	"All the trimmed scraps of an often-restarted single specimen [of *H. difformis*] are capable of generating new [plants]" and new *H. difformis* plants are plants produced along the main leaves (Kasselmann, 2003; Paghat, 2013). Plants in the genus *Hygrophila* easily reroot from cut stem pieces to produce new plants (Wilson, 2006). One aquarist writes, "when it gets too big, just cut it off where ever you feel like with scissors. It will get too big! Planting? Umm, chuck it in, get it stuck in the gravel, or near the gravel, it'll root. It's not picky about substrate in the least. If you have some, it'll root." Another writes, "Even a single leaf that got ripped off would grow roots and more leaves, even a small stem!" (The Planted Tank, 2014).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - mod	0	We found no evidence of herbicide resistance or tolerance in *H. difformis*. Not listed by Heap (2014). We used moderate uncertainty because very little information exists on control methods for this species. However, because *H. difformis* does not appear to be actively controlled in any areas, it is unlikely to have been exposed to herbicides and developed resistance.
ES-21 (Number of cold hardiness zones suitable for its survival)	6	0	
ES-22 (Number of climate types suitable for its survival)	5	2	
ES-23 (Number of precipitation bands suitable for its survival)	11	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	? - max		In tissue culture experiments, *H. difformis* had an inhibitory effect on the freshwater cyanobacteria *Microcystis aeruginosa*, possibly due to the release of phosphorus-containing allelochemicals (Meng and Liu, 2009). Helps prevent algae in aquariums (Krishanu, 2012; Pal and Samanta, 2011). *Hygrophila* species have anti-microbial properties (Chandran et al., 2013). Because this information is from laboratory studies and not field observations, we answered unknown.
Imp-G2 (Parasitic)	n - negl	0	We found no evidence that this plant is parasitic; it is an aquatic plant in the family Acanthaceae (NGRP, 2014), which is not reported to contain parasitic plants (Heide-Jørgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	? - max		We found very little information about this species. *Hygrophila difformis* has only started naturalizing in its introduced range in the past few years (USF Herbarium, 2014; Wu et al., 2010), which may not be enough time for *H. difformis* to cause noticeable impacts. Thus, we answered unknown for the majority of questions in the natural areas and anthropogenic sections of this weed risk assessment.
Imp-N2 (Change community structure)	? - max		Unknown.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-N3 (Change community composition)	? - max		"In warmer climates it is potentially an invasive weed that will out-compete & threaten native plants" (Paghat, 2013). Because this evidence seems to be speculation, we answered unknown.
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	? - max		Unknown.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	? - max		Unknown.
Imp-N6 (Weed status in natural systems)	b - mod	0.2	Listed as a "potential environmental weed of Australia" by Csurhes and Edwards (1998) and as an environmental weed by Randall (2014). In 2011, Texas proposed making *H. difformis* ineligible to be sold (Pet Product News International, 2011a), but due to concerns expressed by business interests that was never done (Pet Product News International, 2011b). The Texas Parks and Wildlife Department used a version of the Australian Weed Risk Assessment (Pheloung et al., 1999) modified for aquatic plants and conducted weed risk assessments for several *Hygrophila* species (Chilton, 2014). *Hygrophila difformis* received a score of 9 (Cook-Hildreth, 2014), greater than the "Reject" threshold score of 6. Randall (2012) lists this plant as an environmental weed. Based on this evidence, we answered "b" with moderate uncertainty. The alternate answers for the Monte Carlo simulation were "a" and "c."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	? - max		Unknown. See comment in Imp-N1.
Imp-A2 (Changes or limits recreational use of an area)	? - max		Unknown.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	y - low	0.1	In aquaria, "it can grow so darned well that it shades & suffocates all other plants" (Paghat, 2013). Grows very fast in aquariums. "It can quickly crowd out neighboring plants" (The Planted Tank, 2014).
Imp-A4 (Weed status in anthropogenic systems)	b - high	0.1	Listed as a "garden thug" by Randall (2014). One aquarist jokingly writes, "This is a weed! I can't seem to ever get rid of the stuff...Mine responds to moving stress with explosive growth." (The Planted Tank, 2014). Based on this evidence, we answered "b" with high uncertainty. The alternate answers for the Monte Carlo simulation were "c" and "a."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	n - high	0	Even though *H. difformis* has been reported to be a weed of rice fields for several decades (Bailey and Bailey, 1976; Moody, 1989), we found no evidence that *H. difformis* has impacts in production systems. Thus, we answered no for questions Imp-P1, Imp-P2, and Imp-P3, but used high uncertainty because very little information is available about this species.
Imp-P2 (Lowers commodity value)	n - high	0	See comment in Imp-P1.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-P3 (Is it likely to impact trade)	n - high	0	See comment in Imp-P1.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	? - max		Unknown. We found no evidence that *H. difformis* affects water resources in production systems, but the *H. polysperma* clogs irrigation channels and pumps (Cuda and Sutton, 2000; Langeland and Burks, 1998; Mora-Olivo et al., 2008; van Dijk et al., 1986). Additionally, *H. difformis* produces new plants on its leaves, followed by the entire plant falling apart and floating to the surface as numerous young plants (Paghat, 2013). This behavior could result in *H. difformis* clogging pumps. However, because this is speculation, we answered unknown.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	? - max		The ethanol extract of *H. difformis* leaves has been tested on mice and is considered "a safe drug" that increases the sleeping time of mice and works as an analgesic (painkiller) (Pal and Samanta, 2011). "When first submerged in an aquarium or pond [its] glands produce a toxic substances that may be toxic to some fish...damage seems to give off the toxin. Once they have been in the water a while the poison seems to disappear....It is used for...all type of herbivorous animals for their food" (Krishanu, 2012). The edible leaves of *H. difformis* are used to treat tooth aches (Pandey and Tripathi, 2010) and as an anticoagulant in India. In parts of Asia, the seed masses of *Hygrophila* species are consumed by humans (van der Pijl, 1982). Due to the conflicting information, we answered unknown.
Imp-P6 (Weed status in production systems)	b - low	0.2	"Often a weed of rice fields" (Bailey and Bailey, 1976). Reported to be a weed of rice fields in India (Moody, 1989). Based on this evidence, we answered "b." The alternate answers for the Monte Carlo analysis are both "c."
GEOGRAPHIC POTENTIAL			Note: Below "p.s." refers to geo-referenced point source (latitude/longitude) data; "occur." refers to occurrence (presence only) data for a region.
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that *H. difformis* occurs in this zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that *H. difformis* occurs in this zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that *H. difformis* occurs in this zone.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence that *H. difformis* occurs in this zone.
Geo-Z5 (Zone 5)	n - low	N/A	We found no evidence that *H. difformis* occurs in this zone.
Geo-Z6 (Zone 6)	n - mod	N/A	We found no evidence that *H. difformis* occurs in this zone.
Geo-Z7 (Zone 7)	n - high	N/A	We found no evidence that *H. difformis* occurs in this zone.
Geo-Z8 (Zone 8)	y - low	N/A	Taiwan (GBIF, 2014, p.s.)
Geo-Z9 (Zone 9)	y - low	N/A	India (Bailey and Bailey, 1976, occur.). A gardening website lists this species as being hardy at 30-40 °F (Dave's Garden, 2014).
Geo-Z10 (Zone 10)	y - low	N/A	India and Thailand (Bailey and Bailey, 1976, occur.). A gardening website lists this species as being hardy at 30-40 °F (Dave's Garden, 2014).
Geo-Z11 (Zone 11)	y - negl	N/A	Taiwan (GBIF, 2014, p.s.), the United States (Florida) (Gann et al., 2014; Kartesz, 2014, occur.), and Bangladesh (NGRP, 2014, occur.). A gardening website lists this species as being hardy at 30-40 °F (Dave's Garden, 2014).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z12 (Zone 12)	y - negl	N/A	India and Thailand (Bailey and Bailey, 1976, occur.).
Geo-Z13 (Zone 13)	y - negl	N/A	Taiwan (GBIF, 2014, p.s.), India, and Thailand (Bailey and Bailey, 1976, occur.). 72-82 °F is recommended for aquarium growth (PetSmart, 2013). 22-30 °C is recommended for aquarium growth (Windeløv, 2004). Grows in 20-28 °C (Krishanu, 2012). 24-28 °C is the optimum temperature range in aquariums (Kasselmann, 2003).
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - low	N/A	Thailand (Bailey and Bailey, 1976, occur.) and Bangladesh (NGRP, 2014, occur.).
Geo-C2 (Tropical savanna)	y - low	N/A	Thailand (Bailey and Bailey, 1976, occur.) and Bangladesh (NGRP, 2014, occur.).
Geo-C3 (Steppe)	y - mod	N/A	India (Bailey and Bailey, 1976, occur.).
Geo-C4 (Desert)	n - high	N/A	We found no evidence that *H. difformis* occurs in this climate class.
Geo-C5 (Mediterranean)	n - high	N/A	We found no evidence that *H. difformis* occurs in this climate class.
Geo-C6 (Humid subtropical)	y - negl	N/A	Taiwan (GBIF, 2014, p.s.) and the United States (Florida) (Kartesz, 2014, occur.).
Geo-C7 (Marine west coast)	y - low	N/A	India (Bailey and Bailey, 1976, occur.) and Nepal (NGRP, 2014, occur.).
Geo-C8 (Humid cont. warm sum.)	n - mod	N/A	We found no evidence that *H. difformis* occurs in this climate class.
Geo-C9 (Humid cont. cool sum.)	n - low	N/A	We found no evidence that *H. difformis* occurs in this climate class.
Geo-C10 (Subarctic)	n - negl	N/A	We found no evidence that *H. difformis* occurs in this climate class.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that *H. difformis* occurs in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that *H. difformis* occurs in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - high	N/A	India (Bailey and Bailey, 1976, occur.). We used high uncertainty because *H. difformis* is an aquatic plant, but answered yes because submerged plants would be buffered from the effects of low precipitation.
Geo-R2 (10-20 inches; 25-51 cm)	y - high	N/A	India (Bailey and Bailey, 1976, occur.). We used high uncertainty because *H. difformis* is an aquatic plant, but answered yes because submerged plants would be buffered from the effects of low precipitation.
Geo-R3 (20-30 inches; 51-76 cm)	y - mod	N/A	India (Bailey and Bailey, 1976, occur.).
Geo-R4 (30-40 inches; 76-102 cm)	y - low	N/A	India (Bailey and Bailey, 1976, occur.) and Nepal (NGRP, 2014, occur.).
Geo-R5 (40-50 inches; 102-127 cm)	y - low	N/A	India (Bailey and Bailey, 1976, occur.) and Nepal (NGRP, 2014, occur.).
Geo-R6 (50-60 inches; 127-152 cm)	y - low	N/A	India (Bailey and Bailey, 1976, occur.) and the United States (Florida) (Kartesz, 2014, occur.).
Geo-R7 (60-70 inches; 152-178 cm)	y - low	N/A	India (Bailey and Bailey, 1976, occur.) and the United States (Florida) (Kartesz, 2014, occur.).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Taiwan (GBIF, 2014, p.s.) and Bangladesh (NGRP, 2014, occur.).
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Bangladesh (NGRP, 2014, occur.).
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	Bangladesh (NGRP, 2014, occur.).
Geo-R11 (100+ inches; 254+ cm)	y - negl	N/A	Taiwan (GBIF, 2014, p.s.).
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Present in the United States in Florida (Kartesz, 2014; NRCS, 2014). *Hygrophila difformis* has been cultivated as an aquarium plant in the United States since the 1970s (Bailey and Bailey, 1976; Rataj and Horeman, 1977). Available at big-box pet supply retailers in the United States (PetCo, 2013; PetSmart, 2013).
Ent-2 (Plant proposed for entry, or entry is imminent)		N/A	
Ent-3 (Human value & cultivation/trade status)		N/A	Cultivated as an aquarium plant (Bailey and Bailey, 1976) and available at from large, big-box pet supply retailers in the United States (PetCo, 2013; PetSmart, 2013).
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	