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## **Weed Risk Assessment for *Limnophila heterophylla* (Plantaginaceae)**



*Limnophila heterophylla* (Creative Commons image; Ito, 2007)

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## Executive Summary

The result of the weed risk assessment for *Limnophila heterophylla* is Moderate Risk of becoming weedy or invasive in the United States. It is a rooted aquatic herb that is primarily a weed of rice in tropical countries. It is not known to be established outside its native range. It is cultivated in the aquarium trade in the United States but is not present outside of cultivation and is not regulated by any state. In its native range, it can form large, dense stands. It reproduces both vegetatively and by seed. It disperses on water but does not appear to have any other natural dispersal vectors. Although information on this species is limited, several congeners are significant weeds. Because it is found exclusively in tropical areas, we estimate that 0.5 to 3.4 percent of the United States is climatically suitable for the species to establish. It has not escaped cultivation in the United States.

## Plant Information and Background

**PLANT SPECIES:** *Limnophila heterophylla* (Roxb.) Benth. (Plantaginaceae) (NPGS, 2020).

**SYNONYMS:** Basionym: *Columnea heterophylla* Roxb. (NPGS, 2020). Several sources also refer to the species as *L. heterophylla* Benth. We found a reference listing *C. heterophylla* Roxb. as a synonym of *L. heterophylla* Benth. (PPQ, 2017), so we are confident that *L. heterophylla* (Roxb.) Benth. and *L. heterophylla* Benth. are the same species.

**COMMON NAMES:** None

**BOTANICAL DESCRIPTION:** *Limnophila heterophylla* is a rooted aquatic herb (Chowdhury and Das, 2013) that grows in shallow, still waters, such as swamps and lake or pond margins (Mirashi, 1959; Mohapatra et al., 2007). The submerged portion can grow about 50 cm tall, with additional height in the emergent portion (Flora of China, 2020). *Limnophila heterophylla* is sometimes used in trade as a name for *L. sessiliflora*, although they are different species (Champion et al., 2008). *Limnophila sessiliflora* has sessile flowers and divided upper aerial leaves, while *L. heterophylla* has pedicellate flowers and undivided upper aerial leaves (Philcox, 1970).

**INITIATION:** *Limnophila heterophylla* is becoming more prevalent in the aquarium plant trade, and the congener *L. sessiliflora* is a Federal Noxious Weed (FNW). We developed this weed risk assessment to determine whether or not *L. heterophylla* poses a similar threat and if it should be listed as an FNW.

**WRA AREA<sup>1</sup>:** United States and Territories

**FOREIGN DISTRIBUTION:** *Limnophila heterophylla* is native to the Indian subcontinent, southeastern Asia, eastern China, and the Philippines (Flora of China, 2020; POWO, 2020). Plants of the World Online (POWO, 2020) indicates that it was introduced in Sudan, but we were unable to verify this. We found no other evidence of the species outside of its native range.

**U.S. DISTRIBUTION AND STATUS:** *Limnophila heterophylla* is cultivated in the aquarium trade in the United States (Buce Plant, 2020), although the congener *L. sessiliflora* is also sometimes sold as *L. heterophylla* (Champion et al., 2008), and hobbyists often have difficulty distinguishing the species (The Planted Tank, 2018). We found no evidence that *L. heterophylla* has escaped cultivation or is otherwise naturalized in the United States (EDDMapS, 2020; Kartesz, 2015; NRCS, 2020). The species is not mentioned on popular gardening forums (Dave's Garden, 2020; GardenWeb, 2020). Furthermore, we found minimal discussion on an aquarium-specific site (The

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<sup>1</sup> The "WRA area" is the area in relation to which the weed risk assessment is conducted (definition modified from that for "PRA area") (IPPC, 2017).

Planted Tank, 2020). Due to the apparent lack of interest, we cannot determine how commonly cultivated the species is. It is not regulated by any state (NPB, 2020).

### Analysis

**ESTABLISHMENT/SPREAD POTENTIAL:** *Limnophila heterophylla* may be introduced in Sudan but it is not otherwise established outside its native range (POWO, 2020). It disperses on water but does not appear to have any other natural dispersal vectors (Razi, 1950). It forms dense stands in still, shallow water (Mirashi, 1959; Mohapatra et al., 2007) and reproduces by seed (Chowdhury and Das, 2010), and members of the genus are self-compatible (Les, 2017). Several congeners are weedy (Holm et al., 1991; Les, 2017; Moody, 1989) and reproduce vegetatively (Aqua Plants, 2020; Rao and Ram, 1981; Spencer and Bowes, 1985). *Limnophila heterophylla* likely reproduces vegetatively as well (WSSA, n.d.). We had Very High uncertainty for this risk element due to a lack of species-specific information.

Risk score = 3.0                      Uncertainty index = 0.28

**IMPACT POTENTIAL:** *Limnophila heterophylla* is primarily a weed of rice in its native range (Mahajan et al., 2014), particularly in India (Holm et al., 1991; Sahu, 1992; Subudhi et al., 2015). Sahu (1992) conducted research on herbicides targeting *L. heterophylla* along with other serious weeds of rice, but we found no information on other specific control efforts. We found no evidence of natural or anthropogenic impact. We had Very High uncertainty for this risk element because the species is not well-studied. Furthermore, because it has not established outside of its native range, we have no information on the impact it may have as an exotic species.

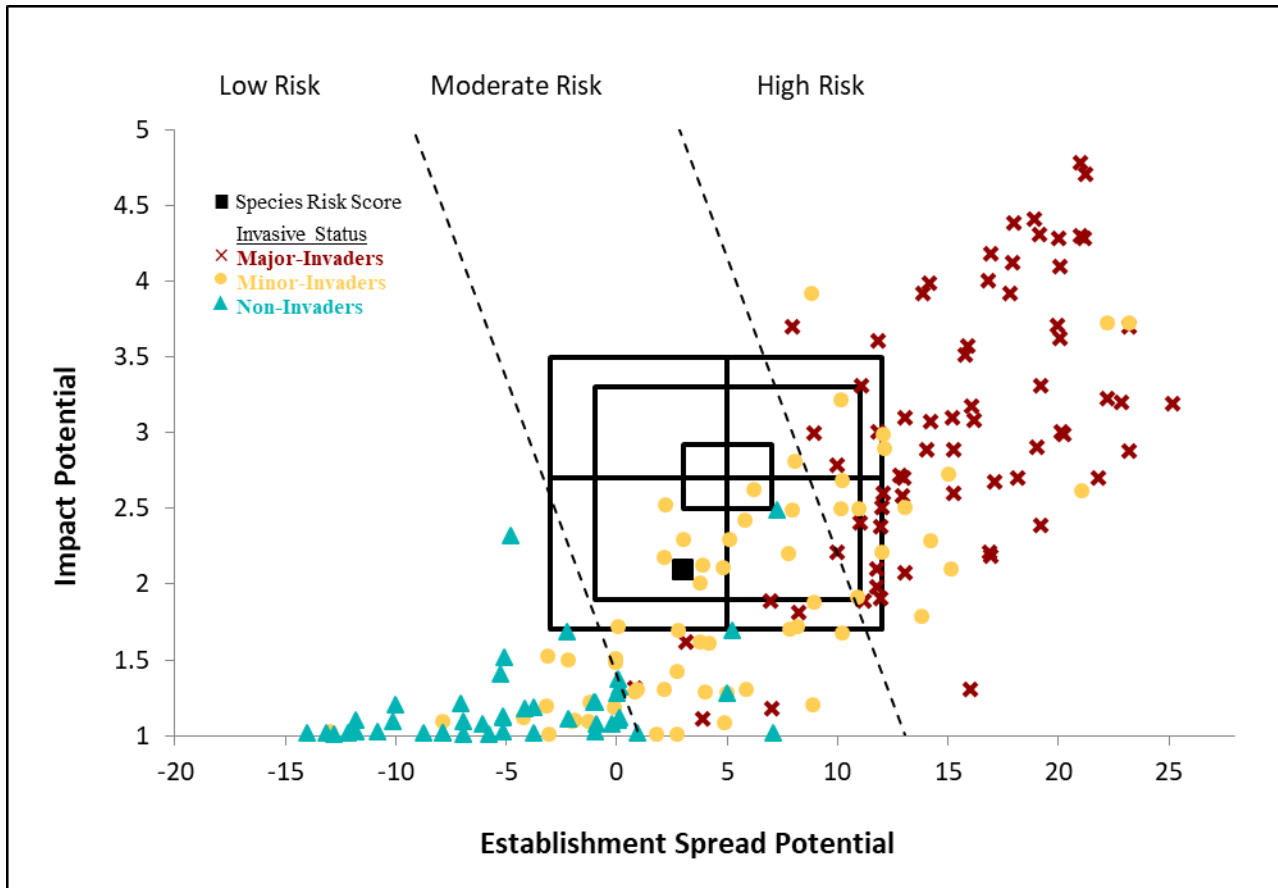
Risk score = 2.1                      Uncertainty index = 0.43

#### **RISK MODEL RESULTS:**

Model Probabilities: P(Major Invader) = 10.3%  
P(Minor Invader) = 68.8%  
P(Non-Invader) = 20.8%

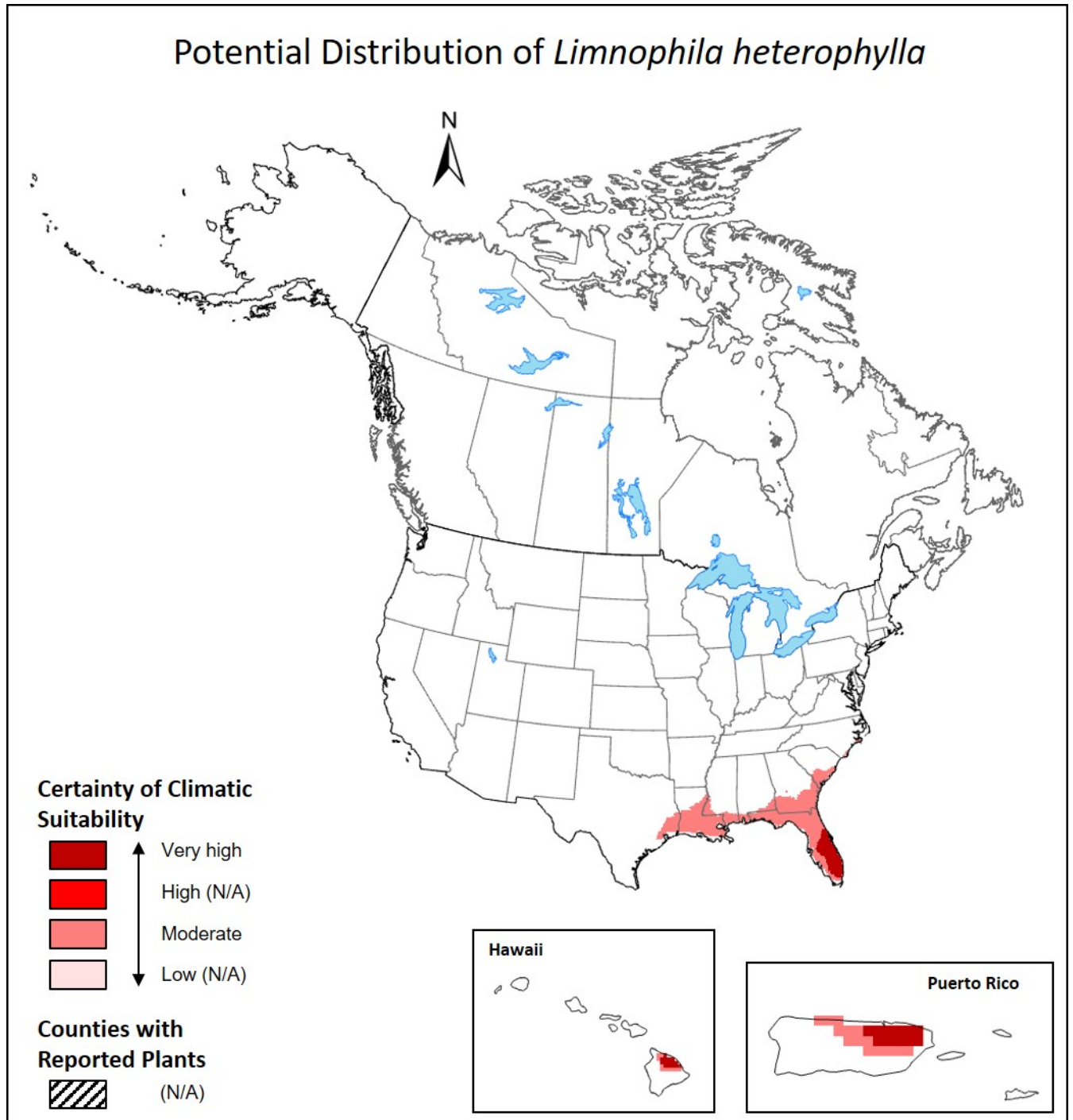
Risk Result = Evaluate Further

Risk Result after Secondary Screening = Moderate Risk



**Figure 1.** Risk and uncertainty results for *Limnophila heterophylla*. The risk score for this species (solid black symbol) is plotted relative to the risk scores of the species used to develop and validate the PPQ WRA model (Koop et al., 2012). The results from the uncertainty analysis are plotted around the risk score for *L. heterophylla* and show other **possible** risk scores should some of our WRA answers change. The smallest, black box contains 50 percent of the simulated risk scores, the second 95 percent, and the largest 99 percent. The black vertical and horizontal lines in the middle of the boxes represent the medians of the simulated risk scores (N=5000). For additional information on the uncertainty analysis used, see Caton et al. (2018).

**GEOGRAPHIC POTENTIAL:** Using the PPQ climate-matching model for weeds (Magarey et al., 2017), we estimate that about 0.5 to 3.4 percent of the United States is suitable for the establishment of *L. heterophylla* (Fig. 1). The maximum area where we estimate that climate is potentially suitable represents the joint distribution of Plant Hardiness Zones 9-13, areas with 50-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savanna, and humid subtropical (App. A). The area of the United States shown to be climatically suitable was determined using only these three climatic variables. Other factors, such as soil, hydrology, disturbance regime, and species interactions may alter the areas in which this species is likely to establish. *Limnophila heterophylla* is an aquatic plant and would only be able to grow in shallow water such as wetlands and lake or pond margins (Chowdhury and Das, 2013; Mirashi, 1959; Mohapatra et al., 2007). The species has been reported as introduced in Sudan (POWO, 2020), but we found no information on whether it is naturalized there. If it were naturalized, that would indicate that it could establish in areas receiving 20 to 50 inches of annual precipitation, which would expand the potential distribution into drier areas of the United States, particularly Texas (data not shown).



**Figure 2.** Potential distribution of *Limnophila heterophylla* in the United States. Climatic suitability was determined using the APHIS-PPQ climate matching tool for invasive plants (Magarey et al., 2017). Map components are shown at different scales.

**ENTRY POTENTIAL:** *Limnophila heterophylla* is grown as an aquarium plant in the United States (Buce Plant, 2020), so it would most likely become established by escaping cultivation. Jyothi and Sureshkumar (2016) suggest that aquatic plants, including *L. heterophylla*, could be increasingly marketed as ornamentals. The species is also used in traditional medicine in India (Dash and Das, 2014; Sasmal et al., 2009). We found no evidence that it is a contaminant of other aquarium commodities; however, since it is an aquatic plant, entry in this way seems possible. Because it is aquatic, it is not likely to contaminate seeds for planting or other commodities produced on land.

Risk score = 0.5

Uncertainty index = 0.04

## Discussion

The result of the weed risk assessment for *Limnophila heterophylla* is Moderate Risk of becoming weedy or invasive in the United States. Because the species is not well-studied and is not established outside its native range, we have very high uncertainty about its entry potential and likely impact. It is grown for the aquarium trade in the United States and is most likely to establish by escaping cultivation. In its native range, it can be a serious weed of rice, but we found no evidence of impact on natural or anthropogenic systems. With no information on its behavior outside its native range, we cannot predict how it would act as an exotic species.

## Suggested Citation

PPQ. 2020. Weed risk assessment for *Limnophila heterophylla* (Roxb.) Benth. (Plantaginaceae). United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (PPQ), Raleigh, NC. 19 pp.

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## Appendix. Weed risk assessment for *Limnophila heterophylla* (Roxb.) Benth. (Plantaginaceae)

The following table includes the evidence and associated references used to evaluate the risk potential of this taxon. We also include the answer, uncertainty rating, and score for each question.

Question ID	Answer - Uncertainty	Score	Notes (and references)
<b>ESTABLISHMENT/SPREAD POTENTIAL</b>			
ES-1 [What is the taxon's establishment and spread status outside its native range? (a) Introduced elsewhere =>75 years ago but not escaped; (b) Introduced <75 years ago but not escaped; (c) Never moved beyond its native range; (d) Escaped/Casual; (e) Naturalized; (f) Invasive; (?) Unknown]	b - mod	-2	<i>Limnophila heterophylla</i> is native to the Indian subcontinent, southeastern Asia, eastern China, and the Philippines (Flora of China, 2020; POWO, 2020). It has been introduced to the United States for cultivation as an aquatic ornamental (Buce Plant, 2020), but we found no evidence that it has escaped. Plants of the World Online (POWO, 2020) describes it as introduced in Sudan, but we are unsure if this means naturalized or just introduced for cultivation. We found no other evidence of its presence in Sudan. Because it seems unlikely that this species or most other aquatic species were in cultivation 75 years ago, we answered "b" with moderate uncertainty. Another possible explanation for the lack of additional evidence is that it is a casual alien in Sudan, so we chose "d" for both alternate answers. Our uncertainty is moderate because we have no additional information about its status in Sudan.
ES-2 (Is the species highly domesticated)	n - negl	0	Although this species is cultivated for the aquarium trade (Amazon, 2020; Buce Plant, 2020), it is highly unlikely that it has undergone any domestication.
ES-3 (Significant weedy congeners)	y - negl	1	The genus <i>Limnophila</i> includes 37 species (Mabberley, 2008). <i>Limnophila conferta</i> , <i>L. gratioides</i> , and <i>L. micrantha</i> are principal weeds in India (Holm et al., 1991). <i>Limnophila aromatica</i> , <i>L. indica</i> , and <i>L. sessiliflora</i> are weeds of rice (Les, 2017; Moody, 1989).
ES-4 (Shade tolerant at some stage of its life cycle)	y - mod	1	Padiya et al. (2013) describe <i>L. heterophylla</i> as growing under shade. Our uncertainty is moderate because they cite another source, which we are not able to access.
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - negl	0	It is not a vine; it is a rooted aquatic plant (Chowdhury and Das, 2013).

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Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-6 (Forms dense thickets, patches, or populations)	y - mod	2	It forms large, dense stands (Mirashi, 1959). We have moderate uncertainty because the only evidence is from an old source.
ES-7 (Aquatic)	y - negl	1	It is a true aquatic plant that grows entirely in water (Chowdhury and Das, 2013).
ES-8 (Grass)	n - negl	0	This species is not a grass; it is an herb in the plant family Plantaginaceae (NPGS, 2020).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence that this species fixes nitrogen. Furthermore, it is not a member of a plant family that is known to contain nitrogen fixing species (Santi et al., 2013).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	It reproduces by seed (Chowdhury and Das, 2010).
ES-11 (Self-compatible or apomictic)	y - low	1	Members of the genus <i>Limnophila</i> are self-compatible (Les, 2017).
ES-12 (Requires specialist pollinators)	? - max		We found no information about pollinators.
ES-13 [What is the taxon's minimum generation time? (a) less than a year with multiple generations per year; (b) 1 year, usually annuals; (c) 2 or 3 years; (d) more than 3 years; or (?) unknown]	b - high	1	A factsheet on the species indicates that <i>L. heterophylla</i> reproduces both vegetatively and by seed (WSSA, n.d.). Although we found no other references for vegetative reproduction of <i>L. heterophylla</i> , vegetative reproduction is documented in <i>L. sessiliflora</i> (Spencer and Bowes, 1985), <i>L. indica</i> (Rao and Ram, 1981), and <i>L. aquatica</i> (Aqua Plants, 2020). Philcox (1970) and the Flora of China (2020) list <i>L. heterophylla</i> as a perennial, although Padiya et al. describe it as an annual (Padiya et al., 2013). Since aquatic plants grow quickly, a vegetative fragment could likely grow large enough to produce new fragments in one year. It is unclear whether a seed could grow into an adult plant and set seed in one year, but the confusion over whether this species is an annual or a perennial suggests that this may be the case. Consequently, we answered "b" with high uncertainty and used "c" for both of our alternate choices for the uncertainty simulation.
ES-14 (Prolific seed producer)	? - max	0	Unknown. WSSA (WSSA, n.d.) reports that each capsule contains many seeds less than 1 mm long, but does not specify how many. Because we found no specific information on seed or flower production, we answered this question as "unknown."
ES-15 (Propagules likely to be dispersed unintentionally by people)	? - max	0	Unknown. We found no evidence for unintentional dispersal of <i>L. heterophylla</i> , but we note that aquatic plants are often dispersed by boats (NY DEC, 2020).

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Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - mod	-1	We found no evidence of this species being spread as a hitchhiker or contaminant in trade (AQAS, 2020). Because it seems unlikely that an aquatic plant would contaminate most types of commodities, we answered "no" with moderate uncertainty.
ES-17 (Number of natural dispersal vectors)	1	-2	Capsules are subglobose and about 2.5 mm long (Flora of China, 2020). Each contains many very small seeds (WSSA, n.d.).
ES-17a (Wind dispersal)	n - mod		We found no evidence, and the seeds do not have any clear adaptations for wind dispersal (WSSA, n.d.). Razi (1950) does not indicate that any <i>Limnophila</i> spp. are dispersed by wind.
ES-17b (Water dispersal)	y - low		We found no evidence specific to <i>L. heterophylla</i> , but Razi (1950) indicates that eight <i>Limnophila</i> species are dispersed by water.
ES-17c (Bird dispersal)	n - mod		We found no evidence for this dispersal method. Razi (1950) does not indicate that any <i>Limnophila</i> spp. are dispersed by birds.
ES-17d (Animal external dispersal)	n - mod		We found no evidence for this dispersal method. Razi (1950) does not indicate that any <i>Limnophila</i> spp. are dispersed by animals.
ES-17e (Animal internal dispersal)	n - mod		We found no evidence for this dispersal method. Razi (1950) does not indicate that any <i>Limnophila</i> spp. are dispersed by animals.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	? - max	0	Unknown
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	? - max	1	Unknown; we suspect that <i>L. heterophylla</i> would tolerate mutilation, as many aquatic plants do (Ramey, 2001), but we found no specific evidence.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	We found no evidence of herbicide resistance (Heap, 2020).
ES-21 (Number of cold hardiness zones suitable for its survival)	5	0	
ES-22 (Number of climate types suitable for its survival)	3	0	
ES-23 (Number of precipitation bands suitable for its survival)	6	0	
<b>IMPACT POTENTIAL</b>			
<b>General Impacts</b>			
Imp-G1 (Allelopathic)	n - mod	0	We found no evidence of allelopathy but have moderate uncertainty because the species is not well-studied.

## Weed Risk Assessment for *Limnophila heterophylla*

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-G2 (Parasitic)	n - negl	0	<i>Limnophila heterophylla</i> is not reported to be parasitic and is not in any of the families known to have parasitic plants (Heide-Jorgensen, 2008).
<b>Impacts to Natural Systems</b>			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	? - max		We found no evidence of this impact, nor any other impact in natural systems. This species is not well-studied and does not appear to have had many opportunities to escape beyond its native range; the oldest reference we found to its presence in trade dates from 2007 (Parker et al., 2007). Therefore, we answered most questions in this sub-element as either unknown or with high uncertainty.
Imp-N2 (Changes habitat structure)	? - max		Unknown
Imp-N3 (Changes species diversity)	? - max		Unknown
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	n - high	0	Since we found no evidence that this species is a weed of natural areas, we answered "no."
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	n - high	0	Since we found no evidence that this species is a weed of natural areas, we answered "no."
Imp-N6 [What is the taxon's weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed and evidence of control efforts]	a - high	0	Jyothi and Sureshkumar (Jyothi and Sureshkumar, 2018) conducted a vegetation survey in a wetland area that included both undisturbed sites and sites in the vicinity of rice farming. They found <i>L. heterophylla</i> only in the agricultural disturbance area, which seems to suggest that it is not a weed of natural areas. Since it has not been widely introduced outside its native range, we do not know how it might affect natural areas as an exotic. Our alternate answers for the uncertainty simulation were both "b."
<b>Impact to Anthropogenic Systems (e.g., cities, suburbs, roadways)</b>			
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	? - max		Unknown; because this species is not well-studied and does not appear to have had many opportunities to escape beyond its native range, we answered most questions in this sub-element as either unknown or with high uncertainty.
Imp-A2 (Changes or limits recreational use of an area)	? - max		Unknown
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - high	0	The species is not discussed on popular gardening forums (Dave's Garden, 2020; GardenWeb, 2020). An online message board specific to aquarium plants had minimal discussion of the species and no comments about impacts on other ornamental plants (The Planted Tank, 2020).

## Weed Risk Assessment for *Limnophila heterophylla*

Question ID	Answer - Uncertainty	Score	Notes (and references)
			We have high uncertainty, however, because the species is not well-studied.
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	a - mod	0	We found no evidence that this species is a weed of anthropogenic systems, but it is also not well-studied. Our alternate answers for the uncertainty simulation were both "b."
<b>Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)</b>			
Imp-P1 (Reduces crop/product yield)	y - low	0.4	It is described as one of the worst weeds of deep-water rice in parts of India, and herbicide trials targeting that weed among others increased rice yield (Sahu, 1992).
Imp-P2 (Lowers commodity value)	n - mod	0	We found no evidence of this impact, but the species is not well-studied.
Imp-P3 (Is it likely to impact trade?)	n - low	0	We found no evidence of regulation for this species (PCIT, 2020). Our uncertainty is low because if any country regulated <i>L. heterophylla</i> , that information would be readily available.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	y - high	0.1	It can restrict water flow in irrigation channels (WSSA, n.d.). We have high uncertainty because this reference is a review article, and we found no other evidence of this impact.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	<i>Limnophila heterophylla</i> was tested as an animal feed and found to be safe (Banerjee and Matai, 1990), which indicates that it is not toxic. Burrows and Tryl (2013) do not list <i>Limnophila</i> as a toxic genus.
Imp-P6 [What is the taxon's weed status in production systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	c - mod	0.6	It is described as a weed of agriculture (Randall, 2007), particularly rice (Mahajan et al., 2014) and listed as a common to serious weed of rice in India (Sahu, 1992; Subudhi et al., 2015}). Holm et al. (1991) list it as a serious weed in India and a common weed in Thailand. Piepho and Alkamper (1991), however, describe it as only an incidental weed of rice in Thailand. Sahu (1992) conducted herbicide research targeting <i>L. heterophylla</i> among other serious weeds of rice, but we found no other evidence of specific control efforts. Our alternate answers for the uncertainty simulation were both "b."
<b>GEOGRAPHIC POTENTIAL</b>			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF Secretariat, 2019).
<b>Plant hardiness zones</b>			



## Weed Risk Assessment for *Limnophila heterophylla*

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence of the species in this Zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence of the species in this Zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence of the species in this Zone.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence of the species in this Zone.
Geo-Z5 (Zone 5)	n - negl	N/A	We found no evidence of the species in this Zone.
Geo-Z6 (Zone 6)	n - negl	N/A	We found no evidence of the species in this Zone.
Geo-Z7 (Zone 7)	n - negl	N/A	We found no evidence of the species in this Zone.
Geo-Z8 (Zone 8)	n - high	N/A	The species is reported from Anhui Province in China (Flora of China, 2020), which is mostly in Zone 8, but we expect that its actual presence is in the southwestern region of the province, which is in Zone 9.
Geo-Z9 (Zone 9)	y - negl	N/A	5 points in China
Geo-Z10 (Zone 10)	y - negl	N/A	2 points in Taiwan; the species is native in India, Bangladesh, Myanmar, Thailand, and Indonesia (Philcox, 1970; POWO, 2020), which are primarily in Zones 10-13.
Geo-Z11 (Zone 11)	y - negl	N/A	1 point in Thailand and 1 in India; the species is native in India, Bangladesh, Myanmar, Thailand, and Indonesia (Philcox, 1970; POWO, 2020), which are primarily in Zones 10-13.
Geo-Z12 (Zone 12)	y - negl	N/A	1 point in Taiwan and 1 in Thailand; the species is native in India, Bangladesh, Myanmar, Thailand, and Indonesia (Philcox, 1970; POWO, 2020), which are primarily in Zones 10-13.
Geo-Z13 (Zone 13)	y - negl	N/A	2 points in Thailand and 1 in Indonesia; the species is native in India, Bangladesh, Myanmar, Thailand, and Indonesia (Philcox, 1970; POWO, 2020), which are primarily in Zones 10-13.
<b>Köppen -Geiger climate classes</b>			
Geo-C1 (Tropical rainforest)	y - negl	N/A	1 point in each of the following countries: India, Malaysia, and Indonesia.
Geo-C2 (Tropical savanna)	y - negl	N/A	5 points in Thailand
Geo-C3 (Steppe)	n - high	N/A	We found no evidence of the species in this climate class, but it may be able to survive in habitats with sufficient water.
Geo-C4 (Desert)	n - low	N/A	We found no evidence of the species in this climate class.
Geo-C5 (Mediterranean)	n - high	N/A	We found no evidence of the species in this climate class, but it may be able to survive in habitats with sufficient water.

## Weed Risk Assessment for *Limnophila heterophylla*

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-C6 (Humid subtropical)	y - negl	N/A	5 points in China, 1 in Taiwan
Geo-C7 (Marine west coast)	n - high	N/A	We found no evidence of the species in this climate class, but it may be able to survive in habitats with sufficient water.
Geo-C8 (Humid cont. warm sum.)	n - negl	N/A	We found no evidence of the species in this climate class.
Geo-C9 (Humid cont. cool sum.)	n - negl	N/A	We found no evidence of the species in this climate class.
Geo-C10 (Subarctic)	n - negl	N/A	We found no evidence of the species in this climate class.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence of the species in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence of the species in this climate class.
<b>10-inch precipitation bands</b>			
Geo-R1 (0-10 inches; 0-25 cm)	n - negl	N/A	We found no evidence of the species in this precipitation band.
Geo-R2 (10-20 inches; 25-51 cm)	n - negl	N/A	We found no evidence of the species in this precipitation band.
Geo-R3 (20-30 inches; 51-76 cm)	n - high	N/A	Plants of the World Online (POWO, 2020) lists the species as introduced in Sudan, which includes the 20-50 inch precipitation bands. We were not able, however, to verify that information from any other sources.
Geo-R4 (30-40 inches; 76-102 cm)	n - high	N/A	Plants of the World Online (POWO, 2020) lists the species as introduced in Sudan, which includes the 20-50 inch precipitation bands. We were not able, however, to verify that information from any other sources.
Geo-R5 (40-50 inches; 102-127 cm)	n - high	N/A	Plants of the World Online (POWO, 2020) lists the species as introduced in Sudan, which includes the 20-50 inch precipitation bands. We were not able, however, to verify that information from any other sources.
Geo-R6 (50-60 inches; 127-152 cm)	y - mod	N/A	We found no geo-referenced points in this precipitation band, but the species is reported from the Anhui Province in China (Flora of China, 2020), which experiences 50-70 inches of annual precipitation in the southern region where the species is likely native.
Geo-R7 (60-70 inches; 152-178 cm)	y - mod	N/A	We found no geo-referenced points in this precipitation band, but the species is reported from the Anhui Province in China (Flora of China, 2020), which experiences 50-70 inches of annual precipitation in the southern region where the species is likely native.
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	4 points in China, 4 in Thailand, 1 in Taiwan; the species is native to southeastern Asia,

## Weed Risk Assessment for *Limnophila heterophylla*

Question ID	Answer - Uncertainty	Score	Notes (and references)
			which generally receives 50-100+ inches of annual precipitation.
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	The species is native to southeastern Asia, which generally receives 50-100+ inches of annual precipitation.
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	The species is native to southeastern Asia, which generally receives 50-100+ inches of annual precipitation.
Geo-R11 (100+ inches; 254+ cm)	y - negl	N/A	2 points in Thailand, 1 in China, India, and Indonesia; the species is native to southeastern Asia, which generally receives 50-100+ inches of annual precipitation.
<b>ENTRY POTENTIAL</b>			
Ent-1 (Plant already here)	n - negl	0	<i>Limnophila heterophylla</i> is cultivated for the aquarium trade in the United States (Buce Plant, 2020), but we are answering the question as “no” in order to evaluate its entry potential.
Ent-2 (Plant proposed for entry, or entry is imminent)	n - low	0	We found no specific evidence of the species being imported.
Ent-3 [Human value & cultivation/trade status: (a) Neither cultivated or positively valued; (b) Not cultivated, but positively valued or potentially beneficial; (c) Cultivated, but no evidence of trade or resale; (d) Commercially cultivated or other evidence of trade or resale]	d - negl	0.5	It is cultivated for the aquarium trade (Buce Plant, 2020), and Jyothi and Sureshkumar (2016) suggest that wetland plants, including <i>L. heterophylla</i> , could be increasingly marketed as ornamentals. It is also used for indigenous medicine in India (Dash and Das, 2014; Sasmal et al., 2009).
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	y - negl		Its native range includes eastern China (POWO, 2020).
Ent-4b (Contaminant of plant propagative material (except seeds))	n - mod	0	We found no evidence of the plant following this pathway.
Ent-4c (Contaminant of seeds for planting)	n - low	0	Because this is an aquatic plant, it is unlikely that it would contaminate seeds for planting.
Ent-4d (Contaminant of ballast water)	n - mod	0	We found no evidence of the plant following this pathway. Although it is an aquatic plant, it grows in freshwater lake margins, ponds, and wetlands (Jyothi and Sureshkumar, 2018; Mirashi, 1959) and in shallow, still water (Mohapatra et al., 2007). Therefore, it is not present in rivers or coastal waters and is unlikely to be carried in water ballast.
Ent-4e (Contaminant of aquarium plants or other aquarium products)	? - max		We found no evidence of the plant following this pathway, but it is sold in the aquarium plant trade, so it seems possible that it could contaminate aquarium products.
Ent-4f (Contaminant of landscape products)	n - low	0	We found no evidence of the plant following this pathway, and it is unlikely that an aquatic plant would contaminate materials used in terrestrial landscaping.

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Question ID	Answer - Uncertainty	Score	Notes (and references)
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	n - mod	0	We found no evidence of the plant following this pathway. It is unlikely that an aquatic plant would contaminate terrestrial vehicles or containers, but it could be carried on boats taken from one freshwater system to another.
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	n - low	0	We found no evidence of the plant following this pathway, and it is not a weed of crops that are likely to be highly processed.
Ent-4i (Contaminant of some other pathway)	a - low	0	We found no evidence of this plant following any other pathways.
Ent-5 (Likely to enter through natural dispersal)	n - negl	0	This species is not present outside cultivation in the western hemisphere (POWO, 2020). It grows in freshwater systems (Jyothi and Sureshkumar, 2018; Mirashi, 1959) and is unlikely to disperse across the ocean.