Arrowleaf False Pickerelweed (*Monochoria hastata*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, February 2021
Revised, April 2021
Web Version, 8/25/2021

Organism Type: Plant
Overall Risk Assessment Category: Uncertain

Photo: Wiethase H. Licensed under Creative Commons Attribution-Share Alike 3.0 Unported. Available: https://commons.wikimedia.org/wiki/File:Monochoria_hastata,_plant.JPG (February 2021).

1 Native Range and Status in the United States

Native Range

From Yu Jiu Hua Shu (2000):

"Guangdong, Guizhou, Hainan, Yunnan [China] [Bhutan, Cambodia, India, Indonesia, Malaysia, Myanmar, Nepal, Sri Lanka, Vietnam]"

From Ali et al. (2018):

"Native range: India, Sri Lanka, South East Asia, Australia and Pacific Islands."

Pellegrini et al. (2018) report the native range of *Pontederia hastata*, currently accepted as a synonym of *M. hastata* (World Flora Online 2021; see Remarks), as "Bangladesh, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Sri Lanka, Thailand and Vietnam."

Pellegrini et al. (2018) report the native range of *Pontederia sagittata*, currently accepted as a synonym of *M. hastata* (World Flora Online 2021; see Remarks), as "Mexico, Costa Rica, Guatemala, Honduras, Panama and Brazil (states of Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo, Paraná, Rio Grande do Sul and Santa Catarina)."

Pellegrini et al. (2018) report the native range of *Pontederia vaginalis*, currently accepted as a synonym of *M. hastata* (World Flora Online 2021; see Remarks), as "Widespread throughout Asia (Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Iran, Japan, Korea, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Russia, Sri Lanka, Thailand and Vietnam) and Oceania (Australia, Fiji, Papua New Guinea and Pacific Islands)."

Status in the United States

Monochoria hastata is not in trade or established in the wild in the contiguous United States.

According to the USDA NRCS (2021), *Monochoria hastata* is a federally listed Noxious Weed in the United States. It is listed as a Class A noxious weed in Alabama, North Carolina, and Vermont. It is listed as a Quarantine plant in California and Oregon. It is listed as a Prohibited aquatic plant, Class 1 in Florida; a Prohibited plant in Massachusetts, and an Invasive aquatic plant/Plant Pest in South Carolina (USDA NRCS 2021).

From Texas Parks and Wildlife (2020):

"The organisms listed here [included *Monochoria hastata*] are legally classified as exotic, harmful, or potentially harmful. No person may possess or place them into water of this state except as authorized by the department. Permits are required for any individual to possess, sell, import, export, transport or propagate listed species for zoological or research purposes; for aquaculture (allowed only for Blue, Nile, or Mozambique tilapia, Triploid Grass Carp, or Pacific White Shrimp); or for aquatic weed control (for example, Triploid Grass Carp in private ponds)."

One occurrence of *Monochoria hastata* has been reported in Hawaii in GBIF Secretariat (2021) and BISON (2021). This occurrence is described as "grown ornamentally in a garden pool" and is from 1944. There are no other records of this species in the wild in the United States.

Means of Introductions in the United States

No records of introduction to the wild in the United States were found.

Remarks

From GBIF Secretariat (2021):

"Other common names: Hastate-leaf-pondweed, leaf pondweed"

From World Flora Online (2021):

"Synonyms
Calcarunia hastata (L.) Raf.,
Carigola hastata (L.) Raf.
Monochoria chinensis Gand.
Monochoria dilatata (Buch.-Ham.) Kunth
Monochoria hastata var. hastata
Monochoria hastifolia C.Presl
Monochoria sagittata Kunth
Pontederia dilatata Buch.-Ham.
Pontederia hastata L.
Pontederia sagittata Roxb.
Pontederia sagittifolia B.Heyne ex Wall.
Pontederia vaginalis Blanco"

Based on morphological and molecular data, Pellegrini et al. (2018) consider *Monochoria* to be a sub-genus of *Pontederia* and promote the use of *Pontederia hastata*, with synonyms *Calcarunia hastata, Carigola hastata,* and *Monochoria hastata*. Despite this recent work, the ERSS follows World Flora Online (2021) in treating *M. hastata* as the accepted name, with synonyms listed above. Pellegrini et al. (2018) also elevate several subspecies or synonyms of *M. hastata* to the level of species, particularly the name *Pontederia sagittata*, which would include the populations in Central America, giving *M. hastata* a native range completely within Asia. As this screening is following the taxonomic structure outlined in World Flora Online (2021), the populations in Central America will be included in the climate match.

Names used to search for information include: *Monochoria hastata, Monochoria, Monochoria hastata (L.) Solms, Pontederia hastata*, arrowleaf false pickerelweed, false pickerelweed, *Calcarunia hastata, Carigola hastata, Monochoria chinensis, Monochoria dilatata, Monochoria hastata var. hastata, Monochoria hastifolia, Monochoria sagittata, Pontederia dilatata, Pontederia hastata, Pontederia sagittata, Pontederia sagittifolia, Pontederia vaginalis*.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to World Flora Online (2021), *Monochoria hastata* is the current, valid species name.

From CABI (2020):

Domain: Eukaryota
Kingdom: Plantae

Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Monocotyledonae
Order: Pontederiales
Family: Pontederiaceae
Genus: *Monochoria*
Species: *Monochoria hastata*

Size, Weight, and Age Range

From Yu Jiu Hua Shu (2000):

"Herbs perennial, aquatic. Vegetative stems often long and robust. Radical leaves with sheath broadened at base; petiole 30–90 cm; leaf blade triangular or triangular-ovate, 5–15(–25) × 3–15 cm, base sagittate to hastate, apex acute to acuminate. Flowering stems erect or obliquely so, 50–90 cm; leaf petiole 7–10 cm."

From CABI (2020):

"*M. hastata* is a perennial aquatic herb (Boonkerd et al., 1993). It is also reported as an annual by Hakim et al. (2013), but this probably refers to the plants dying if fields dry out (Boonkerd et al., 1993)."

Environment

From Yu Jiu Hua Shu (2000):

"Pools, rice fields, ditches; […]"

From CABI (2020):

"It can grow in very wet soils and in water, becoming a floating plant in deeper water. It prefers fertile, medium to heavy soils with a pH range of 5 to 6.5, tolerating pH 4 to 7 (Useful Tropical Plants, 2019)."

Climate

From Yu Jiu Hua Shu (2000):

"100–700 m."

From CABI (2020):

"It is apparently confined to tropical areas, and it is not spreading into subtropical or temperate regions."

"*M. hastata* is a tropical aquatic herb growing best in sunny areas with temperatures of 25- 35°C, tolerating 16-38°C. It prefers an annual rainfall of 1500-2000 mm, tolerating 1000-4000 mm."

According to CABI (2020), this species grows between 28ºN and 18ºS latitude.

Distribution Outside the United States

Native

From Wu et al. (2000):

"Guangdong, Guizhou, Hainan, Yunnan [China] [Bhutan, Cambodia, India, Indonesia, Malaysia, Myanmar, Nepal, Sri Lanka, Vietnam]"

From Ali et al. (2018):

"Native range: India, Sri Lanka, South East Asia, Australia and Pacific Islands."

Pellegrini et al. (2018) report the native range of *Pontederia hastata*, currently accepted as a synonym of *M. hastata* (World Flora Online 2021; see Remarks), as "Bangladesh, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Sri Lanka, Thailand and Vietnam."

Pellegrini et al. (2018) report the native range of *Pontederia sagittata*, currently accepted as a synonym of *M. hastata* (World Flora Online 2021; see Remarks), as "Mexico, Costa Rica, Guatemala, Honduras, Panama and Brazil (states of Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo, Paraná, Rio Grande do Sul and Santa Catarina)."

Pellegrini et al. (2018) report the native range of *Pontederia vaginalis*, currently accepted as a synonym of *M. hastata* (World Flora Online 2021; see Remarks), as "Widespread throughout Asia (Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Iran, Japan, Korea, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Russia, Sri Lanka, Thailand and Vietnam) and Oceania (Australia, Fiji, Papua New Guinea and Pacific Islands)."

Introduced

From Ali et al. (2018):

"*Monochoria hastata* (L.) Solms. of family Pontederiaceae is the first time reported as a new species in the alien weed flora of Pakistan. *M. hastata* has been found in flooded rice fields, ponds and swampy places in the District Narowal of the Province Punjab, Pakistan. […] At present, this exotic weed is not widespread in Pakistan hence, it is may be possible to eradicate it before it is widely established and difficult to control."

"According to local peoples of the district, *M. hastata* is non-native plant to Pakistan and introduced to their area in just last few years."

"During the field work, *M. hastata* was also found growing in the flooded rice fields near Tehsil Shakargarh of district Narowal."

From CABI (2020):

"It is only listed as invasive in rice fields in Singapore, without further details (PIER, 2019)."

Monochoria hastata is reported as introduced but current status uncertain in Singapore and as introduced, currently present, and invasive in Indonesia (Global Register of Introduced and Invasive Species information provided in GBIF Secretariat 2021).

Means of Introduction Outside the United States

From Ali et al. (2018):

"The source of introduction of this plant to Pakistan is unknown to local people and non-existent in the literature. However, it is suspected that it invaded from India where it has been reported already (Subudhi et al., 2015). Further, this plant was found as a floating species in *Nala Baien* (a river tributary) which is [sic] enters Pakistan from India near the village *Nalooya* therefore it is likely that its seeds or whole plant may have [sic] introduced from India through this water channel or flood water"

"The common mode of reproduction of *M. hastata* is through seeds, and likely through stolons, which are produced in large quantities and deposited in the soil after dispersion. This plant is likely to spread further during flooding events of monsoon and expected to invade more rice growing areas of Pakistan."

Short Description

From Ali et al. (2018):

"Description: The main distinguishing characteristics of *M. hastata* are its leaves that are 'hastate', i.e. basal lobes scheme backwards from connection of petiole and leaf lamina, and the inner margin of each lobe diverges laterally followed by inward bending creating an arrowhead appearance (Fig. 1 [in source material]). Roots are fibrous, adventitious stem: submerged and 40 to 70 cm long (Fig. 1a [in source material]). Leaves are with floating hastate blades, 12–20 cm long and 1.5–10 cm wide, sheathing at the base of petiole 10.5–17 cm long but it varies with depth of water (Fig. 1d [in source material]). Inflorescence of plant is dense corymbose raceme of 5–7.5 cm long with 25–52 flowers, subtended by a spathe-like leaf – sheath (Fig. 1c [in source material]). Flower is pedicellate having 3–3.5 cm long stalk, actinomorphic parianth, bisexual, purplish blue, 1–1.5 cm long and 0.5 cm wide, segments 6 free, petaloid. Stamens are dimorphic 6, 7–10 mm long, one blue anther and other five are yellow in colour, inserted on the sepals, anthers 5–6 mm long (Fig. 1e [in source material]). There are three carpels, polycarpellary, syncarpous, style hairy at apex, ovary superior 3-locular, with axial placentation numerous ovules. Fruit is a capsule 6–7 mm long and 4–5 mm in diameter (Fig. 1f [in source material])."

From CABI (2020):

"*Monochoria hastata* is similar to *M. vaginalis* (Ali et al., 2018; PIER, 2019). The rhizome in *M. vaginalis* is short while in *M. hastata* it is longer and branched. The leaves of *M. hastata* usually have a sagittate or hastate base whereas in *M. vaginalis* they are obtuse, rounded or

truncate-cordate. *M. hastata* usually has more flowers per raceme than *M. vaginalis*. The flowers of *M. hastata* do not open simultaneously and the pedicels are unequal in length, being longer at the base of the raceme."

Biology

From Ali et al. (2018):

"[…] reproduces both sexually (seed) and vegetatively (stolons)."

From CABI (2020):

"*M. hastata* reproduction is by seeds and vegetatively by rhizome fragmentation (Boonkerd et al., 1993; Useful Tropical Plants, 2019). Anthesis takes place during the morning and the flowers are self-compatible (Boonkerd et al., 1993; Huelsenbeck et al., 2003). In India the flowers are foraged for pollen by *Apis mellifera* (Pal and Karmakar, 2013). The seeds are produced in abundance and the germination is underwater (Ali et al., 2018)."

"Plants of *M. hastata* usually grow in clumps (India Biodiversity Portal, 2019)."

From Yu Jiu Hua Shu (2000):

"Herbs perennial, aquatic. Vegetative stems often long and robust. Radical leaves with sheath broadened at base; petiole 30–90 cm; leaf blade triangular or triangular-ovate, 5–15(–25) × 3–15 cm, base sagittate to hastate, apex acute to acuminate. Flowering stems erect or obliquely so, 50–90 cm; leaf petiole 7–10 cm. Inflorescences erect or suberect, remaining so after anthesis, subumbellate to shortly racemose, 10–40-flowered; peduncle distinctly shorter than associated leaf petiole. Pedicels 1–3 cm. Perianth segments bluish with green median vein and reddish blotch, ovate, 1–1.6 cm. Larger stamen: anther 5.3–6.5 mm. Smaller stamens: filaments filiform; anthers 3–4 mm. Style densely and shortly spreading hairy at apex. Capsule oblong, ca. 1 cm. Seeds brown, oblong; wings ca. 10. Fl. [flowers] Aug, fr. [fruits] Mar."

Human Uses

From Ali et al. (2018):

"[…] different parts of *M. hastata* plant are used for treating ailments such as toothache, asthma, cough, cold, fever, but also for stomach and liver disorders, haemorrhage, hepatitis, anemia, scurvy and diabetes (Ileperuma et al., 2015). Phytoremediation potential of *M. hastata* is recently investigated in India, Switzerland and Bangladesh and is a bioaccumulator of Cadmium (Cd), Arsenic (As) and Mercury (Pb) and plays effective role in reclamation of contaminated area (Islam et al., 2013; Claudia et al., 2014; Hazra et al., 2015; Buruah et al., 2017).

From CABI (2020):

"*M. hastata* is used as a vegetable in its native range (Patwary et al., 1989; Maikhuri and Gangwar, 1993; Ogle et al., 2003; Ali et al., 2018; Useful Tropical Plants, 2019). The plants are

usually foraged from natural populations (Boonkerd et al., 1993). It is also used as fodder for cattle (Patwary et al., 1989) and occasionally as an ornamental (Useful Tropical Plants, 2019)."

"In Oceania, *M. hastata* is reported only as cultivated in Fiji, without further details (PIER, 2019)."

Diseases

No information available.

Threat to Humans

From Ali et al. (2018):

"The occurrence of this plant inside rice fields is of concern for local rice growers who are already battling against many other problematic weeds of rice crop. This plantis [sic] already reported as a weed of rice fields in many other countries such as India (Subudhiet al., 2015), Bangladesh (Hassan et al., 2010), Thailand (Cruz-Garcia and Price, 2011), Malaysia (Hakim et al., 2013), Indonesia (Backer and Bakhuizen van den Brink, 1968) and Fiji (Parham, 1958)."

3 Impacts of Introductions

No data were available to document negative impacts of introductions for *Monochoria hastata.* The following section refers to general impact statements, where the plant may be a nuisance within its native range, and potential, not documented impacts.

From Ali et al. (2018):

"It has been also reported as a weed of rice fields in many countries of South and Southeast Asia and is an aggressive weed that reproduces both sexually (seed) and vegetatively (stolons)."

"*M. hastata* is an exotic weed, which is first time reported [sic] from Pakistan growing in wetlands and rice fields. Since this plant is already reported as a problematic rice weed in many countries authorities need to be vigilant and take action to manage it and stop its further spread."

From CABI (2020):

"It [*M. hastata*] is only listed as invasive in rice fields in Singapore, without further details (PIER, 2019). *M. hastata* is not reported as invasive in natural habitats; nor is there information about its effects on biodiversity."

"*M. hastata* is an aquatic herb with a medium to high risk of introduction into tropical areas worldwide. It is apparently confined to tropical areas, and it is not spreading into subtropical or temperate regions. Boonkerd et al. (1993) reports it as being unable to survive winter temperatures in subtropical areas.

M. hastata could be introduced to suitable areas through its use as an ornamental, flooding events and interconnected waterways (Ali et al., 2018; Useful Tropical Plants, 2019). Because of

its presence as a weed of rice and the possible detrimental effects on agriculture, *M. hastata* is listed as a noxious weed in the USA (USDA-NRCS, 2019). Although it has not been reported as a contaminant of rice products, its spread through cultivation practices needs more research."

"*M. hastata* is reported as a weed of rice fields, but with very little information available (PIER, 2019). Boonkerd et al. (1993) report that at high population densities, *M. hastata* is competitive and can reduce rice yields considerably."

According to the USDA NRCSD (2021), *Monochoria hastata* is a federally listed Noxious Weed in the United States. It is listed as a Class A noxious weed in Alabama, North Carolina, and Vermont. It is listed as a Quarantine plant in California and Oregon. It listed as a Prohibited aquatic plant, Class 1 in Florida; a Prohibited plant in Massachusetts, and an Invasive aquatic plant/Plant Pest in South Carolina (USDA NRCS 2021).

4 History of Invasiveness

The history of invasiveness of *Monochoria hastata* is classified as Data Deficient. *M. hastata* is in the ornamental plant trade (volume unknown) outside the contiguous United States, and *M. hastata* is prohibited federally and in several U.S. States. There are documented introductions of *M. hastata* outside its native range, and it seems to be locally established in Pakistan. It is also reported as introduced, present, and invasive in Indonesia, however, other sources also list it as native to Indonesia. The negative impacts of *M. hastata* as an agricultural weed have only come from areas within the native range and are general statements versus a detailed field study of impacts. Information is scarce about how *M. hastata* introductions affect native species, the environment, the economy, or human health.

5 Global Distribution

Figure 1. Known global distribution of *Monochoria hastata*. Observations are reported from Southeast Asia (China, Thailand, Malaysia, India, Indonesia), northern Australia, Central America (Mexico: Veracruz, Yucatan; Guatemala, Honduras), Fiji, and Hawaii. Map from GBIF Secretariat (2021). Georeferenced observations were not available to represent parts of the reported range of the species (i.e. Afghanistan, Bhutan, Brazil, Costa Rica, Iran, Japan, Korea, Pakistan, Panama, Philippines, and Russia).

6 Distribution Within the United States

Figure 2. Known distribution of *Monochoria hastata* in the United States. *M. hastata* has been reported in Hilo, Hawaii. Map from BISON (2021). This report is from an ornamental pond in 1944. There was no evidence in the literature that this is an established, wild population and therefore it was not used in climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Monochoria hastata* was low for most of the contiguous United States. There was a high match in peninsular Florida, and a medium match in northern Florida and along the Gulf of Mexico and southeastern Atlantic coast. There were small regions of medium climate match in west Texas, southern Arizona and New Mexico, and along the Pacific Ocean coast of California and around the Puget Sound. The overall Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.013, medium. (Scores between 0.005 and 0.103, exclusive, are classified as medium). Florida had a high individual climate score; all other States had a low individual climate score.

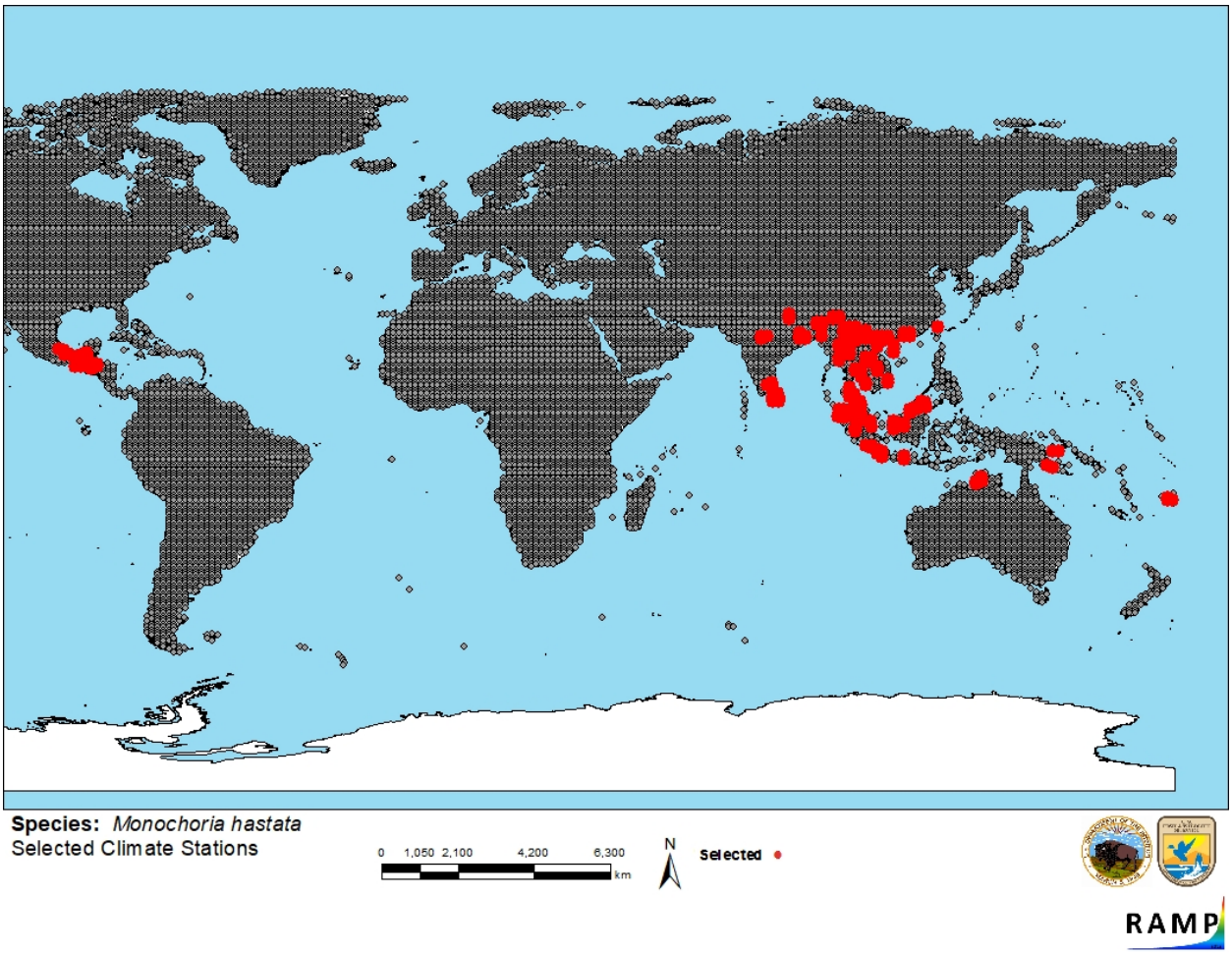

Figure 3. RAMP (Sanders et al. 2018) source map showing weather stations in Southeast Asia, Northern Australia, and Central America selected as source locations (red: China, Thailand, Malaysia, India, Indonesia, Fiji, Australia, Mexico, Guatemala, Honduras) and non-source locations (gray) for *Monochoria hastata* climate matching. Source locations from GBIF Secretariat (2021). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

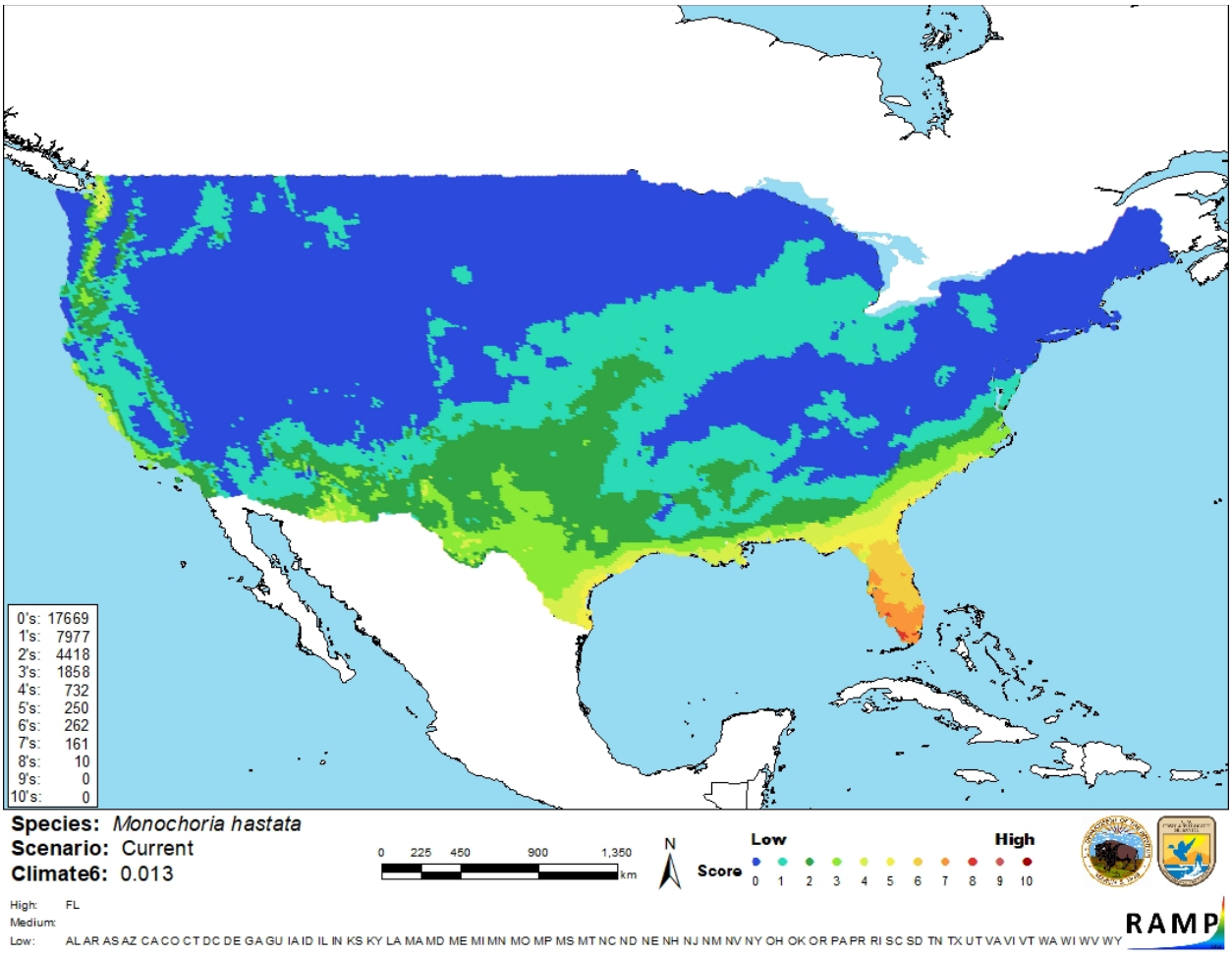

Figure 4. Map of RAMP (Sanders et al. 2018) climate matches for *Monochoria hastata* in the contiguous United States based on source locations reported by GBIF Secretariat (2021). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: (Count of target points with climate scores 6-10)/ (Count of all target points)	Overall Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

8 Certainty of Assessment

The certainty of this assessment is low. The taxonomy of this species is not fully resolved. There is information showing that *M. hastata* can become established outside its native range (e.g.,

Pakistan). However, no peer-reviewed studies have documented any impacts from known introductions. Based on this lack of information, the certainty of this assessment is low.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Monochoria hastata, the Arrowleaf False Pickerelweed, is an aquatic plant that is native to Southeast Asia and Australia and (as *Pontederia sagittata*) to Central America. *M. hastata* can be found in tropical and subtropical wetlands, swamps, and ponds. Within its native range, *M. hastata* is a known weed of rice paddies. *M. hastata* is used as a food source, ornamental plant, and medicinal herb by humans, as well as for bioremediation. *M. hastata* is listed as a Federal Noxious Weed by USDA; it is also prohibited in multiple states. The history of invasiveness is classified as Data Deficient due to the lack of known impacts from the introductions. The climate match to the contiguous United States for *M. hastata* was medium. However, only Florida, the Gulf and southern Atlantic coasts, and small areas of the southwest and Pacific Coast had a medium or high climate match. The certainty of assessment is low due to a lack of information and taxonomic uncertainty. The overall risk assessment category is Uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 4): Data Deficient**
- **Overall Climate Match Category (Sec. 7): Medium**
- **Certainty of Assessment (Sec. 8): Low**
- **Remarks/Important additional information: No additional information**
- **Overall Risk Assessment Category: Uncertain**

10 Literature Cited

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 11.

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11 Literature Cited in Quoted Material

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

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