Frogbit (*Hydrocharis dubia*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, August 2020
Revised, January 2021
Web Version, 3/24/2021

Organism Type: Plant
Overall Risk Assessment Category: Uncertain

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1 Native Range and Status in the United States

Native Range

From Catalog of Life (2020):

"Bangladesh; China North-Central; China South-Central; China Southeast; Hainan; India; Japan; Jawa; Korea; Manchuria; Myanmar; Nansei-shoto; New Guinea; New South Wales; Philippines; Primorye; Queensland; Sulawesi; Taiwan; Thailand; Vietnam; West Himalaya."

From PROSEA (2020):

"From southern and eastern Asia to Australia, including South-East Asia."

From POWO (2020):

"This species is accepted, and its native range is Russian Far East to Tropical Asia."

From Juffe Bignoli (2011):

"Australia (Queensland, New South Wales); Bangladesh; China (Henan, Guangxi, Heilongjiang, Guangdong, Shaanxi, Shandong, Jiangxi, Fujian, Jiangsu, Hunan, Zhejiang, Hubei, Sichuan, Hebei, Yunnan, Hainan, Jilin, Liaoning); India; Indonesia (Jawa, Sulawesi); Japan; Korea, Republic of; Myanmar; Papua New Guinea (Papua New Guinea (main island group)); Philippines; Taiwan, Province of China; Thailand; Viet Nam"

"This aquatic plant has been recorded in several countries across southeast and east Asia, Indonesia and northern Australia. In China it has been recorded in the provinces of Anhui, Fujian, Guangdong, Guangxi, NE Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Shaanxi, Shandong, Sichuan, Taiwan, Yunnan, and Zhejiang. In Thailand it is found in the Chiang Mai (northern), Nakhon Ratchasima (eastern) and Ang Thong in Saraburi (central)."

Discrepancies on the status of this species in Australia were found. Bean (2020) lists this species as "naturalized in QLD [Queensland, Australia]" and will therefore be classified as nonnative to Australia in this ERSS.

Status in the United States

Hydrocharis dubia has not been introduced in the wild in the United States. This species has not been reported in trade in the United States.

Means of Introductions in the United States

There are no known introductions of *H. dubia* in the United States.

Remarks

From Bean (2011):

"It has been accepted as an indigenous species in Australia but recently this has been repeatedly questioned by weed control authorities."

"*Hydrocharis dubia* fails all of the ecological criteria for an indigenous species, and the historical criteria are equivocal. In the key of Bean (2007) it readily keys to "alien" […]"

"[…] there is a strong weight of evidence to support an alien status for *Hydrocharis dubia* with regard to its occurrences in Australia."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

WFO (2021) lists *Hydrocharis dubia* as an accepted species name in the Hydrocharitaceae family.

From GBIF Secretariat (2020):

"Kingdom Plantae
Phylum Tracheophyta
Class Liliopsida
Order Alismatales
Family Hydrocharitaceae
Genus *Hydrocharis* L.
Species *Hyrdocharis dubia* Backer"

Size, Weight, and Age Range

From Stanley and Ross (1989):

"Leaves with a petiole up to 12 cm long and blade shape broad-ovate to circular, up to 6 cm long and nearly as wide, with a heart-shaped to kidney-shaped base. Flowers 2–3 cm diameter with three petals 10–15 mm long […]"

Environment

From Juffe Bignoli (2011):

"It grows in ponds, lakes and streams of lowlands."

"Freshwater (=Inland waters)"

"Wetlands (inland)

From PROSEA (2020):

"In pools and marshes, up to 1200 m altitude, locally gregarious."

From Stanley and Ross (1989):

"An aquatic perennial with emergent and floating leaves; stolons rooted in shallow water, floating across deeper water."

Climate

No information on climate was found.

Distribution Outside the United States

Native

From Catalog of Life (2020):

"Bangladesh; China North-Central; China South-Central; China Southeast; Hainan; India; Japan; Jawa; Korea; Manchuria; Myanmar; Nansei-shoto; New Guinea; New South Wales; Philippines; Primorye; Queensland; Sulawesi; Taiwan; Thailand; Vietnam; West Himalaya."

From PROSEA (2020):

"From southern and eastern Asia to Australia, including South-East Asia."

From POWO (2020):

"This species is accepted, and its native range is Russian Far East to Tropical Asia."

From Juffe Bignoli (2011):

"Australia (Queensland, New South Wales); Bangladesh; China (Henan, Guangxi, Heilongjiang, Guangdong, Shaanxi, Shandong, Jiangxi, Fujian, Jiangsu, Hunan, Zhejiang, Hubei, Sichuan, Hebei, Yunnan, Hainan, Jilin, Liaoning); India; Indonesia (Jawa, Sulawesi); Japan; Korea, Republic of; Myanmar; Papua New Guinea (Papua New Guinea (main island group)); Philippines; Taiwan, Province of China; Thailand; Viet Nam"

"This aquatic plant has been recorded in several countries across southeast and east Asia, Indonesia and northern Australia. In China it has been recorded in the provinces of Anhui, Fujian, Guangdong, Guangxi, NE Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Shaanxi, Shandong, Sichuan, Taiwan, Yunnan, and Zhejiang. In Thailand it is found in the Chiang Mai (northern), Nakhon Ratchasima (eastern) and Ang Thong in Saraburi (central)."

Discrepancies on the status of this species in Australia were found. Bean (2020) lists this species as "naturalized in QLD [Queensland, Australia]" and will therefore be classified as nonnative to Australia.

Introduced

GBIF Secretariat (2020) reported the only known introduction of *H. dubia* outside of its native range was in India. No further information on this introduction or its establishment in India was found.

According to the Census of Queensland Flora [Brown and Bostock 2020, Bean 2020] *H. dubia* is listed as "naturalized in QLD [Queensland, Australia]," and is therefore classified as an introduced species in Australia.

From POWO (2020):

"New South Wales, Queensland"

From Bean (2011):

"It has been accepted as an indigenous species in Australia but recently this has been repeatedly questioned by weed control authorities."

"*Hydrocharis dubia* fails all of the ecological criteria for an indigenous species, and the historical criteria are equivocal. In the key of Bean (2007) it readily keys to "alien" […]"

"[…] there is a strong weight of evidence to support an alien status for *Hydrocharis dubia* with regard to its occurrences in Australia."

"*Hydrocharis dubia* has been found at 13 Australian locations in Queensland (Qld) and New South Wales (NSW) based on herbarium records […]."

Means of Introduction Outside the United States

From Bean (2011):

"[…] the species is indigenous to south-east Asia, and natural dispersal from that region to Australia is not an unreasonable hypothesis; […]"

Short Description

From PROSEA (2020):

"Small, aquatic, free-floating or rooting, fleshy, monoecious herb."

"Leaves emerged or floating, in rosettes; petiole up to 15 cm long with wide air-channels; leaf-blade ovate-cordate to broadly ovate, 2.5-6 cm × 2.5-7.5 cm, nerves curved, parallel, joining the marginal nerve, connected by straight, parallel cross-veins."

"Flowers enclosed in an axillary sheath before anthesis; male sheath peduncled with 2-4 pedicelled flowers; female sheath sessile with a solitary pedicelled flower; sepals white; petals white with a yellow base."

From Stanley and Ross (1989):

"Leaves with a petiole up to 12 cm long and blade shape broadovate to circular, up to 6 cm long and nearly as wide, with a heartshaped to kidney-shaped base. Flowers 2–3 cm diameter with three petals 10–15 mm long, rounded, white, yellow at the very base. Male flowers grouped 1–4

together on short stems. Female flowers arising singly on a stem 1–8 cm long. Fruit is berry-like, 5– 10 mm long, maturing underwater. Seeds are numerous, 1–1.5 mm long and have been described as both echinate (spiny) and tuberculate (warty)."

From Xu et al. (2012):

"*Hydrocharis dubia* (Bl.) Backer, a floating-leaved aquatic macrophyte, is a clonal weedy species […]"

From Tsuchiya (1989):

"Stems of *H. dubia* are either contracted, bearing rosette leaves, or elongate-stoloniferous and leafless. The leaves, spirally arranged in a dense rosette, either float or occasionally emerge above the water surface. Adventitious roots with large and abundant root hairs are borne on leafy stems. The plant is usually rooted in the bottom sediment but occasionally hangs free in the water, i.e., free-floating."

Biology

From Tsuchiya (1989):

"This species propagates vegetatively by elongation of stolons to form new rosette ramets, and overwinters in the form of hibernacula (known as winter buds or turions). Seeds are also formed, but little is known about sexual reproduction and establishment of seedlings. *H. dubia* may spread primarily by means of rapid clonal growth over the water surface, similar to most free floating plants."

From Ru et al. (2015):

"The structure of the fruit, seed and seedling of *Hydrocharis dubia* in Hydrocharitaceae were studied with light microscope. The results show that the fruit has incompletely six locules with superficial placentation. The seed has anchorlike trichomes occur [sic] on the surface and with no endosperm. The seed embryo develops on the water. The hypocotyl hairs appear earlier than the primary root which develops weakly. The adventitious roots are formed with the leaf development. The paracytic stomata are present in the upper epidermis of the young leaf and the air canals are present in the mesophyll. The petiole has a sheath-like base. The seedlings usually die and only a few could develop into mature plants and the development of the species is similar to those of the other taxa in Alismatales."

Human Uses

From Zhao et al. (2017):

"It can be used as fodder, vegetable, or green manure. More importantly, it is very useful in purifying water quality (Zhao et al., 2008)."

Diseases
No information on diseases associated with this species was found.

Threat to Humans
No information on threat to humans was found.

3 Impacts of Introductions
Introductions were reported from Australia and in India, however no information on impacts of introduction were found.

4 History of Invasiveness
The history of invasiveness is classified as Data Deficient. Introductions were reported from both Australia and India. Although the species has become established in Australia, it has previously been treated as a native species and that understanding was only questioned in the last few decades. It is now officially listed by the Queensland Government as a nonnative species. No information was found to confirm that the introduction listed in India was outside the native range of the species in that country or if it had become established. No information on impacts from introduction in either country was found.

5 Global Distribution

Figure 1. Known global distribution of *Hydrocharis dubia*. Locations are in Russia, Japan, China, South Korea, Taiwan, Thailand, Indonesia, Papua New Guinea, Australia, and Pakistan. Map from GBIF Secretariat (2020). The location in Pakistan will not be included in the climate match as no further information was found to indicate these locations represent established populations of this species.

No georeferenced observations were available from Bangladesh, India, Myanmar, Philippines, or Vietnam which are listed as part of the native range of *Hydrocharis dubia.*

6 Distribution Within the United States

Hydrocharis dubia has not been reported in the wild in the United States.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Hydrocharis dubia* was generally medium to high. High match was found throughout most central States and in the Southeast, primarily in coastal areas. Medium match was found primarily in the eastern half of the country, with a low match throughout much of the West and parts of northern New England. The overall Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.339, high (scores of 0.103 and above are classified as high). The following States received a high individual Climate 6 score: Colorado, Florida, Georgia, Iowa, Kansas, Michigan, Minnesota, Missouri, Montana, North Carolina, North Dakota, Nebraska, New Jersey, New Mexico, Oklahoma, South Carolina, South Dakota, Texas, Virginia, Wisconsin, and West Virginia. The following States received medium individual Climate 6 scores: Alabama, Arkansas, Arizona, Illinois, Kentucky, Massachusetts, Tennessee, and Wyoming. All remaining States received low individual scores.

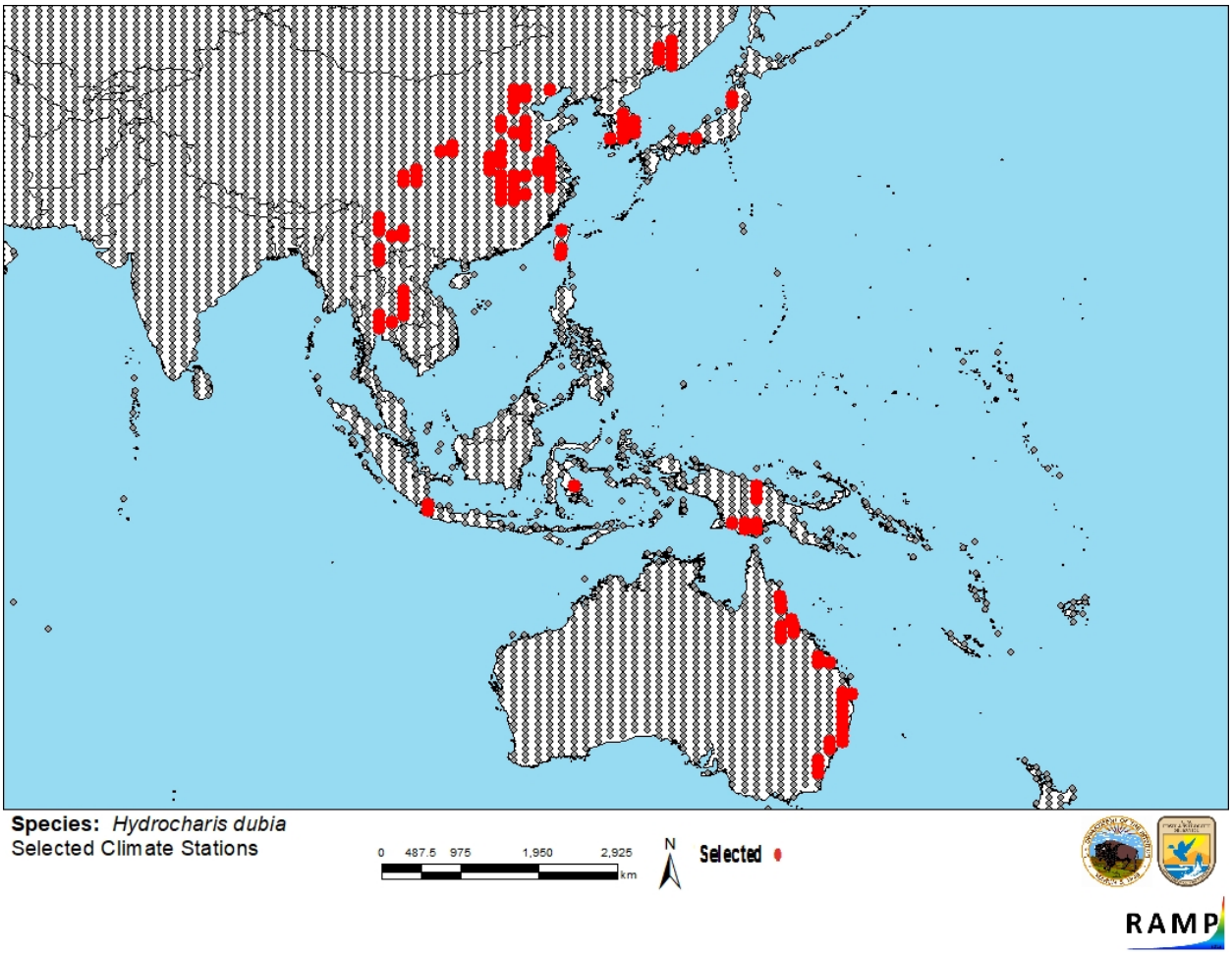

Figure 2. RAMP (Sanders et al. 2018) source map showing selected source locations (red; Russia, South Korea, China, Thailand, Indonesia, Japan, Papua New Guinea, Taiwan, Australia) and non-source locations (gray) for *Hydrocharis dubia.* Source locations from GBIF Secretariat (2020). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

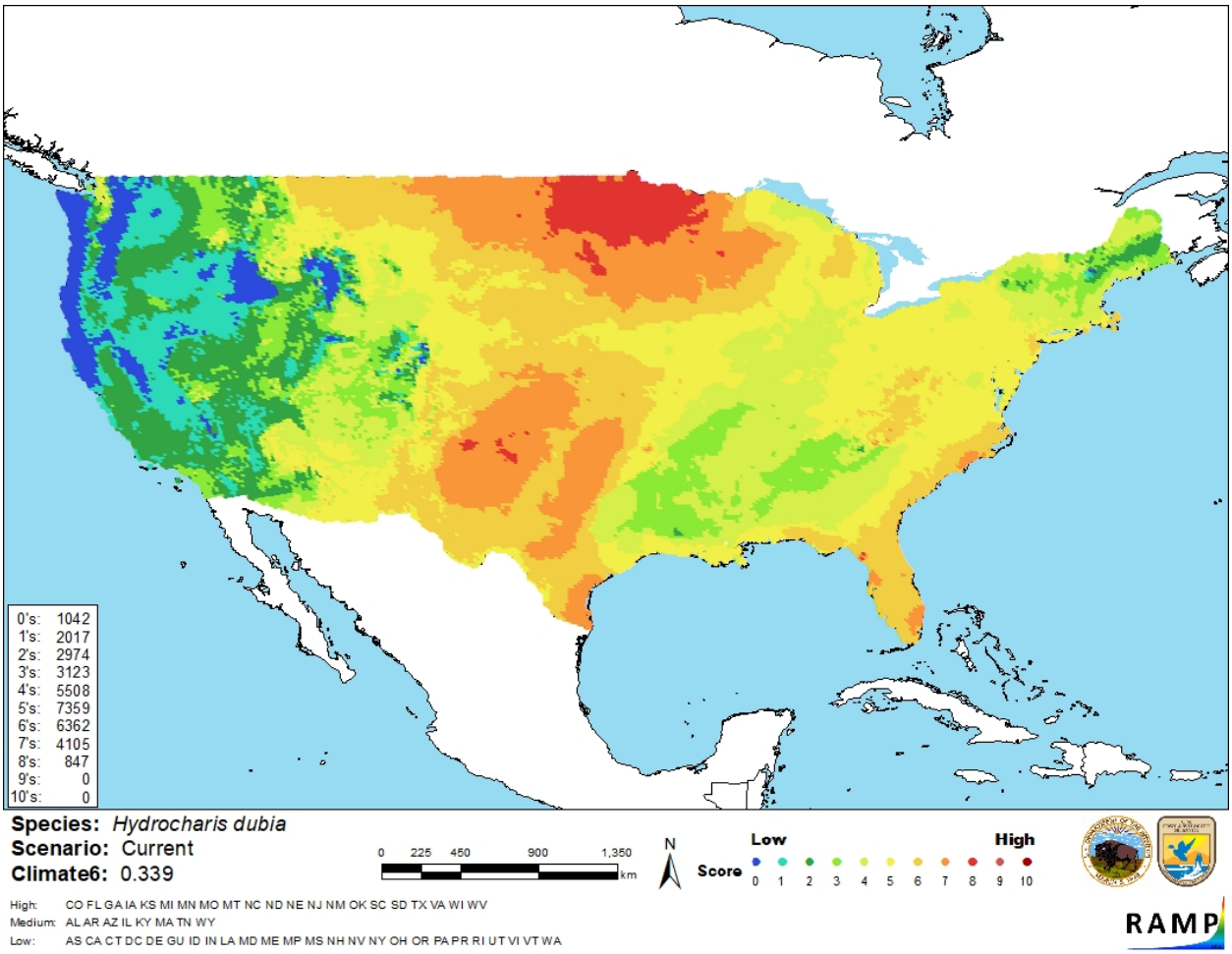

Figure 3. Map of RAMP (Sanders et al. 2018) climate matches for *Hydrocharis dubia* in the contiguous United States based on source locations reported by GBIF Secretariat (2020). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

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 assessment is Low. Limited information is available on the biology and ecology of *Hydrocharis dubia.* This species has become naturalized outside of its native range. No impacts of introduction have been reported. Further information is needed to increase certainty.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Frogbit (*Hydrocharis dubia*) is an aquatic perennial plant species native to eastern Asia, from Russia to Papua New Guinea. *Hyrdocharis dubia* has become naturalized in Australia. It is also recorded as introduced to India but no information on establishment was found. No impacts of introduction have been documented. *H. dubia* has been used in agriculture as fodder and a green manure; it has also been used in water treatment projects. No information on this species in trade was found. The history of invasiveness is classified as Data Deficient. The overall climate match for the contiguous United States was high, with high match generally being found in the central States and in parts of the Southeast. The certainty of assessment is Low due to limited available information on *H. dubia*. The overall risk assessment category for *Hydrocharis dubia* is Uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 4): Data Deficient**
- **Overall Climate Match Category (Sec. 7): High**
- **Certainty of Assessment (Sec. 8): Low**
- **Remarks, Important additional information: No additional remarks**
- **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.

Bean AR. 2020. Rhamnaceae. In Brown GK, Bostock PD, editors. Census of the Queensland Flora 2020. Queensland Department of Environment and Science, Queensland Government. Available: www.data.qld.gov.au/dataset/census-of-the-queensland-flora-2020 (January 2021). (CSV data table)

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Brown GK, Bostock PD. 2020. Introduction to the Census of the Queensland Flora 2020. Queensland Department of Environment and Science, Queensland Government.

GBIF Secretariat. 2020. GBIF backbone taxonomy: *Hydrocharis dubia* Backer. Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/5329272 (January 2021).

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Ru J, Liu M, Cheng XY, Wang C. 2015. The morphological study of the fruit, seed and seedling of *Hydrocharis dubia* (Hydrocharitaceae). Pakistan Journal of Botany 47(4):1467–1472.

Sanders S, Castiglione C, Hoff M. 2018. Risk Assessment Mapping Program: RAMP. Version 3.1. U.S. Fish and Wildlife Service.

Stanley TD, Ross EM. 1989. Flora of South-Eastern Queensland. Volume 3. Brisbane: Queensland Department of Primary Industries. Available: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20243 (January 2021).

Tsuchiya T. 1989. Growth and biomass turnover of *Hydrocharis dubia* L. cultured under different nutrient conditions. Ecological Research 4(2):157–166.

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Xu Q, Fu Y, Min H, Cai S, Sha S, Cheng G. 2012. Laboratory assessment of uptake and toxicity of lanthanum (La) in the leaves of *Hydrocharis dubia* (Bl.) Backer. Environmental Science and Pollution Research 19(9):3950–3958.

Zhao S, Huang W, Jiang H, Sun J, Yin L, Li W. 2017. *Hydrocharis dubia* seeds maintain high seed vigor in ambient wet storage condition through scavenging hydrogen peroxide by antioxidant systems. Aquatic Botany 143:18–24.

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.

Bean AR. 2007. A new system for determining which plant species are indigenous in Australia. Australian Systematic Botany 20: 1–43.

Zhao J, Shi GX, Yuan QH, 2008. Polyamines content and physiological and biochemical responses to ladder concentration of nickel stress in *Hydrocharis dubia* (Bl.) Backer leaves. Biometals 21:665–674.