Ricefield Waternymph (*Najas graminea*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, August 2020
Revised, January 2021
Web Version, 3/26/2021

Organism Type: Plant
Overall Risk Assessment Category: Uncertain

Photo: Show_ryu. Licensed under the Creative Commons Attribution-Share Alike 3.0 Unported, 2.5 Generic, 2.0 Generic and 1.0 Generic license. Available: https://commons.wikimedia.org/wiki/File:Najas_graminea.JPG (August 2020).

1 Native Range and Status in the United States

Native Range

From Rantizien (1952):

"The occurrence of *N. graminea* in Jur represents one of the westernmost spontaneous localities of that species. *N. graminea* has a wide distribution in the Old World tropics from Japan and

New Caledonia to Algeria, Egypt, and Sudan. In Africa this species is restricted to the northern and eastern parts, Algeria, Egypt (numerous localities), Abyssinia, Socotra and the Anglo-Egyptian Sudan (Kordofan; White Nile and Bahr el Ghazal Provinces)."

From Triest (1987):

"*N. graminea*, further known from […], Middle East to tropical Asia, Japan, Australia […], occurs in northern Africa (Algeria, Nile delta) and in tropical Africa (Soudano-Zambezian Region)."

Marwat et al. (2011) stated *N. graminea* is rare, but native to northwestern Pakistan in Dera Ismail Khan District [Chashma Lake and Khisore range Badari Dam].

From India Biodiversity Portal (No date):

"Native: Afghanistan; Algeria; Australia (Ashmore-Cartier Is., Northern Territory); Botswana; Cambodia; Cameroon; Central African Republic; Chad; China (Anhui, Fujian, Guangdong, Guangxi, Hainan, Hebei, Henan, Hubei, Jiangsu, Liaoning, Sichuan, Yunnan, Zhejiang); Congo, The Democratic Republic of the; Egypt (Egypt (African part)); Eritrea; Ethiopia; Gambia; Guinea-Bissau; India; Indonesia (Jawa, Lesser Sunda Is., Maluku, Sulawesi, Sumatera); Iran, Islamic Republic of; Iraq; Japan (Nansei-shoto); Kazakhstan; Kenya; Korea, Republic of; Lebanon; Mali; Myanmar (Myanmar (mainland)); Nepal; New Caledonia; Oman; Palestinian Territory, Occupied; Papua New Guinea (Papua New Guinea (main island group)); Philippines; Rwanda; South Africa (North-West Province); Sri Lanka; Sudan; Syrian Arab Republic; Taiwan, Province of China (Taiwan, Province of China (main island)); Tajikistan; Tanzania, United Republic of; Thailand; Turkey; Uzbekistan; Viet Nam; Yemen"

Status in the United States

From Haynes (1979):

"[…] the species [*Najas graminea*] apparently was introduced into California prior to 1946 and now is evidently quite rare there."

From Rantzien (1952):

"It has been introduced […] recently into U.S.A. (California in a rice- field 1949 acc. to inf. in litt. from H. L. Mason, Univ. of Calif., Dec. 1, 1950)."

Thorne et al. (2012) reported that *N. graminea* is uncommon, but established in the Sacramento Valley, California.

According to BISON (2020), *Najas graminea* was first reported in 1946 in Butte Creek Drainage, Butte County, California, where it is established. It was reported to have become established in the Honcut Headwaters – Lower Feather drainage in 1991. Most recently, it was reported to be established in the Upper Cache drainage, Colusa County, California, in 2008. It

has only been reported in Butte and Colusa County, California. This species has not been reported outside these two counties in California within the United States.

No record of *N. graminea* in trade in the United States was found.

Means of Introductions in the United States

No means of introduction were reported in the literature. There is no conclusive evidence that indicates this species is in trade in the United States and has not been reported on any prohibited lists.

Remarks

This species appears to have several morphological types, resistance to aquatic pesticides, a high metal adsorption ability, and can tolerate high salinity waters.

From de Wilde (1961):

"During my work on *Najas* I have seen many hundreds of sheets and examined a couple of thousands of flowers and have come across some specimens of *Najas graminea* Del., a species which normally has naked flowers but in which occasionally some flowers are provided with an envelope which is intermediary between a spathe and a leaf. These envelopes have in common with the spathe that they are at least partly closed and have no midrib, and no sheath-like auricles (which arc obviously suppressed through the connation of the leaf margins). They have in common with leaves that they are green, elongated, and possess intravaginal scales as in normal leaves. Besides I have observed in two specimens from Asia, which are in all other respects agreeing with *N. graminea*, a further stage which nearly approaches that of a normal spathe. In a sheet marked "Ass. Malariol. Publ. Health No. 1" (BM) from Burma one male flower was naked, the three others had a completely closed spathe but with a very thin and relatively long cylindric neck. In another Indian specimen marked "Hook. f. & Th." p.p. (K) all flowers had such a long-necked spathe."

Lee et al. (1998) and Lee et al. (1999) concluded that *Najas graminea* had promising potential for metal [Cu, Zn, Pb, Cd, and Ni] removal from aquatic systems. They suggested it could be grown in river, stream, acid mining drainage, or in clean water systems initially and then transfer to the polluted water to remove metals from aquatic systems.

From Mallik et al. (2011):

"The effects of NaCl on the H2O2 content and the activities of catalase (CAT) and superoxide dismutase (SOD) were studied in diverse group of plants, such as a unicellular alga, *Chlorella* sp., an aquatic macrophyte, *Najas graminea*, and a mangrove plant, *Suaeda maritima*, all showing high tolerance to NaCl."

From Silprasit et al. (2016):

"The plants observed including *N. graminea* Del., *Nitella sp*., *U. aurea lour*, and *H. verticellata* were found to be remained alive in glyphosate-contaminated water."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to World Flora Online (2021), *Najas graminea* is an accepted name in the Hydrocharitaceae family.

From ITIS (2020):

Kingdom Plantae
Subkingdom Viridiplantae
Infrakingdom Streptophyta
Superdivision Embryophyta
Division Tracheophyta
Subdivision Spermatophytina
Class Magnoliopsida
Superorder Lilianae
Order Alismatales
Family Hydrocharitaceae
Genus *Najas*
Species *Najas graminea*

Size, Weight, and Age Range

From Haynes (1979):

"[…] Stems to 35 cm long, 0.2-0.5 mm in diameter, […]"

From Triest (1987):

"[…] Stems up to 60 cm high, unarmed, 0.4-1.5 mm in diameter, […]"

Environment

From Zhuang (2017):

"This aquatic plant grows in ponds, river, streams, lakes and paddy fields, usually in still or slow-moving water."

From Thorne et al. (2012):

"Irrigation ditches; rice fields"

Climate

From Pall (2011):

"This species is wide-spread in tropical and subtropical regions […]"

Distribution Outside the United States

Native

From Rantizien (1952):

"The occurrence of *N. graminea* in Jur represents one of the westernmost spontaneous localities of that species. *N. graminea* has a wide distribution in the Old World tropics from Japan and New Caledonia to Algeria, Egypt, and Sudan. In Africa this species is restricted to the northern and eastern parts, Algeria, Egypt (numerous localities), Abyssinia, Socotra and the Anglo-Egyptian Sudan (Kordofan; White Nile and Bahr el Ghazal Provinces)."

From Triest (1987):

"*N. graminea*, further known from […], Middle East to tropical Asia, Japan, Australia […], occurs in northern Africa (Algeria, Nile delta) and in tropical Africa (Soudano-Zambezian Region)."

Marwat et al. (2011) stated *N. graminea* is rare, but native to northwestern Pakistan in Dera Ismail Khan District [Chashma Lake and Khisore range Badari Dam].

From India Biodiversity Portal (No date):

"Native: Afghanistan; Algeria; Australia (Ashmore-Cartier Is., Northern Territory); Botswana; Cambodia; Cameroon; Central African Republic; Chad; China (Anhui, Fujian, Guangdong, Guangxi, Hainan, Hebei, Henan, Hubei, Jiangsu, Liaoning, Sichuan, Yunnan, Zhejiang); Congo, The Democratic Republic of the; Egypt (Egypt (African part)); Eritrea; Ethiopia; Gambia; Guinea-Bissau; India; Indonesia (Jawa, Lesser Sunda Is., Maluku, Sulawesi, Sumatera); Iran, Islamic Republic of; Iraq; Japan (Nansei-shoto); Kazakhstan; Kenya; Korea, Republic of; Lebanon; Mali; Myanmar (Myanmar (mainland)); Nepal; New Caledonia; Oman; Palestinian Territory, Occupied; Papua New Guinea (Papua New Guinea (main island group)); Philippines; Rwanda; South Africa (North-West Province); Sri Lanka; Sudan; Syrian Arab Republic; Taiwan, Province of China (Taiwan, Province of China (main island)); Tajikistan; Tanzania, United Republic of; Thailand; Turkey; Uzbekistan; Viet Nam; Yemen"

Introduced

From Rantzien (1952):

"It has been introduced into Europe (England, Italy, Bulgaria) […]"

From Zhuang (2017):

"It has become naturalised in Spain, Italy, Bulgaria, the Crimea […]."

From Pall (2011):

"This species is wide-spread in tropical and subtropical regions and has already been found on North Italian paddy-fields (Casper & Krausch 1980)."

Thiébaut (2007) stated this species had been reported in France before 1997 and Hussner (2012) stated it had been reported in both France and Italy.

Means of Introduction Outside the United States

Means of introduction for *Najas graminea* were not reported.

Short Description

From Triest (1987):

"Plants submerged, monoecious, slender. Stems up to 60 cm high, unarmed, 0.4-1.5 mm in diameter, often plumose above because of the closely packed leaves. Leaves (9.2-) 14-20 (-33) mm long, flat, acute, linear-lanceolate, (0.24-) 0.5-0.8 (-1.0) mm wide (incl. teeth on both sides), (0.19-) 0.4-0.7 (-0.84) mm wide (excl. teeth on both sides); margin on each side minutely serrulate with (18-) 34-70 inconspicuous spiny teeth, each mainly consisting of the brownish spine-cell (a unicellular tooth, invisible to the unaided eye); leaf teeth 0.02-0.07 (-0.12) mm long, the ratio of teeth length to leaf width being 0.03-0.10 (-0.22); midrib without spiny teeth; septa absent; fibres absent or present on margin and near midrib; leaf sheath (1.4-) 2.0-3.0 (-3.9) mm (incl. auricle and spine-cells) by 0.9-2.1 mm (ratio = 1.1-1.9 (-2.9)), deeply auriculate, the auricle being (0.4-) 0.8-1.2 (-1.5) mm long (incl. spine-cells) and (0.16-) 0.2-0.3 (-0.5) mm wide (ratio = (1.4-) 2.0-4.5 (-6.5)), serrulate with 3-14 spine-cells on each side; apex of the auricle acute. Inflorescences axillary, male and female flowers solitary, or 2-4 together at the same node but the male ones more to the top of the plant. Male flower naked; inner envelope protruding 0.05-0.13 mm above the anther; anther 0.7-1.3 mm by 0.3-0.5 mm, 4-sporangiate. Female flower naked, 1.6-3.7 mm long; ovary 0.7- 1.6 mm by 0.26-0.87 mm; style and stigma 0.5-1.8 mm; stigma 2 (-3) lobed. Fruit with persistent, thin, membraneous pericarp and the remaining parts of style. Seed elliptical oblong, (1.26-) 1.5-2.4 (-4.20) mm by (0.42-) 0.5-0.7 (-0.81) mm, sometimes slightly recurved [ratio = (2.2-) 2.6-4.0 (-5.2)]; testa pitted with aréoles arranged regularly in longitudinal rows, each row of (23-) 25-35 (-60); aréoles mostly hexagonal, 0.06-0.08 mm long."

From Haynes (1979):

"Plants monoecious. Stems to 35 cm long, 0.2-0.5 mm in diameter, sparingly branched; internodes 0.4-1.9 cm long, without prickles. Leaves cm long; laminae spreading to ascending, 0.5-1.0 mm teeth at apex, minutely serrulate with ca. 40 teeth per side, the terminal teeth similar in size and structure to lateral teeth, the teeth unicellular, the midrib without prickles; sheaths 1.0-1.5 mm wide, wider than the laminae, deeply auriculate, minutely serrulate with 8-15 teeth per side, the teeth similar in structure and size to those of the laminae. Flowers 1-2 per axil, the staminate in the upper axils, the carpellate throughout, the involucre clear in color; staminate flowers 2.0-3.0 mm long, the involucre beaks 1.0- 1.5 mm long, 4-lobed, the anther 1.5 mm long, 4-loculed; carpellate flowers to 3.5 mm long, the styles to 1.0 mm long, the stigmas 2-lobed.

Seeds 1.7- 2.5 mm long, 0.4-0.6 mm wide, greenish-brown, fusiform, the testa pitted, the areolae 4-angled, less than 0.1 mm long, less than 0.1 mm broad, in ca. 35 rows, the end walls slightly raised. Chromosome number, 2 n - 48 (Sharma and Chatterjee 1967). […]. By the deeply auriculate sheaths, *N. gramínea* is one of the easiest of the North and Central American *Najas* to recognize."

From Pall (2011):

"[…] the leaves of *Najas graminea* are often densely tufted on short lateral shoots, grooved at the leaf basis and slightly carinate at the reverse side."

Biology

Calflora (2020) stated that *N. graminea* blooms from June to August.

From NBN Atlas (2021):

"The flowers are monoecious. The flowering season is from July to September."

Human Uses

From Rantzien (1952):

"By its vigorous growth this species has become an important weed in the irrigation channels of Egypt and in rice-fields on some of the Indonesian islands."

From NBN Atlas (2021):

"This plant is also commercialized in the aquarium trade."

Lee et al. (1998) and Lee et al. (1999) concluded that *Najas graminea* had promising potential for metal [Cu, Zn, Pb, Cd, and Ni] removal from aquatic systems. They suggested it could be grown in river, stream, acid mining drainage, or in clean water systems initially and then transfer to the polluted water to remove metals from aquatic systems.

Diseases

No records of diseases were found for *Najas graminea*.

Threat to Humans

No information on threats to humans was found for *Najas graminea*.

3 Impacts of Introductions

Najas graminea has been introduced to France, Italy, England, Spain, Bulgaria, the Crimea, and the United States (California), with populations becoming established in the wild. Even though establishment did occur, there were no records of impacts from those introductions found.

4 History of Invasiveness

This species has been introduced in several areas of Europe and the United States (California), where it has become established. It has been found in rice fields of California and Northern Italy. *N. graminea* was first reported in the United States in the 1940's and is established in two counties of California. No records of impacts from the introductions were found. With known established populations, but a lack of information on impacts, the history of invasiveness for this species is classified as Data Deficient.

5 Global Distribution

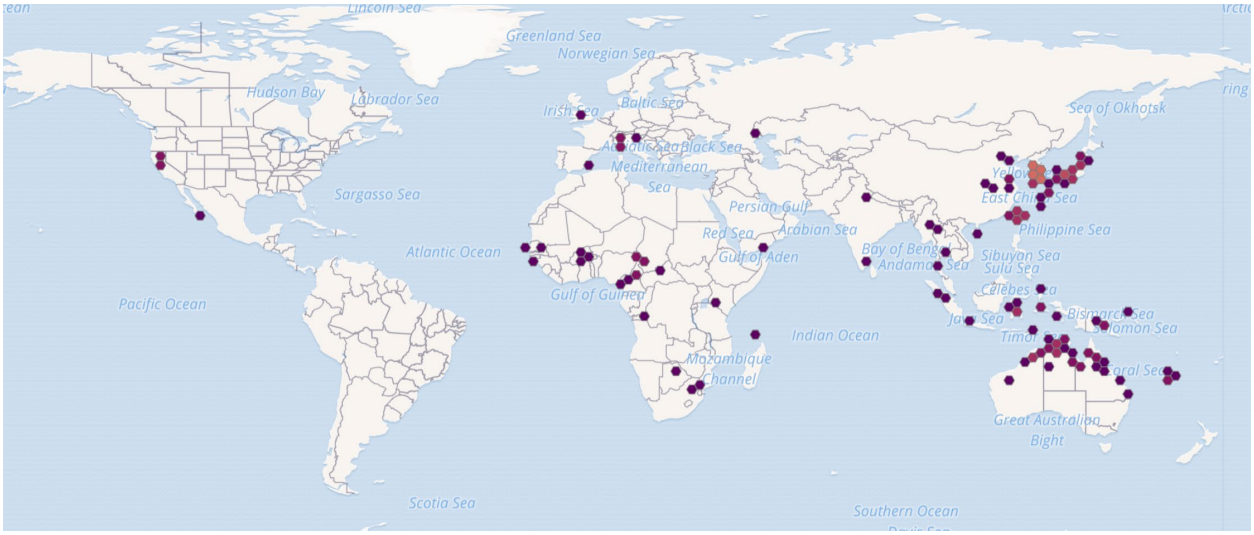

Figure 1. Known global distribution of *Najas graminea*. Observations are reported from Africa, Asia, Australia, and North America. Map from GBIF Secretariat (2020). There were no records or references of *Najas graminea* being present in Mexico or Russia near the Caspian Sea in the literature so these reference points were not used during the climate matching analysis. The point in Spain was also not included in the climate matching analysis because the point is from a botanical garden and not a wild established population. There were a couple sources that mentioned *Najas graminea* as being introduced into the Crimea and Bulgaria but a specific location was not provided and therefore no points were added into the climate matching analysis for those locations.

6 Distribution Within the United States

Figure 2. Known distribution of *Najas graminea* in the United States. Map from BISON (2020). Reference points in California represent established populations in the Sacromento Valley south of Chico and west of Lake Tahoe.

7 Climate Matching

Summary of Climate Matching Analysis

Most of the contiguous United States had a medium to high climate match. Areas of highest match occurred in the southwest, along the border with Mexico and in California. Other areas of medium to high match occurred in the Midwest, the Great Lakes region, the Appalachian Mountains region, Southern Great Plains, and the East Coast states. Areas of low climate match occurred in the central Rocky Mountains region, parts of Washington State, northern Wisconsin, Louisiana, and the northern New England region. The overall Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.355, high (scores 0.103 and greater are classified as high). More than half the States had high individual Climate 6 scores. States that had medium individual Climate 6 scores included: Alabama, Georgia, Massachusetts, Minnesota, North Dakota, South Dakota, Washington, and Wisconsin. The States with low individual Climate 6 scores were Colorado, Idaho, Louisiana, Maine, Mississippi, Montana, New Hampshire, Nevada, Rhode Island, Utah, Vermont, and Wyoming.

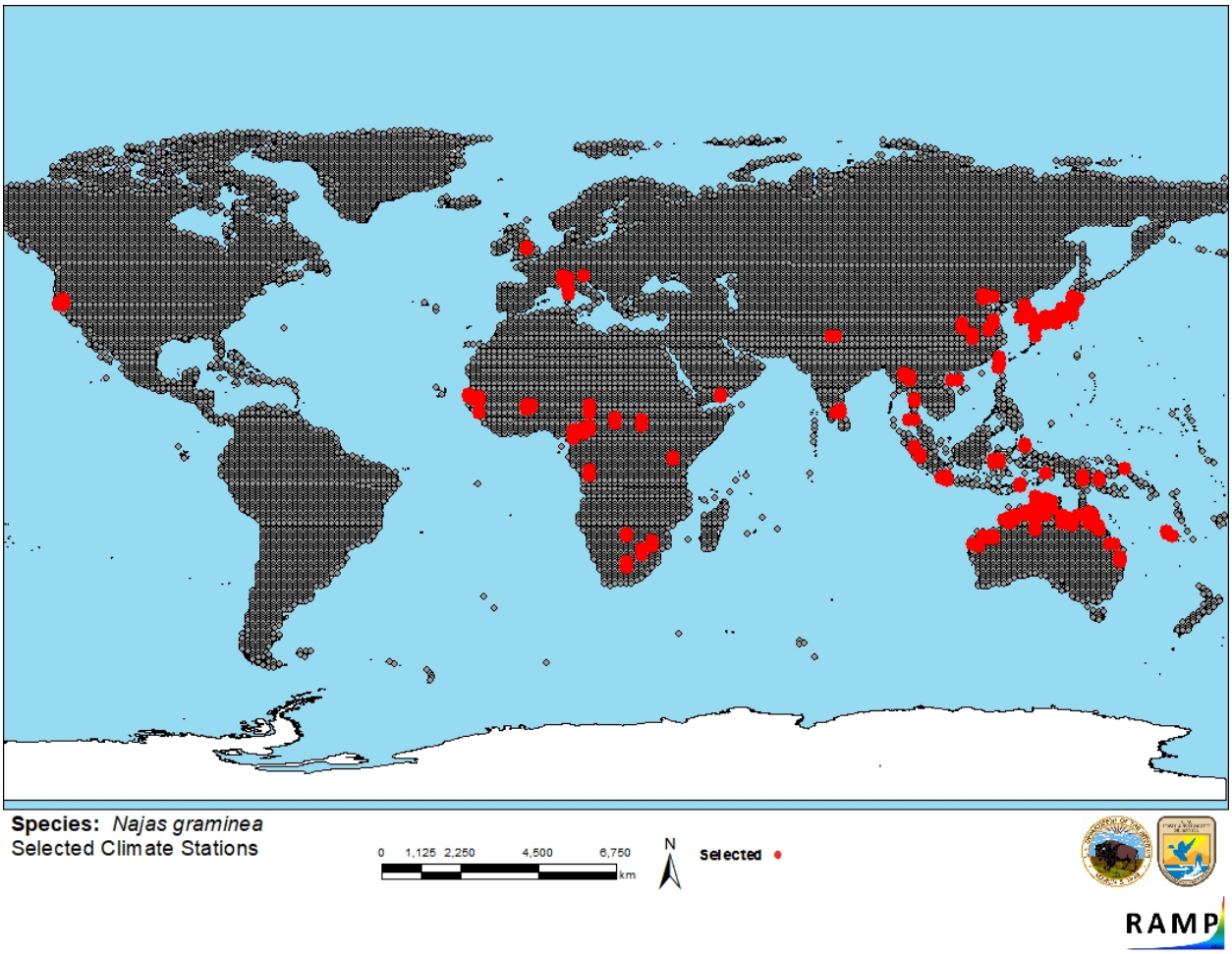

Figure 3. RAMP (Sanders et al. 2018) source map showing weather stations in Europe, Africa, Asia, Australia, and the United States selected as source locations (red; England, France, Italy, South Africa, Guinea, Cameroon, Central African Republic, Chad, India, Thailand, China, Korea, Japan, Indonesia, Australia, Papua New Guinea and California, United States) and non-source locations (gray) for *Najas graminea* climate matching. 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.

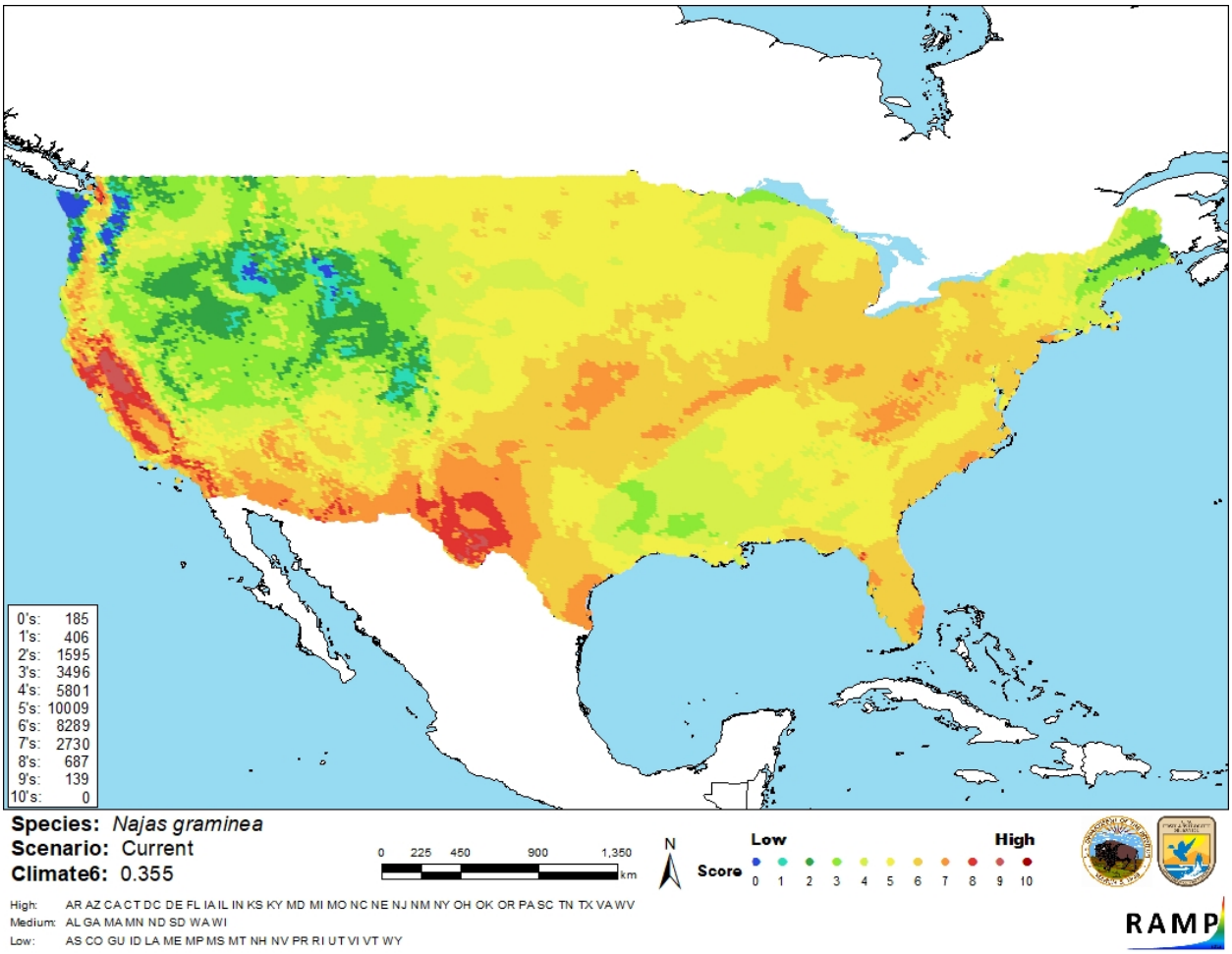

Figure 4. Map of RAMP (Sanders et al. 2018) climate matches for *Najas graminea* in the contiguous United States based on source locations reported by GBIF Secretariat (2020). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

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

Some information was available regarding the distribution and morphology of *Najas graminea*, but information regarding biology and ecology was lacking. There were several records of introductions to other countries resulting in established nonnative populations. No records

regarding the impacts and interactions were found. With known nonnative populations, but lack of information regarding the impacts of introductions, the certainty of assessment is Low.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Najas graminea, Ricefield waternymph, is a freshwater submersed, aquatic plant native to the subtropical and tropical regions of east Africa, Southeast Asia, and Australia. It has been introduced to parts of Europe and the United States (California) which has resulted in established, nonnative populations. *N. graminea* is present in the aquarium trade and has been suggested for use in bioremediation of heavy metals. The history of invasiveness for this species is Data Deficient due to the lack of information regarding impacts of introductions. The overall climate match for the contiguous United States was High. Most of the contiguous United States had a high or medium match except for much of the Rocky Mountains, parts of the Northeast, and parts of the Pacific Northwest. The certainty of assessment was Low due to the lack of information regarding this species impacts in the areas where it was introduced and has become established. Due to its high Climate 6 score and lack of information regarding impacts, the overall risk for this species 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: None**
- **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.

BISON. 2020. Biodiversity Information Serving Our Nation. U.S. Geological Survey. Available: https://bison.usgs.gov/#home (August 2020).

Calflora. 2020. Information on California plants for education, research and conservation, with data contributed by public and private institutions and individuals, including the Consortium of California Herbaria. Berkeley, California: The Calflora Database. Available: https://www.calflora.org/cgi-bin/species_query.cgi?where-calrecnum=5742 (August 2020).

de Wilde WJJO. 1961. The morphological evaluation and taxonomic value of the spathe in *Najas*, with descriptions of three new Asiatic-Malaysian taxa. Acta Botanica Neerlandica 10:164–170.

GBIF Secretariat. 2020. GBIF backbone taxonomy: *Najas graminea* Delile. Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/5329404 (August 2020).

Haynes RR. 1979. Revision of North and Central American *Najas* (Najadaceae). Contributions to Botany 8:34–56.

Hussner A. 2012. Alien aquatic plant species in European countries. Weed Research 52:297–306.

India Biodiversity Portal. No date. *Najas graminea* Delile. India Biodiversity Portal, species page. Available: https://indiabiodiversity.org/species/show/259143 (January 2021).

[ITIS] Integrated Taxonomic Information System. 2020. *Najas graminea* Delile. Reston, Virginia: Integrated Taxonomic Information System. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=39000#null (August 2020).

Lee C-L, Wang C, Hsu C-H, Chiou A-A. 1998. Heavy metal sorption by aquatic plants in Taiwan. Bulletin of Environmental Contamination and Toxicology 61:497–504.

Lee C-L, Wang TC, Lin C-K, Mok H-K. 1999. Heavy metals removal by a promising locally available aquatic plant, *Najas graminea* Del., in Taiwan. Water Science and Technology 39:177–181.

Mallik S, Nayak M, Sahu BB, Panigrahi AK, Shaw BP. 2011. Response of antioxidant enzymes to high NaCl concentration in different salt-tolerant plants. Biologia Plantarum 55:191–195.

Marwat SK, Khan MA, Ahmad M, Zafar M. 2011. Floristic account of submersed aquatic angiosperms of Dera Ismail Khan District, northwestern Pakistan. Journal of Aquatic Plant Management 49:125–128.

[NBN Atlas] National Biodiversity Network Atlas. 2021. *Najas graminea* Delile. National Biodiversity Atlas. Available: https://species.nbnatlas.org/species/NHMSYS0000460843 (January 2021).

Pall K. 2011. *Najas flexilis* (Najadaceae or Hydrocharitaceae), a Natura 2000 species – new for Austria. Neilreichia 6:11–26.

Rantzien HH. 1952. Notes on some tropical African species of *Najas* in the Kew Herbarium. Kew Bulletin 7:29–40.

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

Silprasit K, Ngamniyom A, Kerksakul P, Thumajitsakul S. 2016. Using morphology and genomic template stability (GTS) to track herbicide effect on some submersed aquatic plants. Applied Environmental Research 38:75–85.

Thiébaut G. 2007. Non-indigenous aquatic and semiaquatic plant species in France. Pages 1–19 in Gherardi F, editor. Biological invaders in inland waters: Profiles, distribution, and threats. Invading Nature - Springer Series in Invasion Ecology 2. Dordrecht, Netherlands: Springer. Available: https://doi.org/10.1007/978-1-4020-6029-8_11 (August 2020).

Thorne RF, Hellquist CB, Haynes RR. 2012. *Najas graminea*. Berkley: University of California, Jepson Flora Project. Available: https://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=34353 (August 2020).

Triest L. 1987. A revision of the genus *Najas* L. (Najadaceae) in Africa and surrounding islands. Brussel, Belgium: Koninklijke Academie Voor Overzeese Wetenschappen, Royal Academy of Overseas Science, and Fondation pour Favoriser les Recherches scientifiques en Afrique.

World Flora Online. 2021. World Flora Online – a project of the World Flora Online Consortium. Available: www.worldfloraonline.org (March 2021).

Zhuang X. 2017. *Najas graminea*. The IUCN Red List of Threatened Species 2017: e.T164296A67788915. Available: https://www.iucnredlist.org/species/164296/67788915 (January 2021).

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.

Casper SJ, Krausch HD. 1980. Pteridophyta und Anthophyta 1. Teil in Ettl H, Gerlof J, Heyning H, editors. Süßwasserflora von Mitteleuropa 23. Stuttgart & New York: Gustav Fischer.

Sharma AK, Chatterjee T. 1967. Cytotaxonomy of Helobiae with special reference to the mode of evolution. Cytologia 32:286–307.