

Spiny naiad (*Najas marina*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, August 2020
Revised, December 2020
Web Version, 3/23/2021

Organism Type: Plant
Overall Risk Assessment Category: High



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1 Native Range and Status in the United States

Native Range

From Handley and Davy (2005):

“*Najas marina* L. [...] is rare throughout its wide European distribution (Preston & Croft 1997; Wigginton 1999). In Britain it occurs, at the north-western limit of its European distribution, only in shallow lakes of the Norfolk and Suffolk Broads of East Anglia.”

From Jenačković et al. (2015):

“This species is native to Europe, Asia and Africa.”

According to Lansdown (2019) *Najas marina* is found and is native in the following countries: Albania; Algeria; Argentina; Aruba; Australia (Western Australia, Victoria, Queensland, Northern Territory, New South Wales); Austria; Azerbaijan; Bahamas; Bangladesh; Belarus; Belgium; Benin; Bolivia, Plurinational States of; Bosnia and Herzegovina; Botswana; Brazil; Bulgaria; Burkina Faso; Burundi; Cameroon; China (Guangxi, Guangdong, Anhui, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jilin, Liaoning, Nei Mongol, Shandong, Shanxi, Xinjiang, Yunnan, Zhejiang); Congo; Congo, The Democratic Republic of the; Croatia; Cuba; Cyprus; Czechia; Denmark; Dominica; Ecuador (Galápagos); Egypt (Sinai, Egypt (African part)); El Salvador; Eritrea; Estonia; Faroe Islands; Finland; France (Corsica, France (mainland)); Georgia; Germany; Ghana; Greece (Kriti, Greece (mainland)); Guinea; Guinea-Bissau; Haiti; Hungary; India; Indonesia (Maluku); Iran, Islamic Republic of; Iraq; Israel; Italy (Sicilia, Italy (mainland), Sardegna); Jamaica; Japan; Jordan; Kazakhstan; Korea, Democratic People's Republic of; Korea, Republic of; Kyrgyzstan; Latvia; Lebanon; Liberia; Libya; Liechtenstein; Lithuania; Luxembourg; Madagascar; Malawi; Mali; Malta; Mauritania; Mexico; Monaco; Mongolia; Montenegro; Morocco; Mozambique; Myanmar; Namibia; Netherlands; Niger; Nigeria; North Macedonia; Norway; Oman; Pakistan; Palestine, State of; Panama; Poland; Portugal (Portugal (mainland)); Puerto Rico; Romania; Russian Federation (West Siberia, Altay, South European Russia, Khabarovsk, Central European Russia, Primoryi, Krasnoyarsk, Amur, Buryatiya, Chita); Rwanda; Réunion; San Marino; Saudi Arabia; Senegal; Serbia; Sierra Leone; Slovakia; Slovenia; South Africa (Eastern Cape Province, KwaZulu-Natal, Northern Cape Province); Spain (Spain (mainland), Canary Is., Balears); Sri Lanka; Sweden; Switzerland; Syrian Arab Republic; Taiwan, Province of China; Tajikistan; Tanzania, United Republic of; Thailand; Togo; Tunisia; Turkey (Turkey-in-Asia, Turkey-in-Europe); Turkmenistan; Turks and Caicos Islands; Uganda; Ukraine; United Kingdom (Great Britain); United States (Florida, California, Arizona, Indiana, Michigan, Minnesota, Nevada, New York, North Dakota, Ohio, Pennsylvania, South Dakota, Texas, Utah, Wisconsin); Uzbekistan; Venezuela, Bolivarian Republic of; Viet Nam; Yemen (North Yemen, Socotra, South Yemen); Zambia; Zimbabwe

Status in the United States

According to USDA (2020) *Najas marina* has been introduced to Hawaii, and is native to the following states: California, Nevada, Utah, Arizona, New Mexico, Texas, Oklahoma, Nebraska, Kansas, North Dakota, South Dakota, Minnesota, Michigan, Wisconsin, Iowa, Illinois, Indiana, Ohio, Pennsylvania, New York, Virginia, Florida and Puerto Rico.

However, according to Cao and Berent (2019a) *Najas marina* has been introduced to parts of Hawaii, New York, Nebraska, Pennsylvania, Ohio, Oklahoma, Indiana, Illinois, Wisconsin, Michigan, and Montana.

From Cao and Berent (2019a):

“*Najas marina* is native to Caribbean Territories, California, Hawaii, continental US [...]”

From Cao and Berent (2019b):

“This species is currently considered non-native in GLANSIS, based on Mills et al. (1993) paper, which states, “Spiny naiad, a plant preferring to grow in brackish and alkaline waters, was first found in North America in 1864 in central New York's Onondaga Lake near Salina, New York (Stuckey 1985). The plants were growing near a salt mine in brackish water. Soon after this initial record, the plant was discovered in other areas of central New York. Spiny naiad is also known from the western Great Lakes region where it invaded in the 1930s. Fossil records of this plant from the midwest indicate that it was present in North America prior to glaciation, supporting debate about whether the newly discovered populations were indigenous or non-native.”

“Listed as a “species of special concern” in Minnesota; meaning it is extremely uncommon and deserves careful monitoring of its status (MN DNR 2013).”

From Wentz and Stuckey (1971):

“Although Braun (1967) treated *N. marina* as native to Ohio, this is a European species which is probably of recent introduction since it was not previously reported from this well-studied portion of western Lake Erie in Ohio (Moseley, 1899; Pieters, 1901; Core, 1948; Stuckey, 1968).”

“Not only does *Najas marina* appear to be a recent introduction in Ohio, but it also has been reported, in recent years from other nearby states, where it was not mapped by Clausen (1936).”

From Stuckey (1985):

“The increase in the past 30 years in the number of known sites for spiny naiad in the southwestern United States, especially in canals and at newly constructed reservoirs, suggests that the species is expanding locally and is now of more frequent occurrence.”

According to McMullen (2003) *Najas marina* is listed and protected as a state endangered native plants in New York.

According to Nelson and Couch (1981) *Najas marina* was first found in Oklahoma in 1979 and was previously unreported.

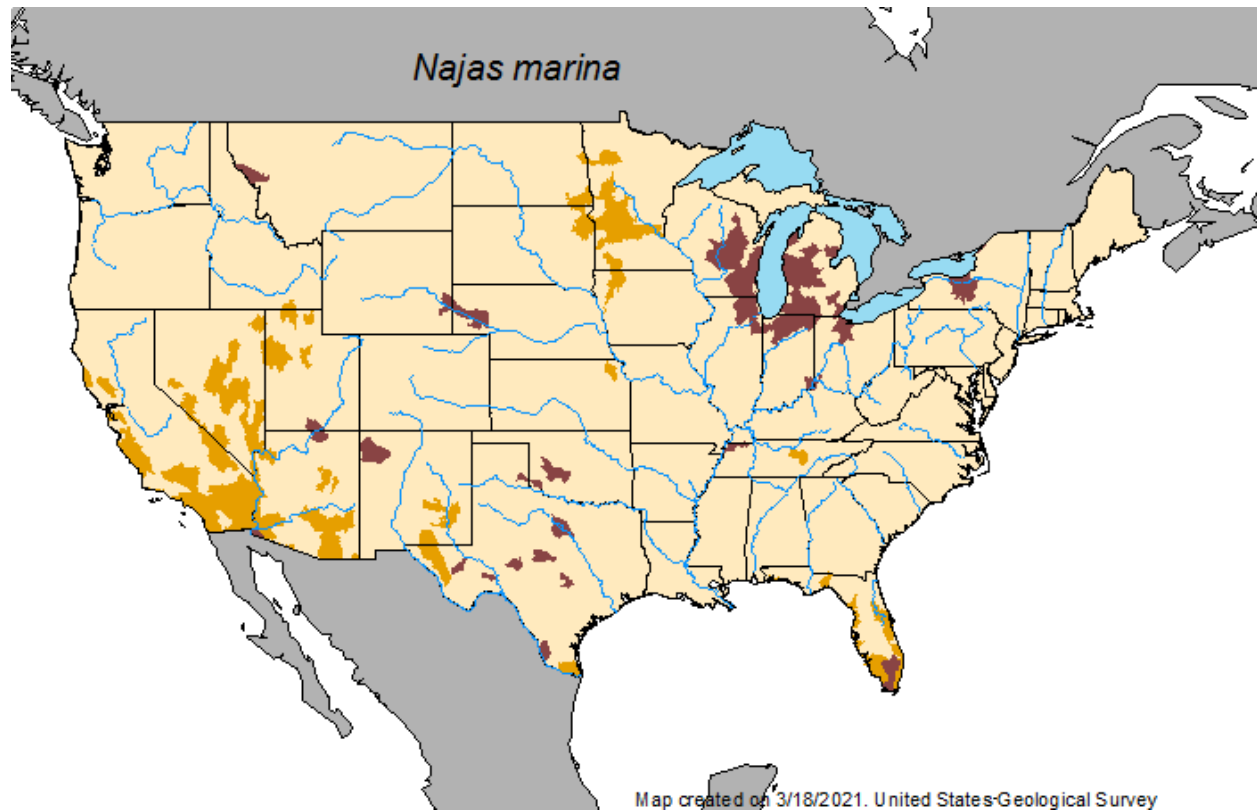


Figure 1. Map of the contiguous United States showing the native (orange) and introduced (red) distribution of *Najas marina* at the HUC 8 level. Map from Cao and Berent (2019a).

According to the WIDNR (2020) *Najas marina* is a restricted species in Wisconsin prohibiting transport, transfer or introduction.

According to the GADNR (2009) *Najas marina* is a Priority 1(b) species for Georgia (USA) Aquatic Nuisance Species meaning it is “not currently present in Georgia but agencies or organizations are concerned about enough to spend a significant amount of time and/or money on for some aspect of management either now or in the next five years.”

No records of *Najas marina* in trade in the United States were found.

Means of Introductions in the United States

From Cao and Berent (2019a):

“Introduced via solid ballast.”

From Cao and Berent (2019b):

“This species is potentially a range expander rather than truly nonindigenous to the Great Lakes region, based on a review of current literature.”

“Two interpretations of the plant's distribution in the Great Lakes have been outlined by Stuckey (1985). He theorizes that the plant was pushed south during glaciation and reinvaded glacial lakes when the ice receded. He suggests that the species persisted in areas where the habitat remained favorable and reinvaded some areas, such as the western Great Lakes region, more recently. The introduction of the plant from Europe or another region where it is common in habitats made brackish and alkaline by human activities (such as areas around salt mines) is also possible. Central New York was a very active botanical center in 1864 and the possibility that the plant was overlooked for years is unlikely. The area around Onondaga Lake has been industrialized since the early 1800s when humans began developing the salt resources around the lake. The salt from this area was transported into other parts of the United States and the salt industry had the power to instigate the construction of the Erie Canal (Murphy 1978). We consider the introduction of spiny naiad into the industrialized area around Onondaga Lake to be a more likely scenario than the persistence of preglacial populations. Spiny naiad is now also known from Europe, Asia, Africa, Australia, South America, and Central America (Stuckey 1985).”

Remarks

From Bräuchler (2015):

“Its taxonomy has been subject to long-standing controversy, resulting in 12 subspecies and 6 varieties currently being more or less broadly accepted (Triest, 1988).”

From Lansdown (2019):

“The plant is assessed as Vulnerable in the Czech Republic (Grulich 2012), Endangered in Norway and Vulnerable in Cyprus, Denmark, Switzerland and the UK. [...] Two subspecies have Red List assessments in the Mediterranean region: *ssp. ehrenbergii* is found in Algeria, Tunisia, Libya and Egypt and it classed as Near Threatened (Ali 2010); and *ssp. arsenariensis* is classed as Critically Endangered and is endemic to Algeria (Rhazi et al. 2010).”

Cao and Berent (2019b):

“The classification of this species is a source of ongoing contention in Great Lakes states, and some environmental managers consider it to be naturalized in the region, though they note that its range appears to slowly be expanding (Nault, M., 2017, pers. comm). Its cosmopolitan nature and sporadic distribution around the world is likely due to its very specific environmental needs, which include brackish, highly alkaline waters. No active management is currently being conducted on *N. marina* in Wisconsin, and further research is needed to determine its ultimate status in the Great Lakes.”

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From WFO (2020):

“This name [*Najas marina*] is reported by Hydrocharitaceae as an accepted name in the genus *Najas* (family Hydrocharitaceae).”

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 marina* (L.)

Size, Weight, and Age Range

From WFO (2020):

“Stems 30-100 cm or more tall, 1-4.5 mm in diam.”

Environment

From Cao and Berent (2019a):

“Spiny naiad is found in 3' or more deep water in brackish or highly alkaline ponds, lakes, and coastal and inland marshes at elevations up to 1000 m in United States (Calflora Plant Observation Library).”

From Sanderson et al. (2008):

“*Najas marina* grows optimally at alinities [sic] in the range 2.7–4.2 ppt, with germination only mildly suppressed when salinity was increased to 5.6 ppt (Agami et al., 1984).”

From McMullen (2003):

“Water depths reported for *Najas marina* populations varies. Paine (1865) noted it abounding in Onondaga Lake in ten to twenty feet of water. However, our more recent records are from

shallow, quiet water, usually 2 to 3 feet in depth. Substrate types are reported to be muddy or sandy.”

From Lansdown (2019):

“It is mainly found in waters of high temperature, pH, sulphates and high electrolyte concentrations (or in saline sites) on sand, silt, clay with shells and thick organic matter.”

Climate

From Fernald (1923):

“[...] tropical and temperate regions [...]”

From Ruegg et al. (2017):

“Two subspecies, *Najas marina* subsp. *marina* and *Najas marina* subsp. *intermedia* (Wolfg. ex Gorski) Casper, are distributed from Europe to Central Asia, in temperate and warm temperate areas (subsp. *marina*) and in cold to warm temperate areas (subsp. *intermedia*) (Triest, 1989).”

Distribution Outside the United States

Native

From Handley and Davy (2005):

“*Najas marina* L. [...] is rare throughout its wide European distribution (Preston & Croft 1997; Wigginton 1999). In Britain it occurs, at the north-western limit of its European distribution, only in shallow lakes of the Norfolk and Suffolk Broads of East Anglia.”

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According to Lansdown (2019) *Najas marina* is found and is native in the following countries: Albania; Algeria; Argentina; Aruba; Australia (Western Australia, Victoria, Queensland, Northern Territory, New South Wales); Austria; Azerbaijan; Bahamas; Bangladesh; Belarus; Belgium; Benin; Bolivia, Plurinational States of; Bosnia and Herzegovina; Botswana; Brazil; Bulgaria; Burkina Faso; Burundi; Cameroon; China (Guangxi, Guangdong, Anhui, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jilin, Liaoning, Nei Mongol, Shandong, Shanxi, Xinjiang, Yunnan, Zhejiang); Congo; Congo, The Democratic Republic of the; Croatia; Cuba; Cyprus; Czechia; Denmark; Dominica; Ecuador (Galápagos); Egypt (Sinai, Egypt (African part)); El Salvador; Eritrea; Estonia; Faroe Islands; Finland; France (Corsica, France (mainland)); Georgia; Germany; Ghana; Greece (Kriti, Greece (mainland)); Guinea; Guinea-Bissau; Haiti; Hungary; India; Indonesia (Maluku); Iran, Islamic Republic of; Iraq; Israel; Italy (Sicilia, Italy (mainland), Sardegna); Jamaica; Japan; Jordan; Kazakhstan; Korea, Democratic People's Republic of; Korea, Republic of; Kyrgyzstan; Latvia; Lebanon; Liberia; Libya; Liechtenstein; Lithuania; Luxembourg; Madagascar; Malawi; Mali; Malta; Mauritania; Mexico;

Monaco; Mongolia; Montenegro; Morocco; Mozambique; Myanmar; Namibia; Netherlands; Niger; Nigeria; North Macedonia; Norway; Oman; Pakistan; Palestine, State of; Panama; Poland; Portugal (Portugal (mainland)); Puerto Rico; Romania; Russian Federation (West Siberia, Altay, South European Russia, Khabarovsk, Central European Russia, Primoryi, Krasnoyarsk, Amur, Buryatiya, Chita); Rwanda; Réunion; San Marino; Saudi Arabia; Senegal; Serbia; Sierra Leone; Slovakia; Slovenia; South Africa (Eastern Cape Province, KwaZulu-Natal, Northern Cape Province); Spain (Spain (mainland), Canary Is., Balears); Sri Lanka; Sweden; Switzerland; Syrian Arab Republic; Taiwan, Province of China; Tajikistan; Tanzania, United Republic of; Thailand; Togo; Tunisia; Turkey (Turkey-in-Asia, Turkey-in-Europe); Turkmenistan; Turks and Caicos Islands; Uganda; Ukraine; United Kingdom (Great Britain); United States (Florida, California, Arizona, Indiana, Michigan, Minnesota, Nevada, New York, North Dakota, Ohio, Pennsylvania, South Dakota, Texas, Utah, Wisconsin); Uzbekistan; Venezuela, Bolivarian Republic of; Viet Nam; Yemen (North Yemen, Socotra, South Yemen); Zambia; Zimbabwe.

Part of the native range of *Najas marina* is within the United States. See Native Range/Status in the United States above for a full description of the native range.

Introduced

According to GBIF (2020) *Najas maraina* has been introduced to France, Spain, and Sri Lanka.

From Amarathunga et al. (2010):

“*Najas marina* or 'katu penda' is one of the nine invasive species that have been identified in the Madu Ganga wetland system in Sri Lanka (Bamberadeniya, et al 2002).

From Kapitonova (2011):

“[...] consider this species [*Najas major*] as an invasive one within the limits of the Vyatka Kama Cis-Ural region, where it could penetrate from its natural habitats, for example, from southern regions of the Republic of Tatarstan [Russia], where it is a rare and disappearing species (Bakin et al., 2000). Our observations show that, at the present time, *Najas major* has spread all the way to the Bui River mouth, entered the Kama River, and spread along shoals of the Nizhnekamsky Reservoir. It actively penetrates into natural freshwater cenoses and can be classified as an invasive species; i.e., the species is able to spread over a large territory (Gel'tman, 2006).”

From Roessler et al. (2012):

“In the freshwater lakes of Southern Bavaria [Germany] a spread of *Najas marina* and *Elodea nuttallii* can be observed and it is assumed that both species profits from climate warming”

“In Central Europe an increased spread of *Najas marina* and *Elodea nuttallii* can be observed.”

According to Galanos (2015), *Najas marina* has been introduced to Rodos Island, Greece.

According to Stuckey (1985), *Najas marina* has been introduced to the Bahama Islands.

Means of Introduction Outside the United States

From Stuckey (1985):

“In the Bahama Islands, where a specimen was first obtained in the Duck Pond near the airport on South Bimini, the plants were believed to have been brought from Florida [no indication of method given] and are now being spread to other islands in the chain by birds (Gillis, Howard, and Proctor 1973; Gillis, 1978).”

From Agami and Waisel (1988):

“[...] mallard ducks play a role in long-distance distribution of *Najas marina* and in the improvement of its germination capability (Agami and Waisel 1986).”

“[...] tilapias and grass-carps play a role in the distribution and the improvement of reproduction of *Najas* [*marina*] [...]”

Short Description

From Cao and Berent (2019a):

“*Najas marina* is a submersed plant with brittle stems that are often branched toward the upward portion of the plant. Stems branch distally, 6-45 cm ' 0.5-4 mm. The internodes (0.3-11 cm) of the stem usually have conspicuous, brownish, prickly teeth. The leaves are opposite or sometimes in whorls of three, 0.5 to 4.0 cm long and 0.4-4.5mm wide, and have 8-13 triangular (multicellular) teeth along the leaf margins and prickles along the midrib on the underside of the leaf. Leaf apex acute, with 1 tooth,. [sic] Leaves spreading to ascending with age and stiff in age. Sheaths 2--4.4 mm wide.”

“Plants are dioecious with the male and female flowers borne on separate individuals. The flowers are solitary in the leaf axils. The female flowers produce ovoid seeds 2.0 to 4.5 mm long that have 3 to 4-angled areolae that are irregularly arranged [...].”

“Flowers 1 per axil, staminate and pistillate on different plants. Staminate flowers in distal to proximal axils, 1.7-3 mm; involucral beaks 2-lobed, 0.3-0.7 mm; anthers 4-loculed, 1.7-3 mm. Pistillate flowers in distal to proximal axils, 2.5-5.7 mm; styles 1.2-1.7 mm; stigmas 3-lobed. Seeds not recurved, reddish brown, ovoid, 2.2-4.5 ' 1.2-2.2 mm, apex with style situated at center; testa dull, 10-15 cell layers thick, pitted; areoles irregularly arranged, not in distinctive rows, not ladderlike, 3-4-angled, longer than broad, end walls slightly raised. $2n = 12$ (Europe).”

“With its prickly internodes and prickles along the abaxial surface of the leaves, *Najas marina* is the easiest of our *Najas* to recognize.”

From WFO (2020):

“Stem up to 50-55 cm long, more than 1 mm broad, rather coarse; spiny, the lower internodes up to 10 cm long. Leaves oblong-linear, 1-3.5 x 2-6 mm, prominently spinose-dentate on the margins and the midrib on dorsal side. Sheath short, rounded, entire or with 1-3 inconspicuous

spines. Flowers solitary. Male flowers enclosed in spathe, neck cylindrical, edge somewhat lobed; anther 4-theous. Female flowers without spathe, style with 2-3 stigmas. Fruits ellipsoid, 23-5 x 1-4 mm. Seeds pale yellow-brownish. Areoles irregular in shape and size.”

From Huang et al. (2001):

“The male flower of *N. marina* is 4.5–6.0 mm long and 2.0–2.5 mm broad with a single sessile anther borne aloft on a short pedicel during anthesis. The female flower is about 5 mm long and its stigma consists of three or two filamentous branches up to 2 mm in length.”

Biology

From Cao and Berent (2019b):

“Plants are reported to reproduce by seed and fragmentation (Tarver et al. 1986). Studies by Vierssen (1982) have shown seed germination of *N. marina* to be best in decomposing organic matter, at 24° C under dark conditions. It is in flower from September to November, and the seeds ripen from September to November. The plant prefers light (sandy), medium (loamy) and heavy (clay) soils. The plant prefers acid, neutral and basic (alkaline) soils and can grow in saline soil. It can grow in semi-shade (light woodland) or no shade.”

Handley and Davy (2000):

“*Najas marina* (Holly-leaved Naiad) is a dioecious annual which grows completely submerged in shallow lakes (1-3 m deep), rooting extensively into the bottom sediments.”

From Huang et al. (2001):

“A unique mechanism of rapid pedicel elongation and curvature in the male flower of *N. marina* that brings the anther to lie opposite to the branches is reported for the first time. This process occurs before anther dehiscence and facilitates dispersal of pollen by water currents. A large number of pollen grains are dispersed in dense “clouds” for 5–10 min after anther dehiscence. Microscopic examination of pollen grains revealed the presence of numerous starch grains in the cytoplasm. These increase the gravity of the pollen grains and provide energy for pollen tube growth to a length of 2 mm in the water. The development of pollen tubes before contact with the stigma enhances the chances of the pollen to be captured by the branched stigmas. In addition, the pollen grains undergo a marked elongation of their polar axes just prior to release. The relatively long period of viability of both precocious and ungerminated pollen grains further enhances pollination. The high pollen loads observed on stigmas could account for the high seed yield in this submerged plant. The precocious pollen grains may be functionally equivalent to the filiform pollen occurring in submarine-pollinated seagrasses.”

Human Uses

From Lansdown (2019):

“This plant is occasionally used in aquariums. The young stem is edible and is consumed in Viet Nam.”

From Bräuchler (2015):

“[...] are used as indicator species for water quality assessment according to the European Water Framework Directive (WFD: Directive 2000/60/EC) in Germany (Schaumburg & al., 2011, 2012).”

Diseases

No diseases were reported for *Najas marina*.

Threat to Humans

From Hoffmann et al. (2013):

“[...] because of the numerous spikes located at the leaves and the internodes of *Najas intermedia*, [synonym for *Najas marina*] mass occurrences can interfere with tourism, more precisely water-based leisure activities like swimming.”

3 Impacts of Introductions

From Amarathunga et al. (2010):

“The dense mats of *Najas marina* plants leads to drastic fluctuations of dissolved oxygen, [...] Thus, the lower concentration of dissolve [sic] oxygen in water is affecting the aquatic fauna. Many fish kill incidents were recorded in Madu Ganga lagoon [Sri Lanka] recent past.”

“Results revealed that, nearly 25% of the lagoon was covered by *Najas marina* and spreading is thriving by high loading of nutrients from the catchments. It reduces biodiversity in the lagoon and prompt actions should be taken to control the spreading of *Najas marina*.”

From Cao and Berent (2019a):

“*Najas marina* can sometimes interfere with boating and fishing. It poses a realistic nuisance threat to ecosystems (U.S.EPA 2008). However, the plant is considered to be an excellent waterfowl food (Tarver et al. 1986).”

From Cao and Berent (2019b):

“In the 1940s, this species [*Najas marina*] was replacing other plants species in Michigan lakes (Wentz and Stuckey 1971).”

From Bambaradeniya et al. 2002

“The aquatic invasive alien plants that form dense mats (ie., Floating species such as *Salvinia molesta* and *Eichhornia crassipes* and submerged species such as *Najas marina* and *Hydrilla verticillata*) tends to accumulate greater amount of sediment.”

“A programme should be initiated to manage the spread of the two most problematic invasive alien plants in Maduganga - *Annona glabra* and *Najas marina*.”

According to the WIDNR (2020) *Najas marina* is a restricted species in Wisconsin prohibiting transport, transfer or introduction.

According to the GADNR (2009) *Najas marina* is a Priority 1(b) species for Georgia (USA) Aquatic Nuisance Species meaning it is “not currently present in Georgia but agencies or organizations are concerned about enough to spend a significant amount of time and/or money on for some aspect of management either now or in the next five years.”

4 History of Invasiveness

The history of invasiveness for *Najas marina* is classified as high. *Najas marina* has become established outside of its native range in several areas and there are documented negative impacts associated with those introductions. Negative impacts from introductions include dissolved oxygen affects, fish kills, reduced biodiversity in a given area, and interference with recreational activities like boating and fishing.

5 Global Distribution

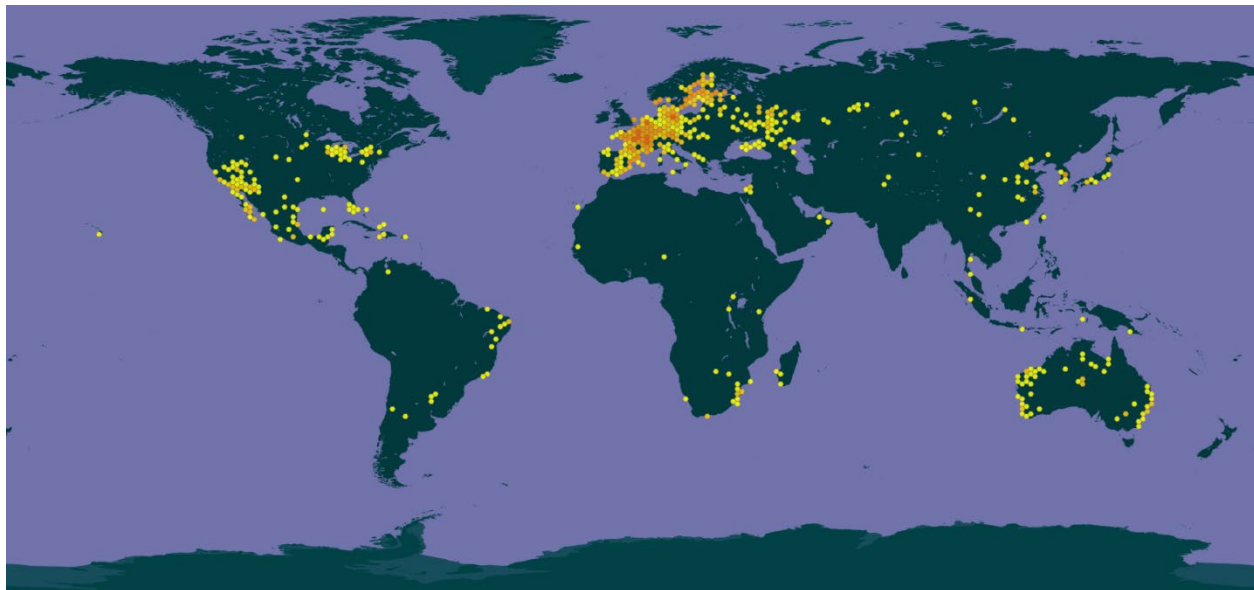


Figure 2. Known global distribution of *Najas marina*. Observations are reported from around the world. Map from GBIF Secretariat (2020). Because the climate matching analysis (section 7) is not valid for marine waters, no marine occurrences were used in the climate matching analysis.

6 Distribution Within the United States

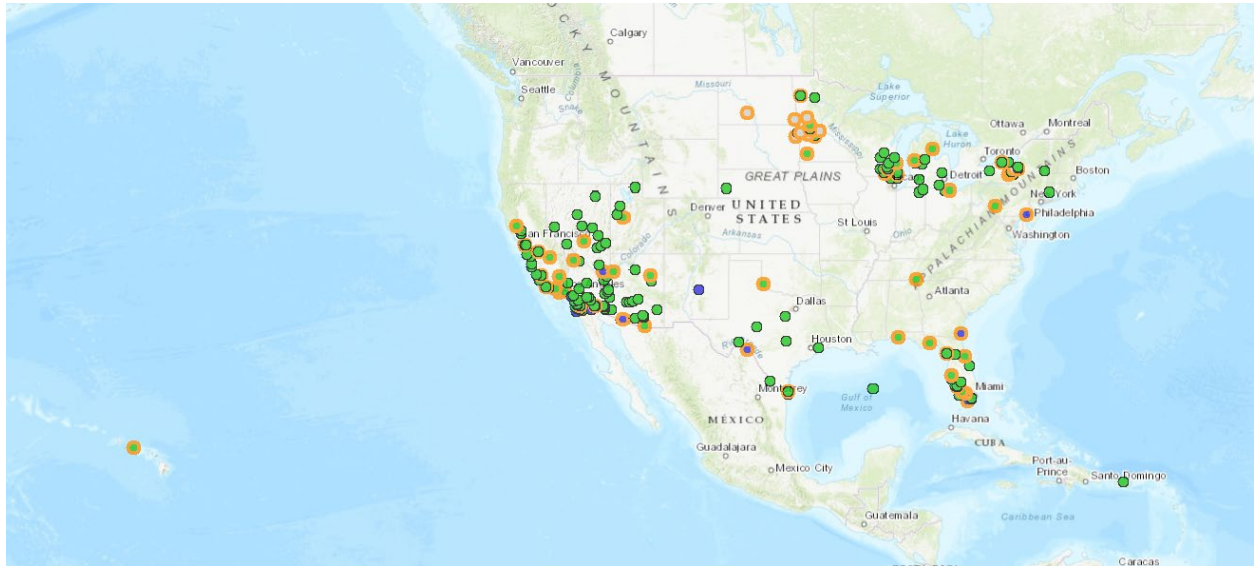


Figure 3. Known distribution of *Najas marina* in the United States. Map from BISON (2020). The point located in Tennessee is not representative of a wild established population and therefore was not used in the climate match. Because the climate matching analysis (section 7) is not valid for marine waters, no marine occurrences were used in the climate matching analysis.

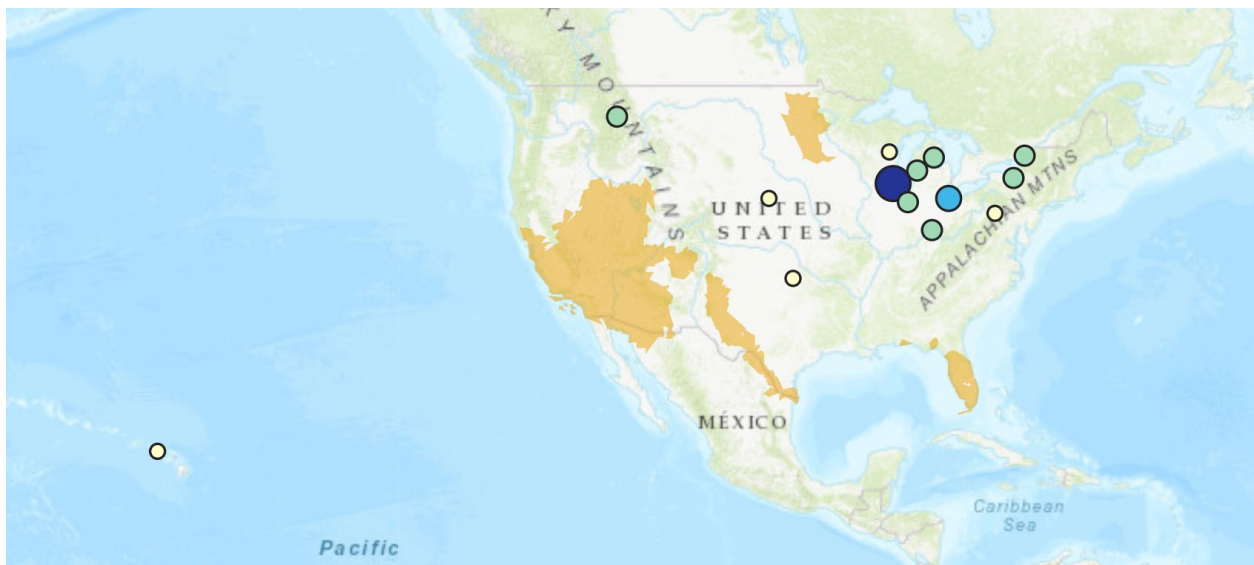


Figure 4. Another map showing known locations in the United States where *Najas marina* has been reported as introduced. Orange areas indicate the understood native range of the species within the contiguous United States. Map from Cao and Berent (2019a).

7 Climate Matching

Summary of Climate Matching Analysis

A majority of the contiguous United States had a high match with a couple of very small areas of low match. The Pacific Northwest coastline, mainly around the Olympic Peninsula, and a small patch in the southern Appalachian Mountains had low matches. Coastal New England and the interior of the southeast had medium matches; everywhere else had a high match. *Najas marina* is known to be present in some areas with high match but there are other areas of high match where the species has yet to be reported, such as the central Plains and northern Rocky Mountains. The overall Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.904, high (scores 0.103 and greater, are classified as high). All States had a high individual Climate 6 score.

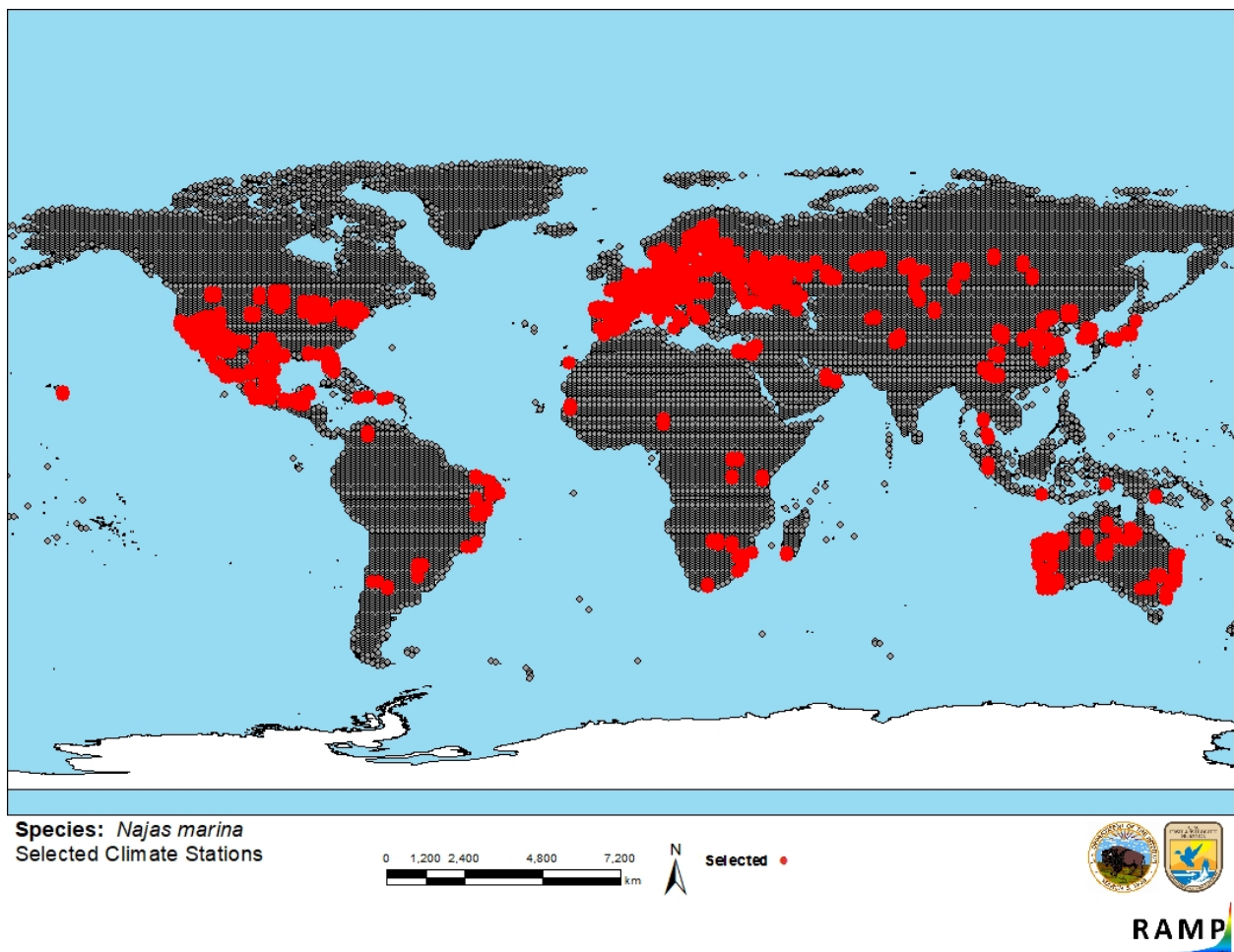


Figure 5. RAMP (Sanders et al. 2018) source map showing weather stations in Europe, eastern Asia, Australia, United States, South and Central America, and Southern Africa selected as source locations (red) and non-source locations (gray) for *Najas marina* climate matching. Source locations from BISON (2020) and 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.

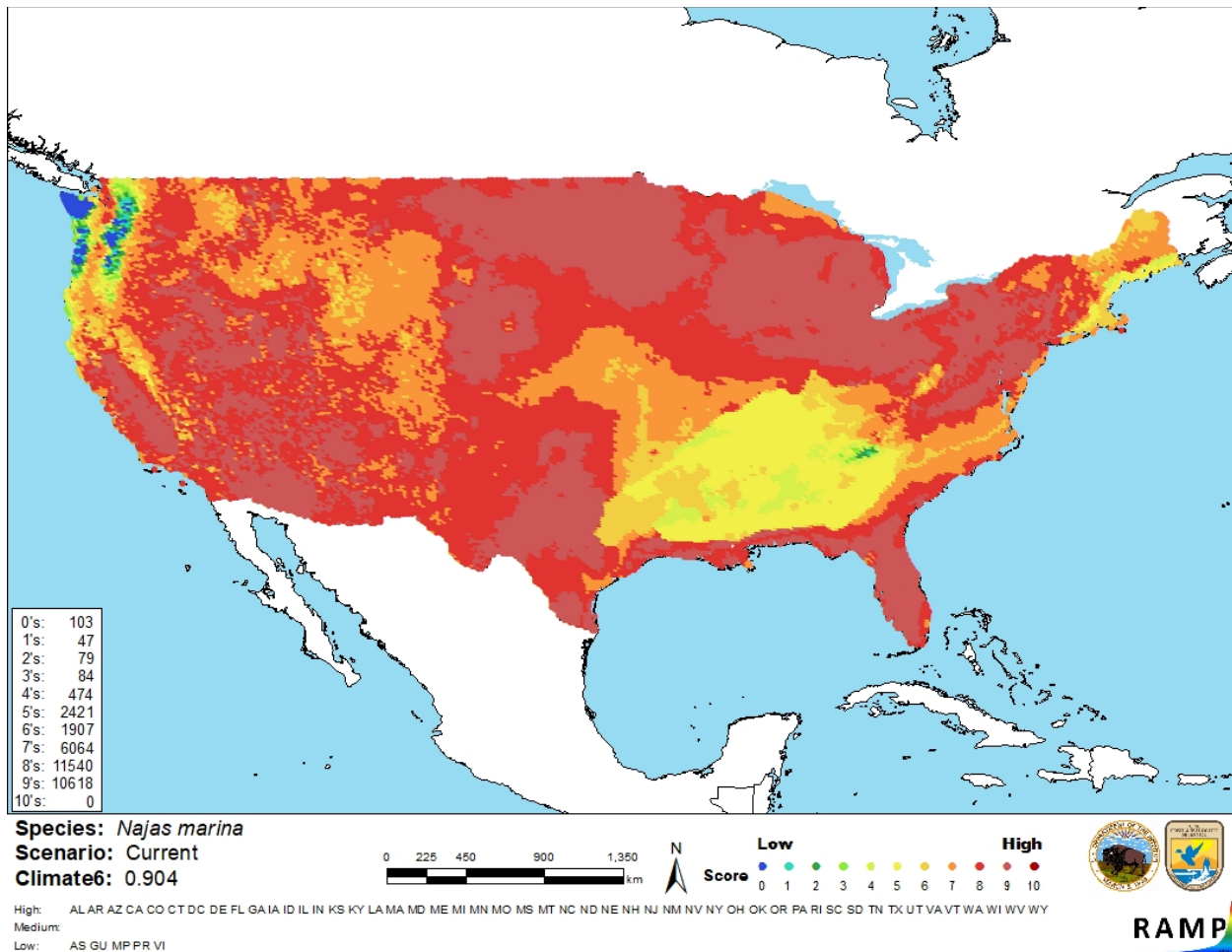


Figure 6. Map of RAMP (Sanders et al. 2018) climate matches for *Najas marina* in the contiguous United States based on source locations reported by from BISON (2020) and GBIF Secretariat (2020). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

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
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

8 Certainty of Assessment

The certainty of this assessment is high. There was ecological and biological information available about *Najas marina*. Information is conflicting regarding species native and non-native range but it is possible that this species is native in one part of a given state or country and

invasive in another. There are records of introductions for *Najas marina* with negative impacts to the ecosystems associated with them.

9 Risk Assessment

Summary of Risk to the Contiguous United States

The Spiny naiad (*Najas marina*) is a dioecious rooted aquatic vascular plant found in brackish or highly alkaline ponds, lakes, and coastal and inland marshes on every continent except Antarctica. This species has been introduced outside of its native range and has become established in those areas. The history of invasiveness for *Najas marina* is high with established introduced populations having negative impacts of introductions. Impacts include obstruction of boating and fishing, fish kills, and reductions in biodiversity. *N. marina* is occasionally used in aquariums, is edible and is consumed by some, and is used as an indicator species for water quality assessment. The overall climate match for *N. marina* was high with few areas of low or medium match. Low match was mainly found in the Pacific Northwest and medium in the interior southeast. The certainty of assessment is high due to the abundant biological and impact of introduction information that was found. The overall risk assessment category for *Najas marina* is high.

Assessment Elements

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

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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