

Spiny Naiad (*Najas marina*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, January 2023

Revised, February 2023

Web Version, 4/11/2025

Organism Type: Flowering Plant

Overall Risk Assessment Category: High



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<http://www.freenatureimages.eu/Plants/Flora%20J-N/Najas%20marina%2C%20Spiny%20Naiad/index.html> (January 2023).

1 Native Range and Status in the United States

Native Range

From Jenačković et al. (2015):

“General distribution: most of Europe, most of Asia (except West Asia), Indonesia, Australia, Mauritius, North Africa, South and Southeastern Africa, [...]. Accordingly, it could be said that

Najas marina L. belongs to the group of cosmopolitan species. This species is native to Europe, Asia and Africa.”

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 Cao and Berent (2023):

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

Lansdown (2019) lists *Najas marina* (s.l.) as native and extant in Africa: Algeria, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Congo, the Democratic Republic of the Congo, Egypt, Eritrea, Ghana, Guinea, Guinea-Bissau, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Réunion, Senegal, Sierra Leone, South Africa, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe; Asia: Azerbaijan, Bangladesh, China, Georgia, India, Indonesia (Maluku), Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Kyrgyzstan, Lebanon, Mongolia, Myanmar, North Korea, Oman, Pakistan, Palestine, Russia, Saudi Arabia, South Korea, Sri Lanka, Syria, Taiwan, Tajikistan, Thailand, Turkey, Turkmenistan, Uzbekistan, Vietnam, and Yemen; Australia; Europe: Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Hungary, Italy (including Sicily and Sardinia), Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain (including Canary and Balearic Islands), Sweden, Switzerland, Ukraine, and the United Kingdom; North America: United States; Central America: El Salvador, Mexico, and Panama; South America: Argentina, Bolivia, Brazil, Galapagos Islands (Ecuador), and Venezuela; and The Caribbean: Aruba, the Bahamas, Cuba, Dominica, Haiti, Jamaica, Puerto Rico, and Turks and Caicos Islands.

Status in the United States

Sources differ in their accounts of the native range of *Najas marina* in the United States. See also Remarks.

From Stuckey (1985):

“In the United States, *N. marina* would have survived continental glaciation at many localities south of the maximum glacial border. The species certainly would have survived in the numerous alkaline lakes in southwestern United States, where the plants were present in the 1860’s. *N. marina* may also have survived as far south as Texas and Florida, but certainly it must have been in Tennessee, as confirmed by the one fossil record from there.”

“In the southwestern United States [...], the earliest specimens came from Arizona along the Santa Cruz River in 1867 [...] and in 1881 [...], from Utah at Lake Utah in 1875 [...], from Nevada at Huntington Valley (Rothrock 1878) and at Ash Meadows in Death Valley in 1891 [...], from California at Clear Lake in 1863 [...], and from Baja California at Tijuana in 1884 [...]. 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.”

“It appears that *N. marina* may be disappearing in New York, Minnesota, and the Dakotas, where at least in the latter region the species is certainly native. It is expanding its range in the Great Lakes region in a manner similar to aggressive non-indigenous species.”

According to USDA, NRCS (2023), *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, and Florida. It is also native to Puerto Rico.

USDA, NRCS (2023) reports *Najas marina* as Endangered in New York and Pennsylvania.

Mills et al. (1993) reports *Najas marina* as introduced to the Great Lakes from Eurasia.

From Cao and Berent (2023):

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

“Great Lakes Nonindigenous Occurrences: The first Great Lakes sighting occurred in 1864 in the Lake Ontario drainage. Established throughout the Great Lakes region (IL, IN, MI, MN, NY, OH, PA, WI).”

From Wisconsin DNR (2023):

“Although native to certain areas of the U.S., it is not a native aquatic plant in Wisconsin and may pose a threat to water bodies.”

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). The earliest known collection is dated 1959.”

“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). The earliest known collection reported for Wisconsin comes from Sheboygan County in 1941 (Ross and Calhoun, 1951) and for Illinois from Lake County in 1964 (Winterringer, 1966). In Michigan, specimens are known from lakes in Montcalm, Newaygo, and Ogemaw Counties as

early as 1938-41 [...] The collections of *N. marina* from these three Great Lakes states also suggest recent introduction and establishment of this plant.”

From Minnesota DNR (2023):

“In Minnesota, suitable habitat for *Najas marina* is limited to prairie lakes in a relatively small portion of the state. The species has been recorded a total of 35 times, although recent searches in seemingly ideal habitat have revealed *N. marina* to be very rare. [...] Given its rarity, *N. marina* was listed as a special concern species in Minnesota in 1996.”

From Nelson and Couch (1981):

“[...] two species of *Najas*, previously unreported for the state, were encountered. *Najas marina* L. (Holly-leaf Naiad) was found in Harmon County (R26W-T4N-10) 29 Jun 1979 in Lake Hall, 10 mi north of Hollis [Oklahoma].”

From Freeman and Pfingsten (2021):

“Three recent collections of *Najas marina* (spiny water-nymph) from Missoula Co., Montana, are documented and illustrated. These collections are the first records for Montana and for the Pacific Northwest region. The occurrence of *N. marina* in Montana reflects a significant northward expansion of this species in the Mountain West.”

“The distributional history of *N. marina* in North America was described by Haynes (1979) and Stuckey (1985) and includes the Caribbean region from Florida to Antigua, the Great Lakes region from the Dakotas to New York, the Sonoran Desert region from northern California to Texas south to Baja California Sur and Guerrero, Mexico, and Pacific island occurrences in Hawai’i, [...] ([...] Pfingsten 2021). It has not previously been collected in the Pacific Northwest (Giblin 2018).”

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

Regulations

Najas marina is regulated as a nonnative species in Georgia (Myszewski and GISMPAC 2009) and Wisconsin (Wisconsin DNR 2023). Please refer back to state agency regulatory documents for details on the regulations, including restrictions on activities involving this species. While effort was made to find all applicable regulations, this list may not be comprehensive. Notably, it does not include regulations that do not explicitly name this species or its genus or family, for example, when omitted from a list of authorized species with blanket regulation for all unnamed species.

Means of Introductions within the United States

From Cao and Berent (2023):

“Introduced via solid ballast.”

“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.”

From Freeman and Pfingsten (2021):

“Seed transport by waterfowl has been postulated as a mechanism for the dispersal of *Najas* species in North America (Meriläinen 1968; Stuckey 1985; Les 2020). [...] Though mallards and other waterfowl make their northward migration from the southern USA to Canada and Alaska each spring (Fink et al. 2020), before annual production of seeds, the consumption of seeds from the previous year is a possible vector for the northward expansion of *N. marina* in the Rocky Mountain West.”

Remarks

A previous version of this ERSS was published in March 2021. Revisions were completed to incorporate new information and conform to updated standards.

There is uncertainty about the taxonomy and distribution of *Najas marina* sensu lato (s.l.). Many subspecies and varieties of *Najas marina* s.l. have been recognized in the past. Recent work has broadly split *N. marina* s.l. into two clades, recognized by some as two separate species: Type A as *Najas major* and Type B as *Najas marina* (e.g., Brauchler 2015; Rüeegg et al. 2017). This split and assignment of subspecies and varieties to these two nominal species is not consistent and has not been incorporated across the full body of literature and scientific works (e.g., Brauchler 2015; Rüeegg et al. 2017; ITIS 2023; WFO 2023). This taxonomic uncertainty has led to an incomplete understanding of the species’ native range and possible cryptic introductions within the United States and around the world. Below are excerpts illustrating these issues.

From Bräuchler (2015):

“[*Najas marina*] 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 Rüeegg et al. (2017):

“Due to the taxonomic uncertainty [of *Najas marina* s.l. species complex], it is however not possible to reliably name new or old records based on morphology alone. Some records are definitely new (Buch et al., 2012), but some simply have been overlooked (Bräuchler, 2010). Thus, it remains cryptic, whether both or just one of the subspecies are spreading or how far one may invade the territory of the other unnoticed.”

“Given the considerable divergence at the DNA sequence level revealed here, it seems more appropriate to consider the taxa as separate species, who do not show a morphological differentiation that is normally caused by effects [such] as selection or drift. We proposed that the two lineages, A and B, from now on should be known by the names *N. major* All. (including *Najas marina* var. *ohwii* Triest, here represented by an isotype) and *N. marina* L. (including “*intermedia*” and “*armata*”).”

From Mills et al. (1993):

“Spiny naiad, [...] was first found in North America in 1864 in central New York's Onondaga Lake near Salina, New York (Stuckey 1985). [...] 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 [sic] indicate that it was present in North America prior to glaciation, supporting debate about whether the newly discovered populations were indigenous or non-native. 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).”

From Cao and Berent (2023):

“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.”

From Troia (2022):

“Recent reports of *Najas marina* L. (Hydrocharitaceae) from Sicily have been interpreted as a confirmation of its presence on the island, where it was earlier mentioned in the 1800s. However the recent finds do not represent “*N. marina*” [...] but *N. marina* subsp. *armata* Horn [...], a different taxon, previously not recorded from Sicily.”

From Lansdown (2019):

“This species is listed as Endangered in Norway and Vulnerable in Cyprus, Denmark, Switzerland and the UK. [...] It was formerly rare in the Czech Republic but many new localities have been discovered (Triest 1998) and the plant is classified as Vulnerable (Grulich 2012).”

Information for this screening was searched for using the valid name *Najas marina*. If information was found referring to a particular subspecies or variety, it was specified with annotations.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2023):

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.

According to WFO (2023), *Najas marina* is the current valid name for this species.

Size, Weight, and Age Range

From WFO (2020):

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

From Agami et al. (1986):

“*Najas marina* L. is usually described in the temperate region as a cold-sensitive annual plant. However, in warm habitats of the tropics, plants of *Najas marina* continue to grow throughout the year and thus should be regarded as perennials.”

Environment

From Cao and Berent (2023):

“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 Freeman and Pfingsten (2021):

“*Najas marina* is often associated with saline, brackish, or alkaline waters (Moyle 1945; Stuckey 1985; Les 2020), and is found in waters with a pH range of 7.8–10.2 (mean 8.6) (Les 2020).”

“Water temperatures of more than 15 C are required for germination and more than 20 C for maturation [of *Najas marina*] (Van Vierssen 1982, Agami and Waisel 1984, Hoffman et al. 2013).”

Climate

From Stuckey (1985):

“*Najas marina* inhabits [...] tropical and temperate regions of the world.”

From Rüegg 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 Jenačković et al. (2015):

“General distribution: most of Europe, most of Asia (except West Asia), Indonesia, Australia, Mauritius, North Africa, South and Southeastern Africa, [...]. Accordingly, it could be said that *Najas marina* L. belongs to the group of cosmopolitan species. This species is native to Europe, Asia and Africa.”

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.”

Lansdown (2019) lists *Najas marina* (s.l.) as native and extant in Africa: Algeria, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Congo, the Democratic Republic of the Congo, Egypt, Eritrea, Ghana, Guinea, Guinea-Bissau, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Réunion, Senegal, Sierra Leone, South Africa, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe; Asia: Azerbaijan, Bangladesh, China, Georgia, India, Indonesia (Maluku), Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Kyrgyzstan, Lebanon, Mongolia, Myanmar, North Korea, Oman, Pakistan, Palestine, Russia, Saudi Arabia, South Korea, Sri Lanka, Syria, Taiwan, Tajikistan, Thailand, Turkey, Turkmenistan, Uzbekistan, Vietnam, and Yemen; Australia; Europe: Albania, Austria,

Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Hungary, Italy (including Sicily and Sardinia), Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain (including Canary and Balearic Islands), Sweden, Switzerland, Ukraine, and the United Kingdom; Central America: El Salvador, Mexico, and Panama; South America: Argentina, Bolivia, Brazil, Galapagos Islands (Ecuador), and Venezuela; and The Caribbean: Aruba, the Bahamas, Cuba, Dominica, Haiti, Jamaica, and Turks and Caicos Islands.

Part of the native range of *Najas marina* may be within the United States. See section 1 for a complete description of the native range and discussion of uncertainty.

Introduced

From Bamberadeniya, et. al (2002)

“Of these invasive plants, [...] *Najas marina* have spread into many places in Maduganga [Sri Lanka]. [...] According to local fishermen, the two submerged invaders - *Hydrilla verticillata* and *Najas marina* have entered Maduganga about 4-5 years ago.”

Galanos (2015) reports *Najas marina* as naturalized in Rodos Island, Greece.

Stuckey (1985) reports *Najas marina* as 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 and are now being spread to other islands in the chain by birds (Gillis, Howard, and Proctor 1973; Gillis, 1978 [personal communication]).”

From Agami and Waisel (1988):

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

“In a previous study we have shown that mallard ducks play a role in long-distance distribution of *Najas marina* and in the improvement of its germination capability (Agami and Waisel 1986).”

Short Description

From WFO (2023):

“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-thecous. 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. [Flora of Pakistan 2020]”

Biology

From Minnesota DNR (2023):

“*Najas marina* is a submerged annual that reproduces primarily or entirely by seed. Seeds are normally produced in great abundance and appear to be dispersed by waterfowl, which also utilize the seeds for food.”

From Cao and Berent (2023):

“Plants are reported to reproduce by seed and fragmentation (Tarver et al. 1986). Studies by [Van] 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.”

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):

“Both subspecies [*N. marina* subsp. *marina* and *N. marina* subsp. *intermedia*] [...] 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 information was found on diseases associated with *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 of *Najas marina* var. *intermedia*] 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 [sic] 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 (2023):

“Great Lakes Impacts: Current research on the environmental impact of *Najas marina* in the Great Lakes is inadequate to support proper assessment.”

“*Najas marina* is found throughout the Great Lakes and is considered to be a nuisance threat to the ecosystem (U.S. EPA 2008). In the 1940s, this species was replacing other plants species in Michigan lakes (Wentz and Stuckey 1971).”

From U.S. EPA (2008):

“found in L. Ontario; widespread; interferes with recreational boating; pose a realistic nuisance threat to ecosystems”

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*.”

Najas marina is regulated in Wisconsin (Wisconsin DNR 2023) and Georgia (Myszewski and GISMPAC 2009). See section 1.

4 History of Invasiveness

The History of Invasiveness for *Najas marina* is classified as High. There is information on introduced and established nonnative populations of *N. marina*. It has been introduced to multiple locations outside of its native range, both inside and outside the United States, and its range is reported to be expanding. Multiple sources report that *N. marina* forms dense monospecific mats that alter water quality and ecosystems, and are a nuisance to recreation. Information is limited regarding details or mechanisms of documented negative impacts of

introduction. The species is known to be in the aquarium trade but information on duration or volume of trade was not available.

5 Global Distribution

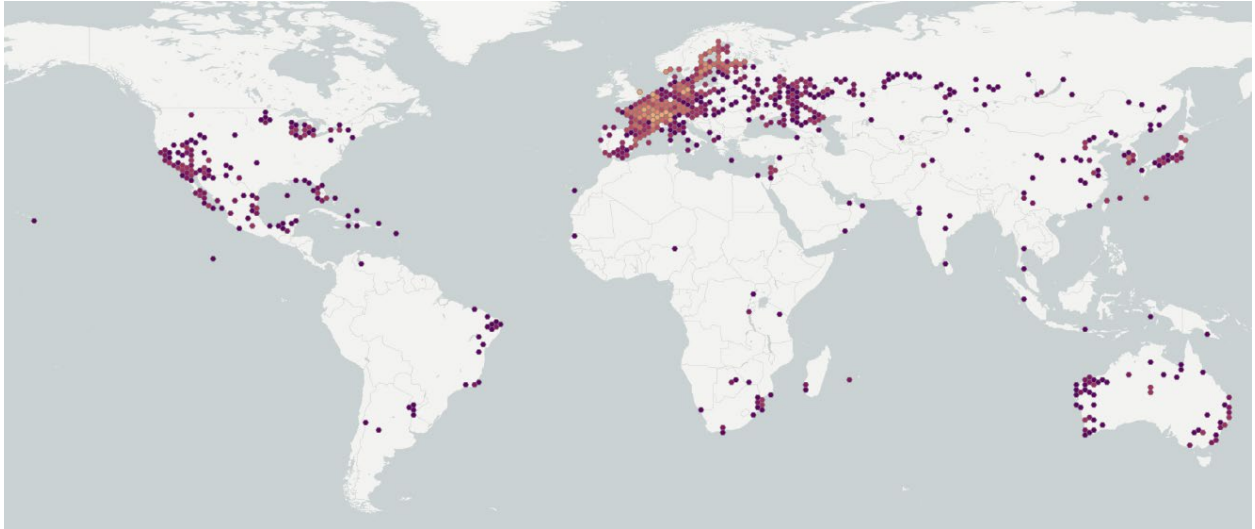


Figure 1. Reported global distribution of *Najas marina*. Map from GBIF Secretariat (2023). Observations are reported globally with most reports coming from North America, Eurasia, and Australia. Points that appear to be located in marine environments are actually located on small islands.

6 Distribution Within the United States



Figure 2. Reported distribution of *Najas marina* in the contiguous United States. Map from Cao and Berent (2025). Orange shading indicates areas of possible native range for *N. marina* in the United States. Orange diamonds indicate nonindigenous observations of *N. marina*.



Figure 3. Reported distribution of *Najas marina* in Hawaii. Map from Cao and Berent (2025). Orange shading indicates areas of possible native range for *N. marina* in Hawaii. Orange diamonds indicate nonindigenous observations of *N. marina*.

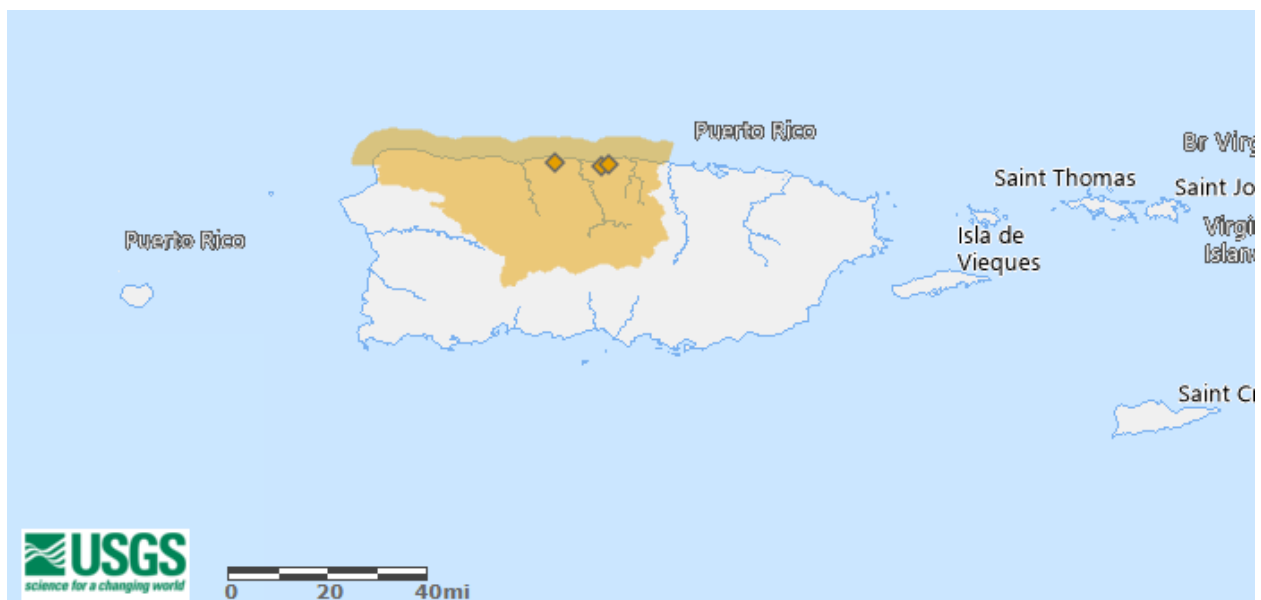


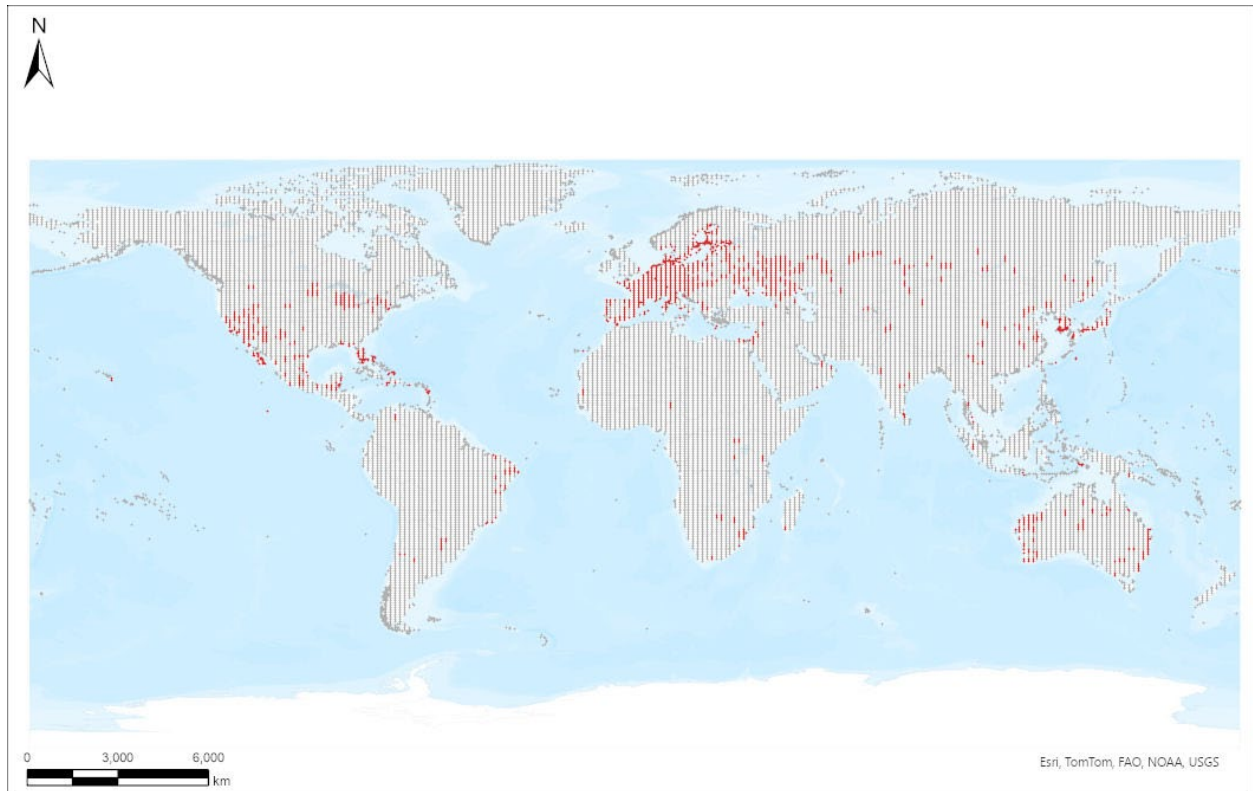
Figure 4. Reported distribution of *Najas marina* in Puerto Rico. Map from Cao and Berent (2025). Orange shading indicates areas of possible native range for *N. marina* in Puerto Rico. Orange diamonds indicate nonindigenous observations of *N. marina*.

7 Climate Matching

Summary of Climate Matching Analysis

The climate matching analysis for *Najas marina* indicated that most of the contiguous United States had a high climate match. The areas of high match include the species' possible native range within the United States and expand outside that range. Areas of low climate match included small, isolated locations along the northwest coast of the United States. There was also an area of medium match in the Southeast. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.987, indicating establishment concern for this species outside its native range. The Climate 6 score is calculated as: (count of target points with scores ≥ 6)/(count of all target points). Establishment concern is warranted for Climate 6 scores greater than or equal to 0.002 based on an analysis of the establishment success of 356 nonnative aquatic species introduced to the United States (USFWS 2024).

Projected climate matches in the contiguous United States under future climate scenarios are available for *Najas marina* (see Appendix). These projected climate matches are provided as additional context for the reader; future climate scenarios are not factored into the Overall Risk Assessment Category.



Species: *Najas marina*

Selected Climate Stations ●



RAMP

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Figure 5. RAMP (Sanders et al. 2023) source map showing weather stations in the world selected as source locations (red; points are distributed worldwide) and non-source locations (gray) for *Najas marina* climate matching. Source locations from GBIF Secretariat (2023). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

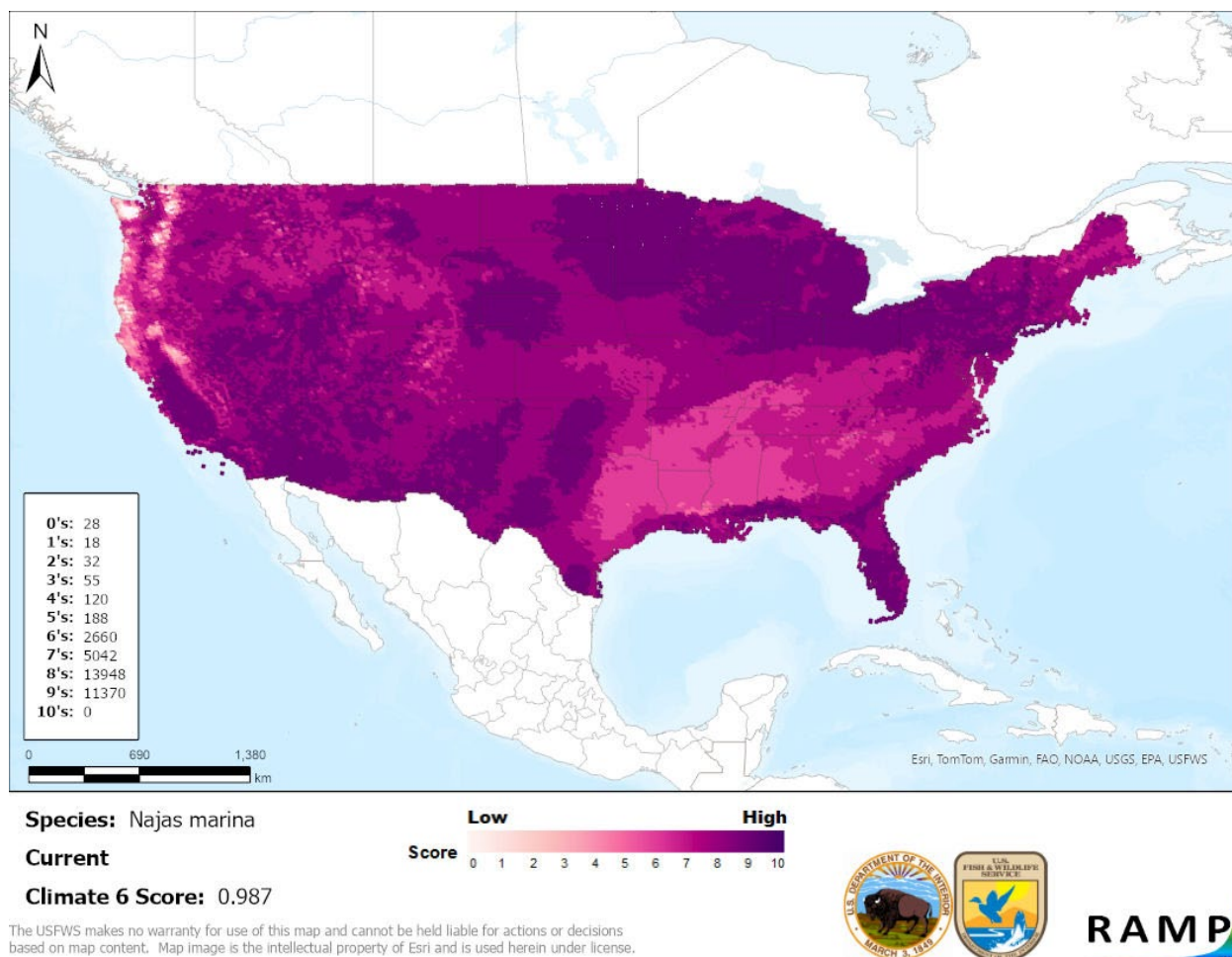


Figure 6. Map of RAMP (Sanders et al. 2023) climate matches for *Najas marina* in the contiguous United States based on source locations reported by GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Najas marina* is classified as Medium. Negative impacts of introduction have been reported in the scientific literature, but not all sources provide support for their claims. Possible salinity requirements of *N. marina* reduce certainty in the interpretation of the climate match analysis. There is reasonably complete information regarding the general distribution of this species complex; however, there is taxonomic uncertainty and disagreement between sources as to its native and introduced ranges.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Najas marina, Spiny Naiad, is an aquatic plant native to Asia, Africa, Europe, and Australia. It may also be native to parts of North America and South America. Multiple subspecies and varieties of *N. marina* have been described, with some work indicating more than one species

may have been included in this species complex historically. This species has been reported as introduced and expanding range in the Great Lakes with a few additional known introductions in Sri Lanka, Greece, and the Bahamas. The History of Invasiveness for *Najas marina* is classified as High due to the multiple documented impacts of introductions, including forming dense stands of vegetation that alter dissolved oxygen and sedimentation. Dissolved oxygen fluctuations related to *N. marina* infestations may be responsible for fish kills in Sri Lanka. In the Great Lakes, *N. marina* is of concern as a nuisance to recreation and ecosystems. The climate matching analysis for the contiguous United States indicates establishment concern for this species outside its native range. High climate match was found across the contiguous United States with small patches of low match along the Pacific Coast, Cascade Mountains, and Sierra Nevada. The Certainty of Assessment for this ERSS is classified as Medium mainly due to conflicting information on the taxonomic status and species range. The Overall Risk Assessment Category for *Najas marina* in the contiguous United States is High.

Assessment Elements

- **History of Invasiveness (see section 4): High**
- **Establishment Concern (see section 7): Yes**
- **Certainty of Assessment (see section 8): Medium**
- **Remarks, Important additional information: There is substantial uncertainty regarding the native range of *Najas marina*.**
- **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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Appendix

Summary of Future Climate Matching Analysis

Future climate projections represent two Shared Socioeconomic Pathways (SSP) developed by the Intergovernmental Panel on Climate Change (IPCC 2021): SSP5, in which emissions triple by the end of the century; and SSP3, in which emissions double by the end of the century. Future climate matches were based on source locations reported by GBIF Secretariat (2023).

Under the future climate scenarios (figure A1), on average, high climate match for *Najas marina* was projected to occur in California, the Colorado Plateau, Great Basin, Great Lakes, Gulf Coast, Northeast, Northern Plains, Southern Atlantic Coast, Southern Florida, Southern Plains, Southwest, and Western Mountains regions of the contiguous United States. Under most scenarios there were small areas of low match along the Northern Pacific Coast and the Cascade and Sierra Nevada ranges. There was also an area of medium match in the Southeast that expanded under SSP5 in time step 2085. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.789 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.983 (model: MRI-ESM2-0, SSP5, 2055). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there is establishment concern for this species under future scenarios. The Climate 6 score for the current climate match (0.987, figure 6) falls above the range of scores for future projections. The time step and climate scenario with the most change relative to current conditions was SSP5, 2085, the most extreme climate change scenario. Under all time step and climate scenarios only minor or no increases in the climate match relative to the current match were observed. Under one or more time step and climate scenarios, areas within the Appalachian Range, Mid-Atlantic, and Northeast saw a large decrease in the climate match relative to current conditions. Additionally, areas within California, the Colorado Plateau, Great Basin, Great Lakes, Gulf Coast, Northern Pacific Coast, Northern Plains, Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions. Additionally, very small areas of large or moderate change may be visible on the maps (figure A3).

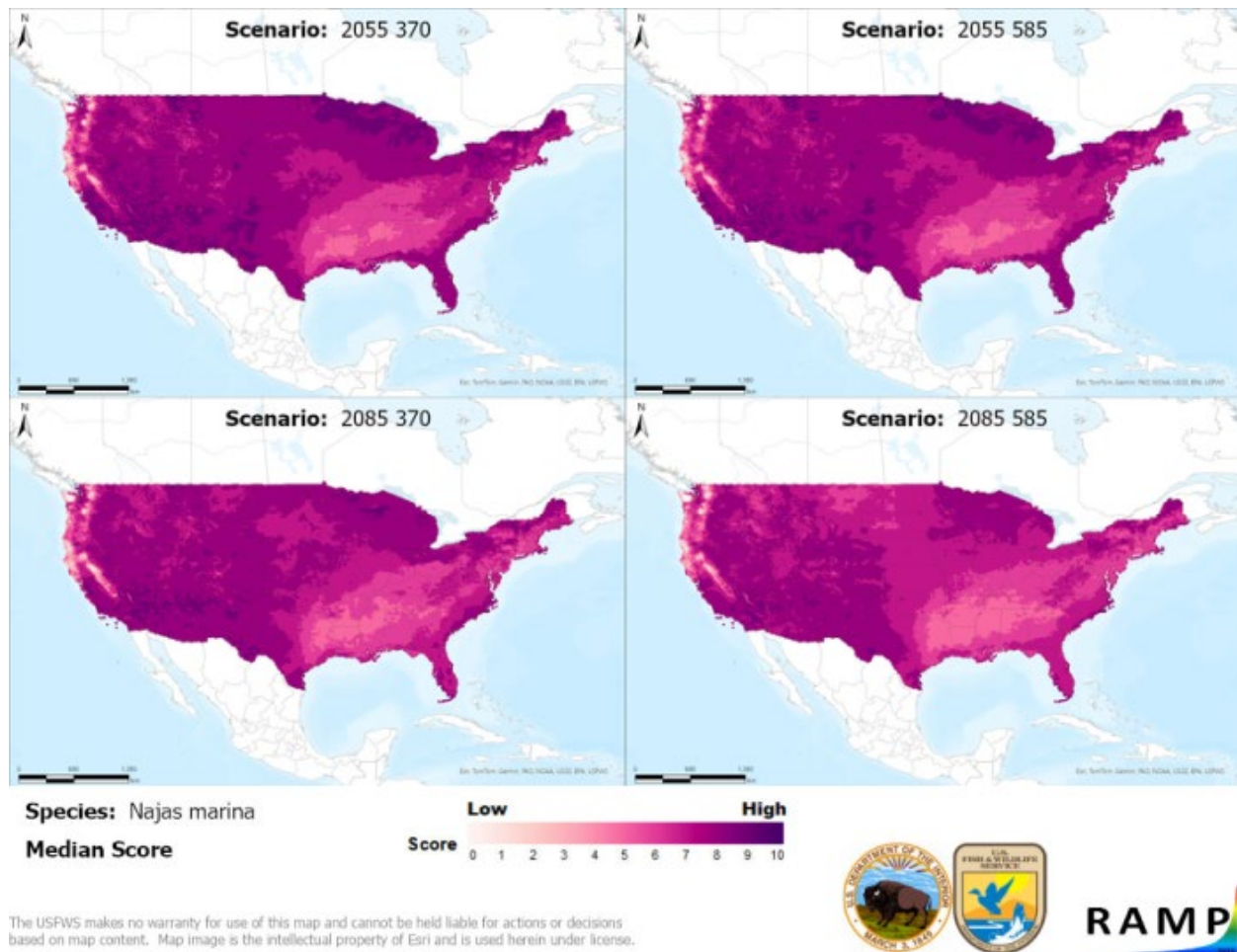


Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Najas marina* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

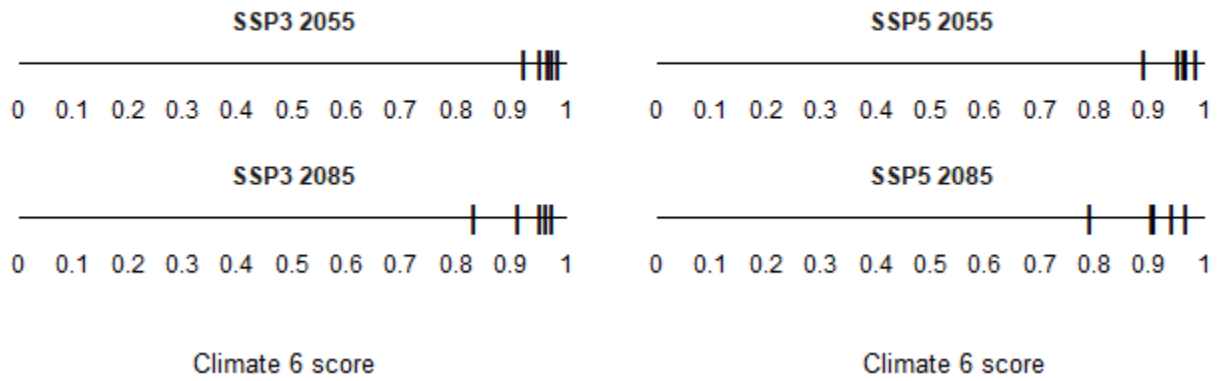
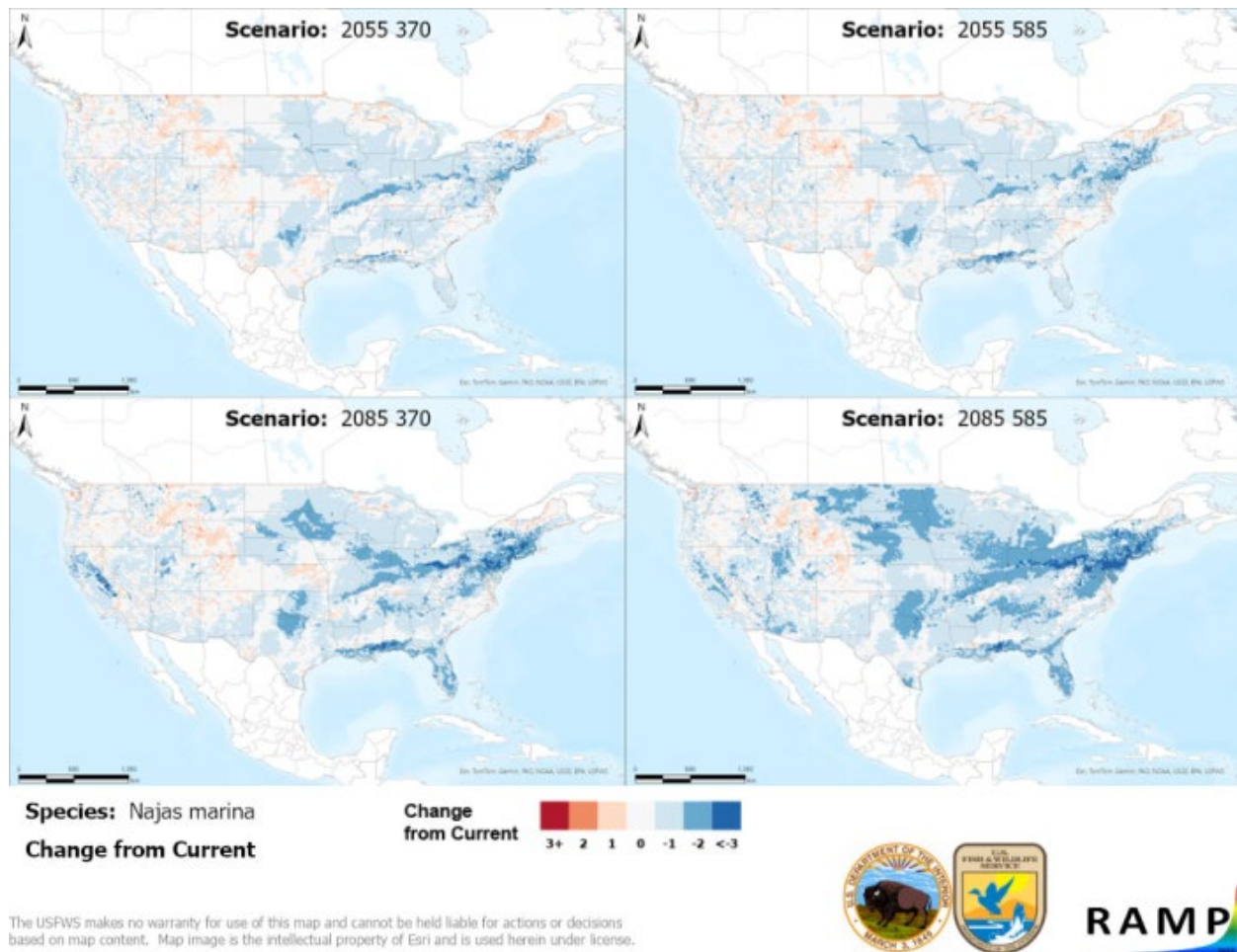


Figure A2. Comparison of projected future Climate 6 scores for *Najas marina* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0.



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Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 6) and the median target point score for future climate scenarios (figure A1) for *Najas marina* based on source locations reported by GBIF Secretariat (2023). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. Shades of blue indicate a lower target point score under future scenarios than under current conditions. Shades of red indicate a higher target point score under future scenarios than under current conditions. Darker shades indicate greater change.

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