U.S. Fish & Wildlife Service

# Tape Grass (*Vallisneria spiralis*)

## Ecological Risk Screening Summary

**U.S. Fish and Wildlife Service, April 2024**
**Revised, April 2025**
**Web Version, 6/13/2025**

Organism Type: Plant
Overall Risk Assessment Category: High

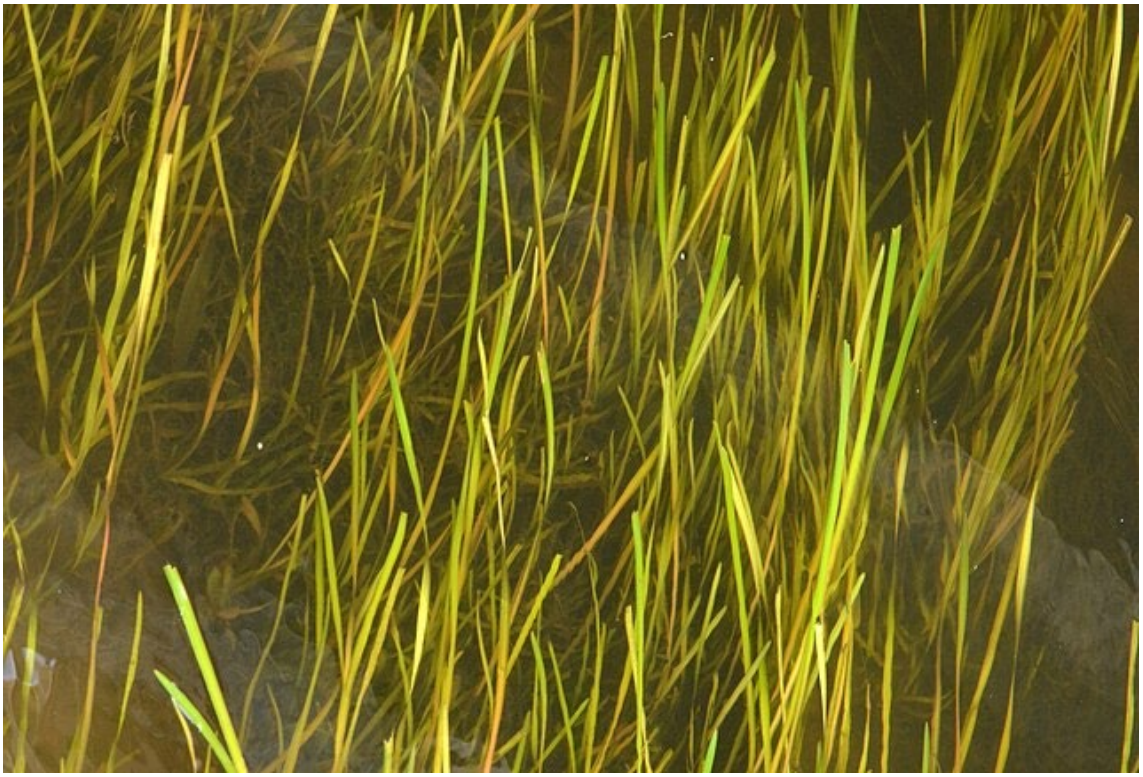

Photo: Lamiot. Licensed under CC BY-SA 4.0 DEED. Available: https://commons.wikimedia.org/wiki/File:Vallisn%C3%A9rie_*Vallisneria*_spiralis_Brant%C3%B4me-Dronne_2014_2.JPG (April 2024).

# 1 Native Range and Status in the United States

## Native Range

From Lewis (2010):

"Native to southern Europe, northern Africa, the Middle East and southwest Asia, […]"

POWO (2024) lists *Vallisneria spiralis* as native in floristic regions in Asia: Afghanistan, Bangladesh, India (including Assam, West Himalaya), Iran, Iraq, Kazakhstan, Kyrgyzstan, Lebanon, Myanmar, Pakistan (including West Himalaya), Palestine, Sri Lanka, Syria, Thailand, Tajikistan, Turkey, Turkmenistan, and Uzbekistan; Africa: Algeria, Botswana, Burundi, Central African Republic, Chad, Democratic Republic of the Congo, Egypt, Equatorial Guinea, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Namibia (Caprivi Strip), Nigeria, Republic of the Congo, Rwanda, Senegal, Sierra Leone, South Africa (including KwaZulu-Natal), Sudan, Tanzania, Uganda, Zambia, and Zimbabwe; and Europe: Bosnia and Herzegovina, Bulgaria, Croatia, France, Greece, Italy, Kosovo, Montenegro, North Macedonia, Portugal, Romania, Russia (North Caucasus, South European Russia, West Siberia), Serbia, Slovenia, Switzerland, and Ukraine.

## Status in the United States

From Les et al. (2008):

"[…] we conclusively documented the presence of the Old World *V. spiralis* in Texas (United States), which constitutes the first authentic record of this nonindigenous species in North America."

From Lewis (2010):

"In the Hawaiian Islands *V. spiralis* was found during freshwater stream survey projects to be locally naturalized and abundant on O'ahu, where it formed dense underwater mats that are the dominant vegetation in areas where found (Staples et al., 2003). As previously mentioned, these Pacific Island records warrant confirmation in the light of recent taxonomic study of *V. spiralis* [see Remarks, below]."

*Vallisneria spiralis* is widely available in the aquarium trade (e.g., Amazon 2024; eBay 2024; Walmart 2024).

### Regulations

No species-specific regulations on possession or trade were found within the United States.

## Means of Introductions within the United States

From Lewis (2010):

"There are also geographically disjunct introductions to […] North America, […]. The use of the species as an aquarium plant, together with its ability to spread vegetatively, is considered to have facilitated its spread and invasiveness."

## Remarks

This ERSS was previously published in June 2018. Revisions were completed to incorporate new information and conform to updated standards.

The genus *Vallisneria* has a complicated taxonomic history with many currently defined species previously lumped under a few names, including *Vallisneria spiralis* (Les et al. 2008). In addition, *Vallisneria* species can be difficult to distinguish morphologically and can hybridize (e.g., Jacobs and Frank 1997; Gorham et al. 2021). This has led to some difficulty in understanding the actual native range of *V. spiralis* under current species concepts. See below excerpts for more details on these topics.

From Lansdown (2019):

"The taxonomy of *Vallisneria* is not yet satisfactorily clarified and there is confusion over the true distribution of some species, which is further confounded by establishment of populations of various taxa derived from horticulture."

From Lewis (2010):

"Les et al. (2008) report what they consider to be the first authentic record of *V. spiralis* in North America, with the material collected in Texas. Previous reports of the species in North America are considered to be misidentifications of *V. americana*."

Gorham et al. (2021) reports records of *Vallisneria spiralis* and *V. denseserrulata* hybrid populations in Florida and Alabama.

From Gorham et al. (2021):

"Because natural ranges of both parent species [*Vallisneria spiralis* and *V. denseserrulata*] are not sympatric in the wild, it is thought that the hybridization event occurred in aquaria. The presence of both species in the aquarium pet trade also makes the industry a potential source of the introduction in the United States. More extensive sampling will be necessary to determine the full distribution of the hybrid, as well as to evaluate its potential impact on native *Vallisneria* populations and the aquatic ecosystems they support."

From Lewis (2010):

"Although commonly reported from India (e.g. Jana and Choudhuri, 1979; Rai et al., 1995), Lowden (1982) assigned most specimens he studied from India, Pakistan and Bangladesh, along with those from South-East Asia, to *V. spiralis* var. *denseserrulata*. As var. *denseserrulata* is now considered a separate species [*Vallisneria denseserrulata*] (Les et al., 2008), clarification is needed on the identity and distribution of *V*. species though Asia. In New Zealand, *V. australis* is present in Lake Pupuke and nearby, where it was first recorded in 1896 (Cheeseman, 1896). Only male plants are known, and this population has been variously recorded as *V. spiralis*, *V. gigantea* (e.g. de Winton et al., 2009), and *V. americana* (P Champion, NIWA, New Zealand, personal communication, 2010)."

"The reported occurrence of *V. spiralis* in British Columbia, Canada (Warrington, 1994) is now considered to be incorrect and *V. americana* to be the species present (Government of British Columbia, 2009)."

"Australian records of *V. spiralis var. denserrulata* (Lowden, 1982) and *Vallisneria spiralis* var. *procera* (Rodway, 1896) have since been determined to be *Vallisneria nana* (Jacobs and Frank, 1997) and *Vallisneria australis* (Les et al., 2008), respectively."

From GISD (2025):

"Juvenile or sterile specimens may be difficult to distinguish (Warrington 1994)."

Mention of commercial products in this Ecological Risk Screening Summary does not entail endorsement by the U.S. Federal Government.

# 2 Biology and Ecology

## Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2024):

Kingdom Plantae
Subkingdom Viridiplantae
Infrakingdom Streptophyta
Superdivision Embryophyta
Division Tracheophyta
Subdivision Spermatophytina
Class Magnoliopsida
Superorder Lilianae
Order Alismatales
Family Hydrocharitaceae
Genus *Vallisneria* L.
Species *Vallisneria spiralis* L.

According to POWO (2024), *Vallisneria spiralis L*. is the current valid name for this species.

## Size, Weight, and Age Range

From GISD (2025):

"Eelgrasses are submerged aquatic plants that can grow up to five metres."

## Environment

From Lansdown (2019):

"It can be found in fresh or brackish water at depths of 0.2-3.5 m."

## Climate

From Lewis (2010):

"Widespread in tropical and subtropical areas of both hemispheres."

## Distribution Outside the United States

### Native

From Lewis (2010):

"Native to southern Europe, northern Africa, the Middle East and southwest Asia, […]"

POWO (2024) lists *Vallisneria spiralis* as native in floristic regions in Asia: Afghanistan, Bangladesh, India (including Assam, West Himalaya), Iran, Iraq, Kazakhstan, Kyrgyzstan, Lebanon, Myanmar, Pakistan (including West Himalaya), Palestine, Sri Lanka, Syria, Thailand, Tajikistan, Turkey, Turkmenistan, and Uzbekistan; Africa: Algeria, Botswana, Burundi, Central African Republic, Chad, Democratic Republic of the Congo, Egypt, Equatorial Guinea, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Namibia (Caprivi Strip), Nigeria, Republic of the Congo, Rwanda, Senegal, Sierra Leone, South Africa (including KwaZulu-Natal), Sudan, Tanzania, Uganda, Zambia, and Zimbabwe; and Europe: Bosnia and Herzegovina, Bulgaria, Croatia, France, Greece, Italy, Kosovo, Montenegro, North Macedonia, Portugal, Romania, Russia (North Caucasus, South European Russia, West Siberia), Serbia, Slovenia, Switzerland, and Ukraine.

### Introduced

From POWO (2024):

"Introduced into: Belgium, Czechoslovakia, Germany, Great Britain, Hungary, Ireland, Mauritius, Netherlands, Poland, Réunion."

From Lewis (2010):

"[…] now spread to the north and northwest [of southern Europe] in France, Belgium, Netherlands, southern Britain, Poland and Russia."

"Lowden (1982) did not find evidence of the species in the Americas, but reported "minor" introductions into Jamaica and Cuba."

"In New Zealand, *V. spiralis* is reported to have been present on the North Island in Lake Wiritoa in the Manawatu-Wanganui region, since 1978, and Meola Creek in the Auckland region since 1982 (de Winton et al., 2009). From 2001 to 2008, the species was documented from 82 sites in the Wellington region, mostly in garden pools. Since 2000 it has also been reported from the Northland region and the Opawa River at Blenheim in the Marlborough region on the South Island (de Winton et al., 2009; P Champion, NIWA, New Zealand, personal communication, 2010). The species is also reported from […] New Caledonia (MacKee, 1994). […] As

previously mentioned, these Pacific Island records warrant confirmation in the light of recent taxonomic study of *V. spiralis*."

From Wasowicz et al. (2014):

"We first recorded this invasive aquatic plant [*Vallisneria spiralis*] in 2013 in a man-made pond south-west of the town of Husavik […] in northern Iceland […]. The pond is about 1.2 ha and is created by warm geothermal water discharged from a local geothermal pipeline network. *V. spiralis* is widespread in the pond and is reproducing vegetatively through runners. […] Given that *V. spiralis* is naturalised and present throughout the pond, we suspect that colonisation took place several years ago."

MyBIS (2025) lists *Vallisneria spiralis* as non-native in Malaysia.

## Means of Introduction Outside the United States

From Lewis (2010):

"The use of the species as an aquarium plant, together with its ability to spread vegetatively, is considered to have facilitated its spread and invasiveness."

## Short Description

From Lewis (2010):

"Freshwater plants with fibrous roots, short stem, horizontal runners, and submerged, linear, strap or tape shaped leaves up to 10 mm wide and 100 cm or more long arranged in a basal rosette; leaves with three to five parallel nerves, entire to finely toothed margins. Plants dioecious; inflorescence axillary. Staminate plants with numerous, minute imperfect flowers enclosed by a dehiscing two-valved, reflexed spathe, flowers with three sepals, one minute petal rudiment, one staminodium and two stamens; scapes thin, 1.0-1.3 mm wide, 10–30 mm long, flowers slightly zygomorphic, with obliquely extended stamens, hairs absent at base of androecium, staminodia adnate near the apex of the fused stigmatic lobes, with lobes shallowly cleft and conspicuously fringed. Pistillate plants with inflorescence subtended by a bivalve spathe; scapes long, extended to spirally coiled; flowers solitary, slightly zygomorphic, with three sepals 2.0–3.5 mm long, three minute transparent petal rudiments, three staminodia and three bifid stigmas borne on short, or highly reduced styles; staminodia small, inconspicuous, adnate to fused discordant stigmatic lobes; stigmas fringed; floral incision deepest between matching stigmatic lobes. Ovary inferior, unilocular; fruit elongate, approx. 9.5–10.0 cm long, ellipsoid, indehiscent; placentation parietal; seeds numerous, ellipsoid, striate, 1.3–2.0 mm long; endosperm absent (Lowden, 1982)."

From WFO (2024):

"Fruit an irregularly dehiscing capsule. Seeds numerous, ellipsoidal, 1.3-2 mm long. Leaves totally submerged, grows in still and flowing water (up to ± 1 m/sec); often very common and sometimes locally dominant. Pollinated on the water surface, with mobile male flowers on the

water surface caught by floating but attached female flowers. Disseminules are seeds and vegetative fragments."

## Biology

From WFO (2024):

"Dioecious, perennial or occasionally annual."

From Lansdown (2019):

"*Vallisneria spiralis* typically occurs in mesotrophic to eutrophic slow-flowing or lentic lowland water bodies, such as canals, ditches, rivers and occasionally lakes."

## Human Uses

From Lansdown (2019):

"The plant is demulcent, refrigerant and stomachic. It is used for the treatment of leucorrhoea and is made into a tea with sesame (*Sesamum indicum*) to increase appetite. Sometimes its young leaves are eaten raw."

"*Vallisneria spiralis* is very widely and frequently sold for aquarium and pond planting, to the extent that accidental or intentional releases into the wild threaten to obscure trends in native populations."

From GISD (2025):

"A study conducted to evaluate the accumulation and toxicity of chromium (Cr) in *V. spiralis* found that after one week the plants ameliorated 59% of Cr from tannery effluent (which contains a high level of chromium). A higher level of remediation was obtained when the tannery effluent was diluted; 95% of Cr was removed from 25% effluent. It was concluded that *V. spiralis* effectively removes chromium by surface absorption or adsorption (incorporating it into its own system or storing it in a bound form). Therefore *V. spiralis* may be effective in bioremediation of diluted tannery effluent and in restoring contaminated wetlands; however safe disposal of contaminated plants in cemented vaults is recommended (Vajpayee et al. 2001)."

## Diseases

No information on diseases of *Vallisneria spiralis* was found.

## Threat to Humans

No information was found on threats to humans from *Vallisneria spiralis*.

# 3 Impacts of Introductions

From GISD (2025):

"They grow in still or flowing water and form a dense monoculture that dominates from the bed of the water-body to the surface. Dense infestations may restrict recreational activities, cause flooding and silting and reduce the aesthetic appeal of a body of water."

From Hutorowicz (2006):

"Over an eleven-year period *Vallisneria spiralis* managed to colonize three lakes included in the open cooling system of two heat and power stations. In Lake Licheńskie [Poland] it almost entirely displaced submerged hydrophytes, occupying the bottom to a depth of about 2.5 m."

From Lewis (2010):

"*V. spiralis* can form dense beds which displace other species of submerged hydrophytes (MAF Biosecurity New Zealand, 2010). In Polish lakes, this is attributed to its clonal mode of propagation and its maximum growth in autumn when native species are dormant (Hutorowicz, 2006; Hutorowicz and Hutorowicz, 2008). […] Leaves of *V. spiralis* can provide substrate for epiphytic algae and associated fauna of rotifers and protists (Hutorowicz and Hutorowicz, 2008)."

From Hussner and Lösch (2005):

"In the River Erft [Germany] this species [*Vallisneria spiralis*] is in competition with *Sparganium emersum* without any signs of replacement. Frequently both taxa form common stands. In this case *Vallisneria spiralis* dominates the shallow (up to 1.0 m) and clear water regions whereas *Sparganium emersum* roots in the deeper and more turbid sections of the river. Here, under competition a partial separation and narrowing of the common ecological niche occurs which is broader in both species if growing without competition."

From Matthews et al. (2012):

"There is no evidence to suggest that *V. spiralis* has a negative impact on native species in the Netherlands. Field observations suggest that there are no signs that native aquatic plant species are displaced by *V. spiralis* in the Biesbosch."

No species-specific regulations on possession or trade were found within the United States.

# 4 History of Invasiveness

*Vallisneria spiralis* has been introduced and become established outside of its native range in Texas, New Zealand, Malaysia, and Europe. Reported impacts include creation of monocultures that displace native species and could impact recreational usage of waterways. The History of Invasiveness for *Vallisneria spiralis* is classified as High. However, it should be noted that

taxonomic changes and misidentification of other *Vallisneria* species have led to changes in the understanding of the introduced range of the species.

# 5 Global Distribution

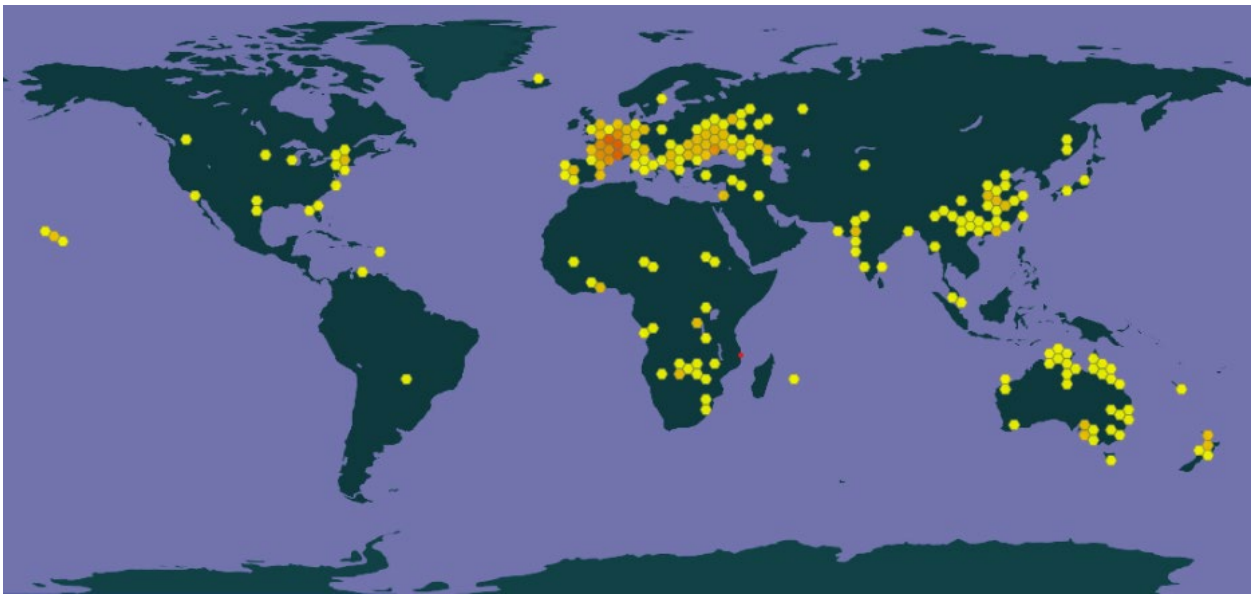

**Figure 1.** Reported global distribution of *Vallisneria spiralis*. Map from GBIF Secretariat (2023). Observations are reported from Australia, South America, North America, Iceland, Europe, Sub-Saharan Africa, Asia, and New Zealand. Points in South America, North America (other than Texas), Sweden, China, Japan, and far eastern Russia were not included in climate matching due to not representing established wild populations of *V. spiralis*. Observations in Iceland (Wasowicz et al. 2014) and central Poland (Hutorowicz 2006) are from thermally regulated waters and were not used in the climate matching analysis.

According to Jacobs and Frank (1997), *Vallisneria spiralis* observations in Australia are correctly identified as *Vallisneria nana*. As such, no points from Australia were included in climate matching analysis.

# 6 Distribution Within the United States

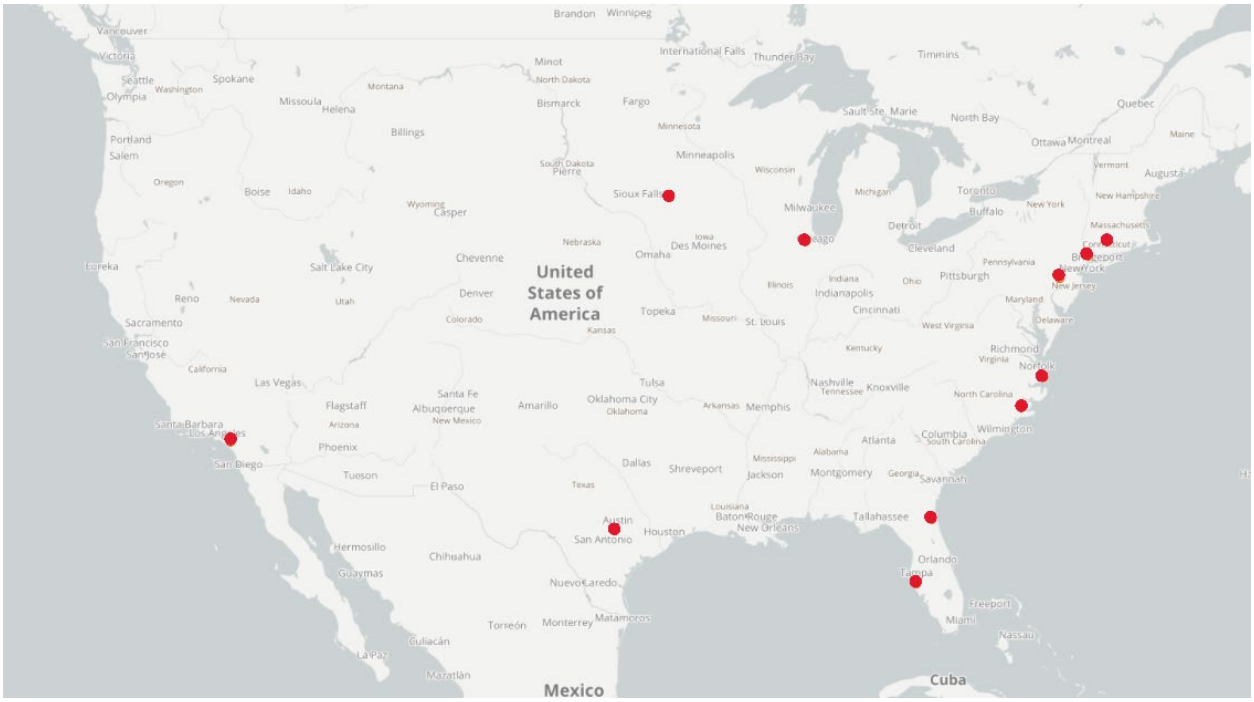


**Figure 2.** Reported distribution of *Vallisneria spiralis* in the contiguous United States. Map adapted from GBIF-US (2023). Observations are reported from California, Connecticut, Florida, Illinois, Iowa, New York, North Carolina, Pennsylvania, and Texas. The points in California, Connecticut, Florida, Illinois, Iowa, New York, North Carolina, and Pennsylvania were not included in the climate match analysis because they do not represent established wild populations of *V. spiralis*.

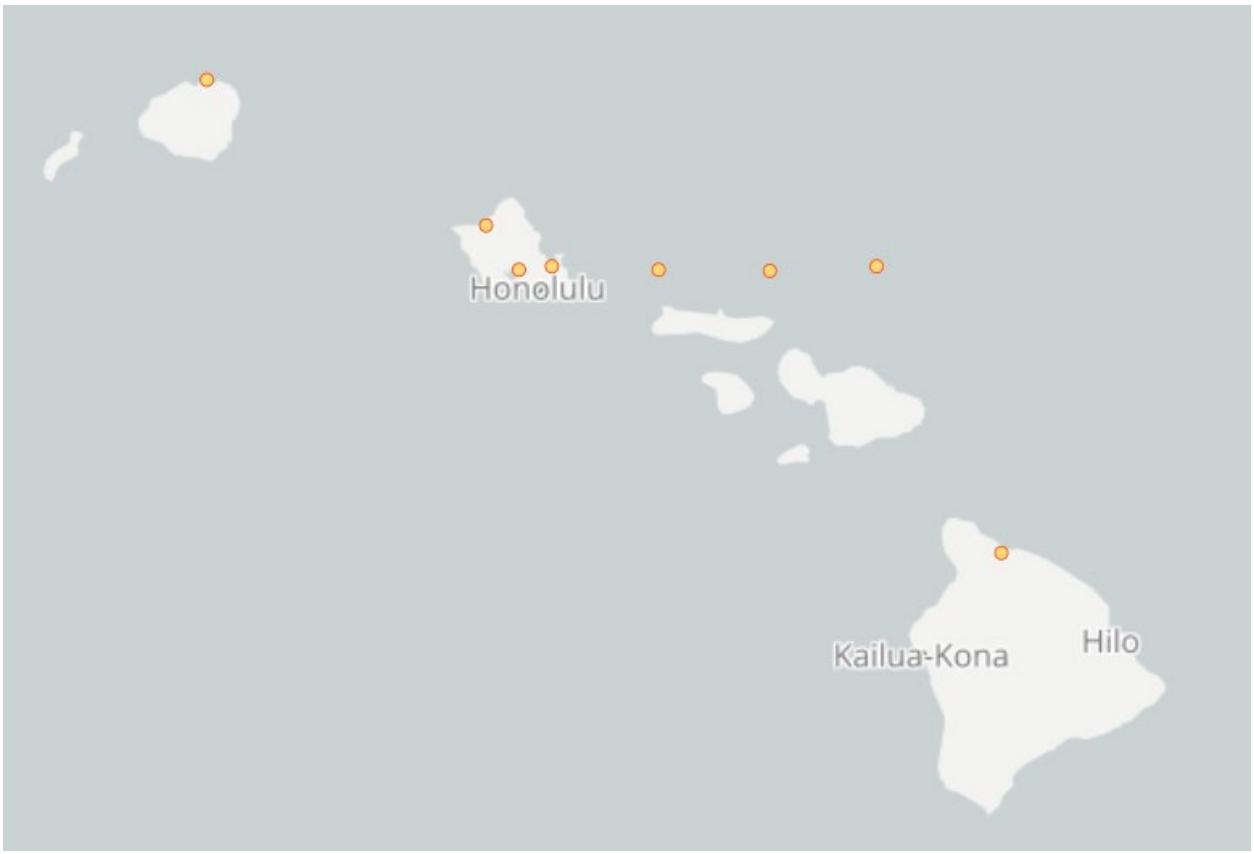


**Figure 3.** Reported distribution of *Vallisneria spiralis* in Hawaii. Map from GBIF-US (2023). Observations are reported from Kauai, Oahu, and Hawaii (main island). Observations in marine locations are the result of coordinate errors and were not used in the climate matching analysis.

# 7 Climate Matching

## Summary of Climate Matching Analysis

The climate matching analysis for *Vallisneria spiralis* to the contiguous United States found mainly medium to high matches. Areas of high climate match were found in the Great Lakes, Appalachian, Southern Plains, California, Northern Plains, and scattered areas of the Colorado Plateau, Western Mountains, and Northern Pacific Regions. Areas of low climate match were restricted to scattered patches in western areas of the Western Mountains, Northern Pacific region, Desert Southwest, and Gulf Coast. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.957, indicating that Yes, there is establishment concern for this species. 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). Populations established in thermally regulated waters were not used in the climate matching analysis as those deviations from surrounding conditions are not able to be accounted for in the analysis.

Projected climate matches in the contiguous United States under future climate scenarios are available for *Vallisneria spiralis* (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.

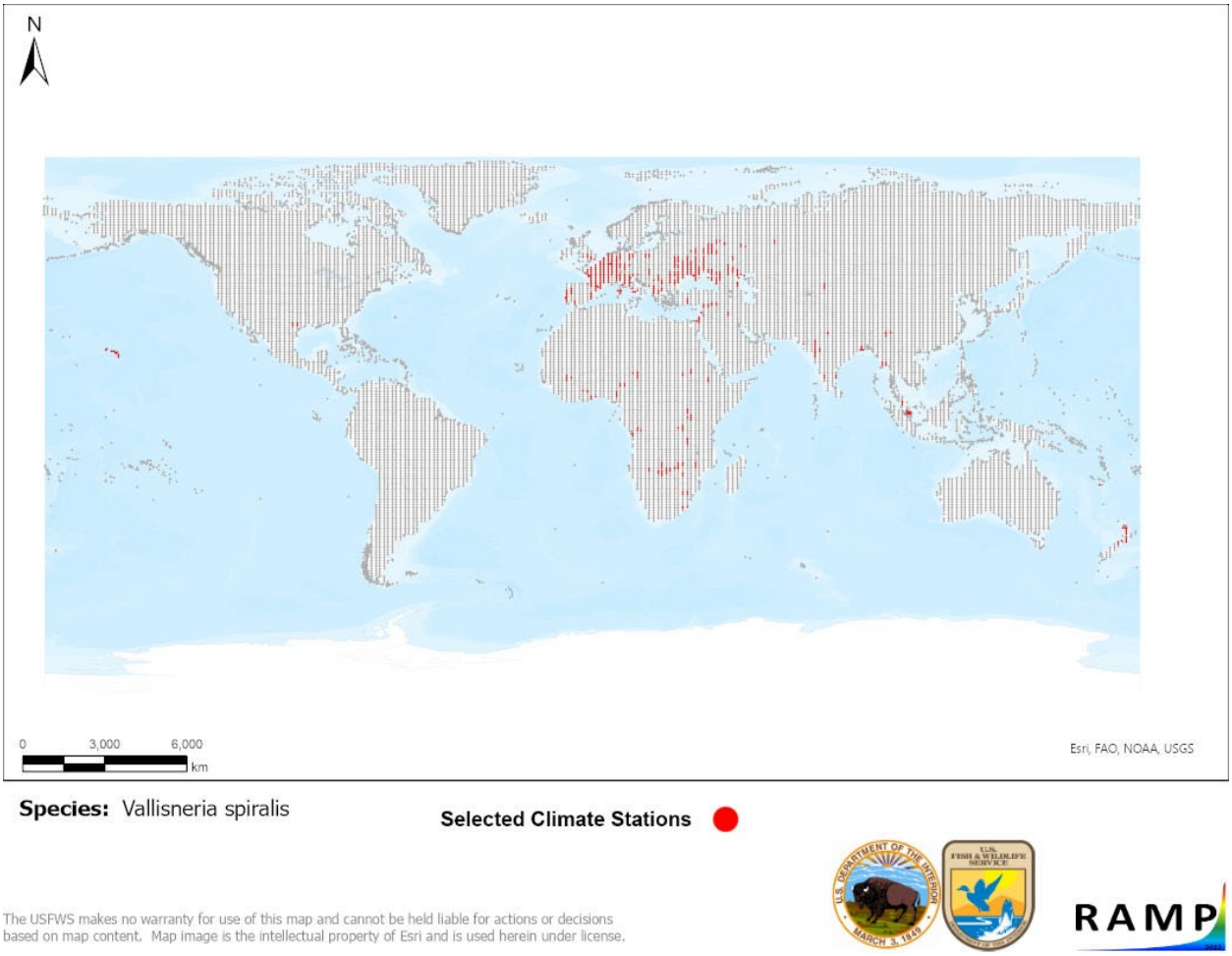


**Figure 4.** RAMP (Sanders et al. 2023) source map showing weather stations globally selected as source locations (red; Albania, Angola, Austria, Belgium, Bulgaria, Burundi, Chad, China, Curaçao, Democratic Republic of the Congo, France, Germany, Ghana, Greece, Hungary, India, Iraq, Israel, Italy, Kyrgyzstan, Luxembourg, Malaysia, Mali, Montenegro, Mozambique, Myanmar, Netherlands, New Zealand, Poland, Portugal, Réunion, Romania, Russia, Serbia, South Africa, Spain, Sudan, Switzerland, Syria, Turkey, Uganda, Ukraine, United Kingdom, United States [Hawaii, Texas], Zambia, Zimbabwe) and non-source locations (gray) for *Vallisneria spiralis* climate matching. Source locations from GBIF Secretariat (2024). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

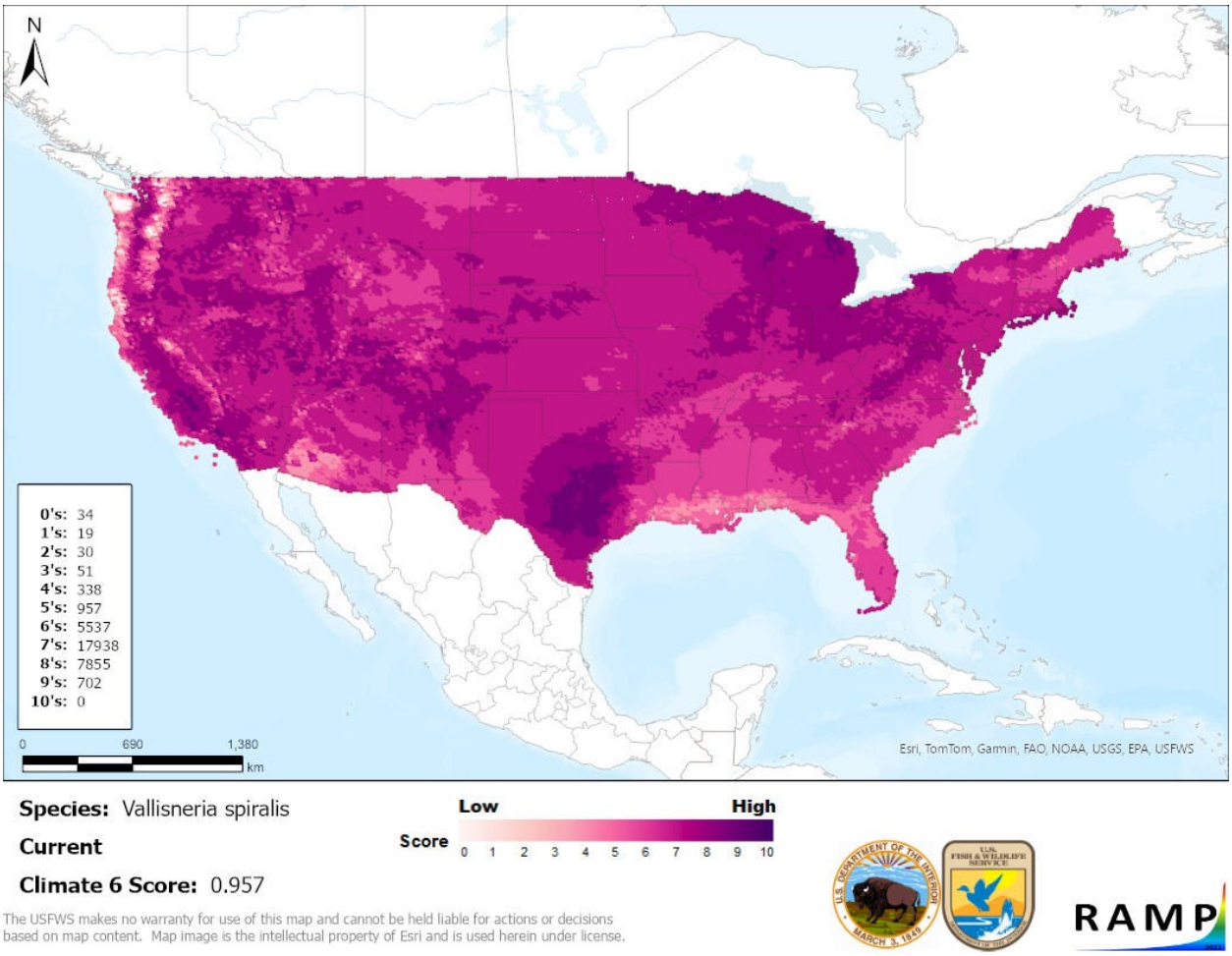


**Figure 5.** Map of RAMP (Sanders et al. 2023) climate matches for *Vallisneria spiralis* in the contiguous United States based on source locations reported by GBIF Secretariat (2024). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

# 8 Certainty of Assessment

There is an abundance of information concerning the biology, ecology, and distribution of *V. spiralis* including records of introduction. Information on impacts from introductions was also available. However, there is a history of misidentification of other species as *V. spiralis* related to taxonomic ambiguity of species within *Vallisneria*. The Certainty of Assessment for *Vallisneria spiralis* is classified as Medium.

# 9 Risk Assessment

## Summary of Risk to the Contiguous United States

*Vallisneria spiralis*, tape grass, is an aquatic plant that is native to Southern Europe, northern Africa, the Middle East, and southwest Asia. It is found in canals, ditches, rivers, and occasionally lakes and other slow moving bodies of water. *V. spiralis* is a common species in the aquarium trade, likely leading to introductions on multiple continents. The History of

Invasiveness for *Vallisneria spiralis* is classified as High. It has been introduced outside its native range and become established. Impacts from established populations include monocultures that displace native submerged aquatic plant species. The climate matching analysis for the contiguous United States indicates establishment concern for this species. The majority of the United States had a medium to high climate match. Small areas of low match were found scattered in the northwest. The Certainty of Assessment for this ERSS is classified as Medium due to a history of misidentification and general taxonomic ambiguity. The Overall Risk Assessment Category for *Vallisneria spiralis* 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: None**
- **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.**


Amazon. 2024. Live *Valisnaria* (Vals) *Spiralis* Italian plant - Provides canopy on tank top & shelter to baby fish - Fast growth, long lasting & easy to care aquatic plants - 6 plants – green. Available: https://www.amazon.com/6-Valisnaria-Vals-Spiralis-Italian/dp/B09B6DVWPV/ref=sr_1_14?adgrpid=1331510318018065&dib=eyJ2IjoiMSJ9.Ip3Ox3-cApB5EhQWsRLjFLPfDbLkZE1B5zwsQc03y7mlSmwhrXoXZpFE1Xx7cwh5mBvb5fNvqty9KLSNjP_oUs44cxiWjT-vRQcSs_QCYU12_i0BEZRzEugQ8OlYOycAdCTEK-9-aPg9kHHD-oFt2Hjr0iUernTS9z1wHhDiOtXA9oHmtndxH0gBwqC6VtRzt3entChu_5CUORh6JDE-_NBrdzJBB9ImHrcszSgh3ASee68KfxADgqUjw9uw0xe6Z9IEd6pOCuzi4dPPkT9AmFWyN12IY5YqZbDiN7MWM4U.vzonPI23U-tOOALnOFPKeC8uMAZsRHnyA0oBZlUu3Gc&dib_tag=se&hvadid=83219688362478&hvbmt=bb&hvdev=c&hvlocphy=91490&hvnetw=o&hvqmt=b&hvtargid=kwd-83220461202572%3Aloc-190&hydadcr=22715_13532680&keywords=vallisneria%2Baquarium%2Bplant%2Blive&qid=1712341633&sr=8-14&th=1 (April 2024).

EBay. 2024. 6 *Valisnaria* (Vals) *spiralis* Italian live aquarium plants. Available: https://www.ebay.com/itm/145594463458?itmmeta=01HTQR7MMQWAHXEDH94AFQMW3P&hash=item21e61b34e2:g:tX0AAOSwG1BlwBJM&itmprp=enc%3AAQAJAAAA4CH%2FODBp%2FayGcwYf2yOkhAZZ4Q0SJ0yNqyynJuJYUS%2BllzuMoaFdqMs%2FnBsm0wki%2Bxh5kTVPkx5HaTcG1fFQ%2BGeuBV1QLYlY23dszqEgNLiUMG30tEPHNf6vIQ9k8sjwLDJpBTTWMDoHllXcba2FVjleJeZUVvFAy77LgN1A9UG5yfaYXb4p7c%2F1fNc%2B%2FXsj2iLEc9NsWKPzAz7KdMEF8weDj7XD4CidfteZLf3%2

FjNjRx8mnN57832EmtJSQbw7vDB6%2FYVkK4S1T7hVCO2PErB0u6tjKP%2BT%2Ft07APvBBr6NO%7Ctkp%3ABFBMusqe-NVj (April 2024).

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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 *Vallisneria spiralis* was projected to occur in California and the Great Lakes regions of the contiguous United States. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.618 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.931 (model: MPI-ESM1-2-HR, SSP3, 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 (0.957, figure 5) 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 one or more time step and climate scenarios, areas within the Colorado Plateau and Southwest saw a moderate increase in the climate match relative to current conditions. No large increases were observed regardless of time step and climate scenarios. Under one or more time step and climate scenarios, areas within the Appalachian Range, Colorado Plateau, and Gulf Coast saw a large decrease in the climate match relative to current conditions. Additionally, areas within California, the Great Basin, Great Lakes, Mid-Atlantic, Northeast, Northern Plains, Southeast, Southern Atlantic Coast, Southern Plains, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions. Additional, very small areas of large or moderate change may be visible on the maps (figure A3). The magnitude of change from current conditions was more pronounced in time step 2085 than in time step 2055 under both scenarios, SSP3 and SSP5. The areas of moderate and large changes also had a larger geographic extent under SSP5 than SSP3 in the 2085 time step.

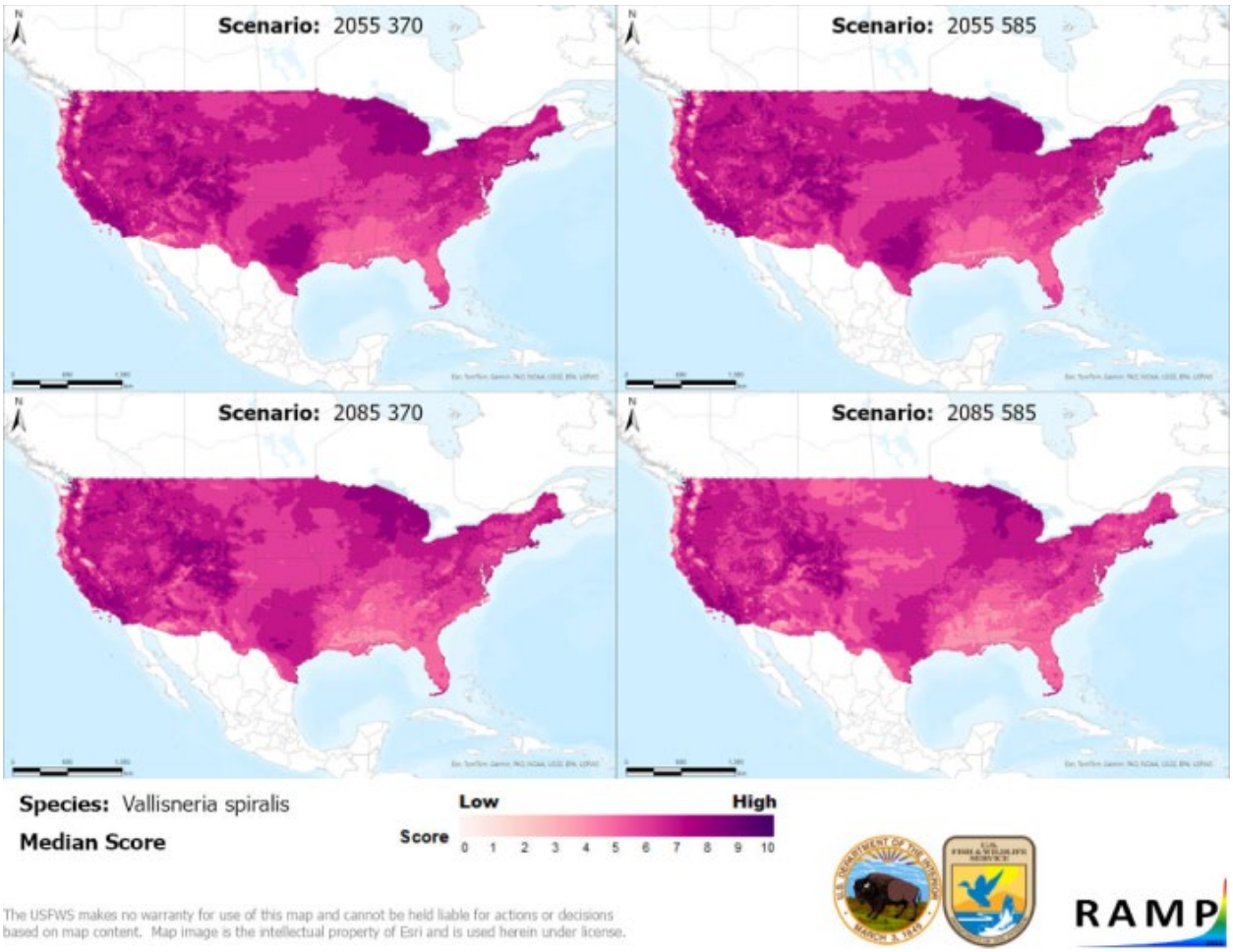


**Figure A1.** Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Vallisneria spiralis* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023). 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.

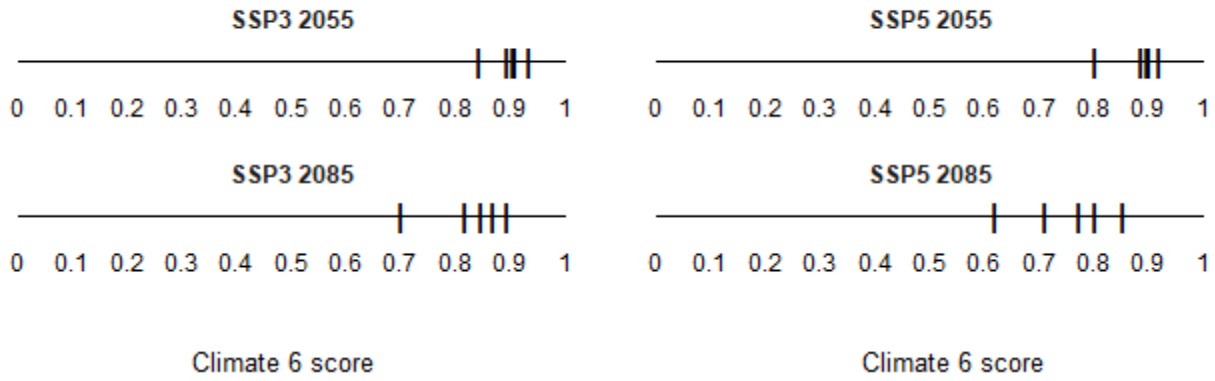


**Figure A2.** Comparison of projected future Climate 6 scores for *Vallisneria spiralis* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 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.

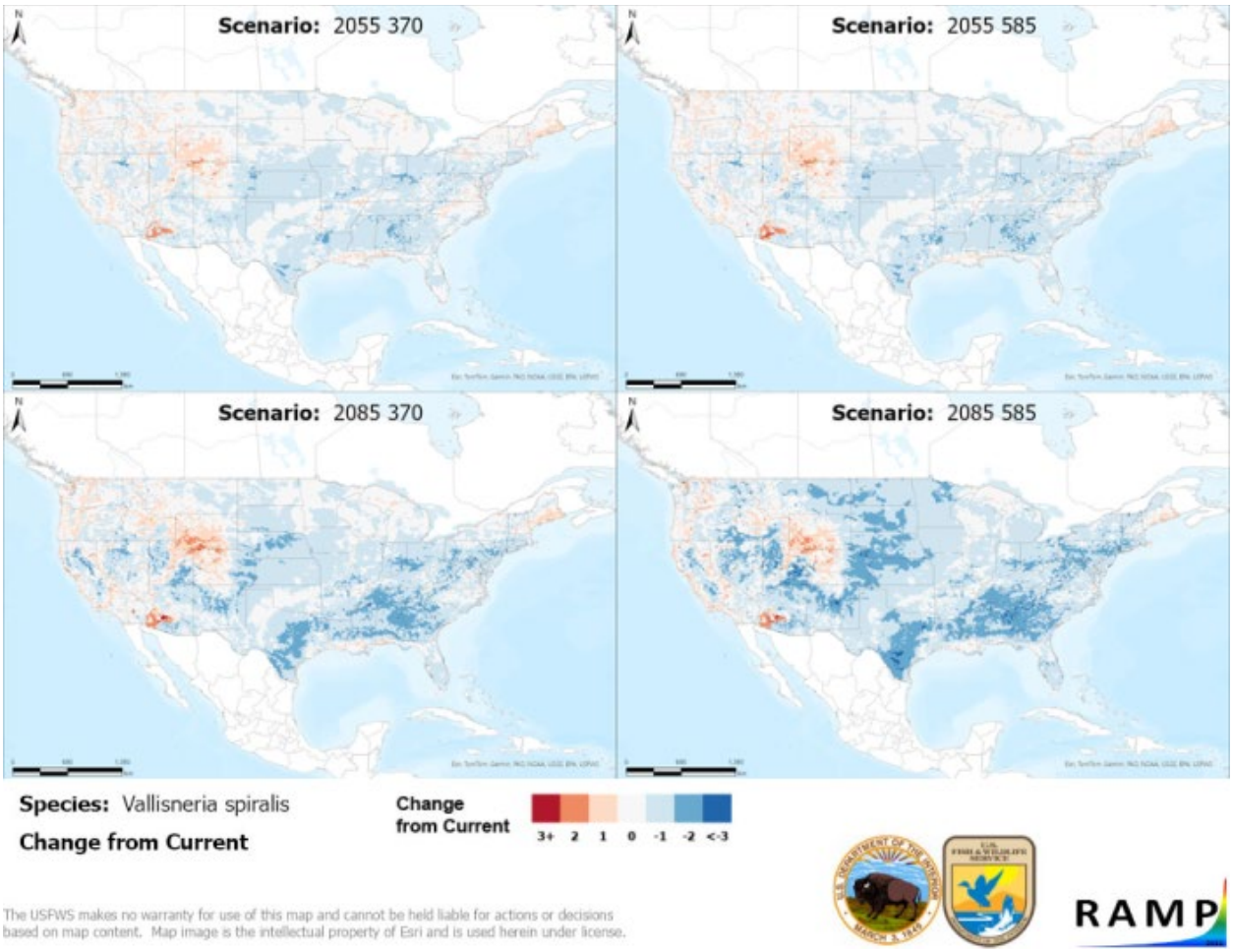


**Figure A3.** RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 5) and the median target point score for future climate scenarios (figure A1) for *Vallisneria spiralis* based on source locations reported 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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