Tape Grass (*Vallisneria spiralis*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, December 2016
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1 Native Range and Status in the United States

Native Range

From Gupta (2014):

"*V. spiralis* is native to much of Africa north and south of the Sahara, from Europe east through the Caucasus and the Middle East to Kazakhstan, the Indian Sub-continent, Myanmar and Thailand. In Europe it is apparently native to central and eastern Europe and parts of the Mediterranean."

From CABI (2015):

"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 (Les et al., 2008), clarification is needed on the identity and distribution of *V.* species though Asia."

Status in the United States

From CABI (2015):

"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*. Lowden (1982) did not find evidence of the species in the Americas,"

"The species is also reported from the Hawaiian Islands (Staples et al., 2003) and New Caledonia (MacKee, 1994). 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*."

Means of Introductions in the United States

No means of introduction to the United States were found for *Vallisneria spiralis*.

Remarks

From CABI (2015):

"Genetic studies across the genus [*Vallisneria*] have demonstrated that the name *V. spiralis* has been applied to a number of morphologically similar species (Les et al., 2008). Outside of it now recognized native range in southern Europe, such as in New Zealand, New Caledonia and the Hawaiian Islands, molecular confirmation of species identity is needed."

USDA (2015) considers *Vallisneria spiralis* a junior synonym for *V. americana*, a widespread native species in the United States. This is the only source that treats *V. spiralis* in this manner. All other sources treat *V. spiralis* and *V. americana* as separate, valid species.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2014):

"Kingdom Plantae

Subkingdom Viridaeplantae
Infrakingdom Streptophyta
Division Tracheophyta
Subdivision Spermatophytina
Infradivision Angiospermae
Class magnoliopsida
Superorder Lilianae
Order Alismatales
Family Hydrocharitaceae
Genus *Vallisneria* L.
Species *Vallisneria spiralis* L."

"Taxonomic Status:
Current Standing: accepted"

Size, Weight, and Age Range

From GISD (2011):

"[…] long strap-like leaves which can vary in length from a few centimetres to 5.5 metres in deep water."

Environment

No information on the specific environmental requirements of *Vallisneria spiralis* could be found.

Climate/Range

From CABI (2015):

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

Distribution Outside the United States

Native

From Gupta (2014):

"*V. spiralis* is native to much of Africa north and south of the Sahara, from Europe east through the Caucasus and the Middle East to Kazakhstan, the Indian Sub-continent, Myanmar and Thailand. In Europe it is apparently native to central and eastern Europe and parts of the Mediterranean."

From CABI (2015):

"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 (Les et al., 2008), clarification is needed on the identity and distribution of *V.* species though Asia."

Introduced

From GISD (2011):

"*Vallisneria spiralis* has been introduced to New Zealand and Canada."

"Details of this species [*Vallisneria spiralis*] in Bay of Plenty [New Zealand] Region
Status: Alien
Invasiveness: Invasive
Occurrence: Eradicated"

From CABI (2015):

"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 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)."

"[…] but reported "minor" introductions into Jamaica and Cuba."

From Gupta (2014):

"It has been introduced to Belgium, Germany, Hungary, Netherlands, Switzerland and the United Kingdom as well as Mauritius and Reunion."

From Foggi et al. (2010):

"The Egyptian population in the Aswan district, Nile Valley region, is introduced."

According to NOBANIS (2016), *V. spiralis* has been introduced and become established in Iceland and the Netherlands; it was introduced with unknown results in Austria, Germany, and Poland.

Means of Introduction Outside the United States

From GISD (2011):

"Aquaculture: The spread of this species to previously unaffected water bodies is normally the result of intentional plantings (Greater Wellington Regional Council 2004b).
Floating vegetation/debris: Waterfowl, flooding or human disturbance in flowing water can cause small fragments to break from the parent plant and form new colonies further downstream (Greater Wellington Regional Council 2004b). There is no evidence of viable seed being produced in New Zealand and any new infestations are formed vegetatively (ie: by the production of runners) (Greater Wellington Regional Council 2004b)."

Short Description

From PIER (2006):

"An annual or a perennial, submersed, stoloniferous, dioecious plant with stems buried in mud; roots fibrous; leaves ribbon-like, sheathing base, arranged in tufts at intervals along a stolon, 1 to 7 cm broad, 1 to 6 m long, upper portion sometimes floating at the surface, 5 to 9 main longitudinal veins with fine transverse connections, acute to obtuse, edges may be finely toothed toward apex, winged at base with one wing folded over edge of next inner leaf and other wing extended; pistillate flower 1.5 to 2.5 cm long, solitary, sessile, within membranous sheath, peduncle may be up to 60 cm long as flower bud is raised to surface; spathe 1.5 to 2 cm long; sepals 3, concave, springing directly from summit of the ovary; petals 3, white, alternate with sepals, minute and scarcely visible; pistil with 3, 2-lobed nearly sessile stigmas; ovary inferior, long, cylindrical, unilocular, with mucilage-filled cavity containing numerous crowded ovules; staminate flower minute, less than 1 mm long and broad, numerous, enclosed by membranous spathe; spathe 1 to 2 cm long, terminal on a 7 cm long peduncle; perianth of 3 sepals, concave, 2 larger than the third; stamens usually 3; petals absent; fruit long, 4 mm broad, many seeds embedded in a gelatinous mass, enveloped by the persistent spathe; seed tapering, ellipsoidal, papillate, 1.5 to 3 mm long (Holm et al., 1997; p. 897)"

Biology

From CABI (2015):

"*Vallisneria* is one of several genera in the Hydrocharitaceae in which staminate flowers detach completely from a spathe at the base of submerged male plants (Les et al., 2008). The flowers rise to the surface and open to form free-floating, raft-like structures which are dispersed by wind and currents. In this genus, as in two other genera in the family (*Maidenia*, *Nechamandra*), the pollen remains dry within elevated anthers and the anthers also remain dry within the perianth of the pistillate flower (Les et al., 2008). The pistillate flowers, attached to submerged plants by long, flexuous peduncles, orient their opening at the water surface and pollination occurs when anthers of the floating staminate flowers contact the stigmas of the pistillate flowers. After fertilization the peduncle coils into a spiral, thus drawing the developing fruit underwater where it matures (Les et al., 2008)."

"*V. spiralis* spreads asexually by means of runners (Hutorowicz and Hutorowicz, 2008)."

"An experimental study into the photosynthetic, photorespiratory and respiratory behaviour of three aquatic angiosperms, including *V. spiralis*, found that under constant conditions of light, temperature and initial gaseous composition there was considerable variation in the rates of dark and light respiration, as well as photosynthesis (Jana and Choudhuri, 1979). All three species were assumed to be basically C3 plants, since all showed photorespiration. Both photosynthesis and respiration rates generally declined with leaf age, with a possible increase in the rate of respiration with the approach of senescence."

"In the River Nile, in a study to assess the impact of river vessel traffic on aquatic vegetation, *V. spiralis* was found to be tolerant of high wave disturbance (Ali et al., 1999)."

From GISD (2011):

"*Vallisneria spiralis* occurs in estuarine habitats, lakes, water courses and wetlands."

From PIER (2006):

""It is most often found in 0.5 to 3 m of water (reported to 10 m in clear water). It is found in lakes, rivers, waterlogged swamps with open water, man-made reservoirs, and irrigation channels. It thrives in streams but is seldom present in fast water" (Holm et al., 1997; pp. 895, 897)."

Human Uses

From GISD (2011):

"Rooted submerged species, especially those that yield high biomass, such as some *Vallisneria* spp. are important in phytoremediation (biological remediation of environmental problems using plants) due to their soil-binding roots, rhizomes and stolons (which help facilitate colonisation by benthic algae, other microbes and invertebrates) (Qian et al. 1999, in Vajpayee et al 2001). 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)."

From Gupta (2014):

"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 tender leaves are eaten raw.
V. 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."

Diseases

No records of diseases of *Vallisneria spiralis* were found.

Threat to Humans

From Matthews et al. (2012):

"There was no information found concerning the public health effects of *V. spiralis* during the literature study or in communications with project partners."

3 Impacts of Introductions

From New Zealand Ministry of Agriculture and Forestry, Biosecurity Division (2008):

"The eelgrass forms dense beds of vegetation which displace native plants, and may affect recreational activities, impede navigation and obstruct water out-takes."

From GISD (2011):

"Dense infestations may restrict recreational activities, cause flooding and silting and reduce the aesthetic appeal of a body of water."

From CABI (2015):

"*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). In other areas, such as in the River Erft in Germany, a dynamic arrangement of native and exotic species has resulted in a high a-diversity of primary producers which is considered to possibly have a positive influence on community composition (Hussner and Lösch, 2005)."

"Leaves of *V. spiralis* can provide substrate for epiphytic algae and associated fauna of rotifers and protists (Hutorowicz and Hutorowicz, 2008)."

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 adverse effects of *V. spiralis* on ecosystem functioning in the Netherlands were identified."

4 Global Distribution

Figure 1. Known global distribution of *Vallisneria spiralis* as reported by GBIF Secretariat (2015).

The record in British Colombia, Canada is considered incorrect (CABI 2015) and was not used as a source location in the climate match.

5 Distribution Within the United States

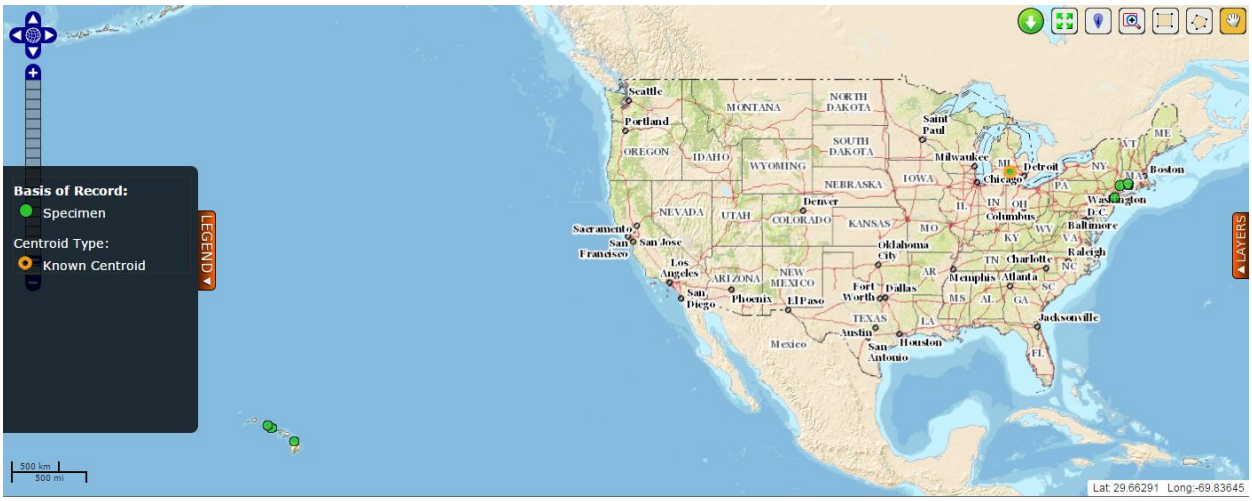

Figure 2. Known distribution of *Vallisneria spiralis* in the United States. Map from BISON (2016); see Section 10 for a full list of databases accessed through BISON.

6 Climate Matching

Identification of *Vallisneria spiralis* populations in areas outside its European and Mediterranean range are in question (CABI 2015). As a result two climate matches were performed, one with all potential *V. spiralis* populations as source locations, and the second with the much more restricted range indicated by new molecular and taxonomic work as source locations.

Summary of Climate Matching Analysis – Worldwide Populations

The climate match was high for the southern Great Lakes region extending south into Virginia and Illinois. The match was also high in parts of Florida, California, and southern Texas. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.387, high, and individually high in Arizona, Arkansas, California, Connecticut, Delaware, Florida, Idaho, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin.

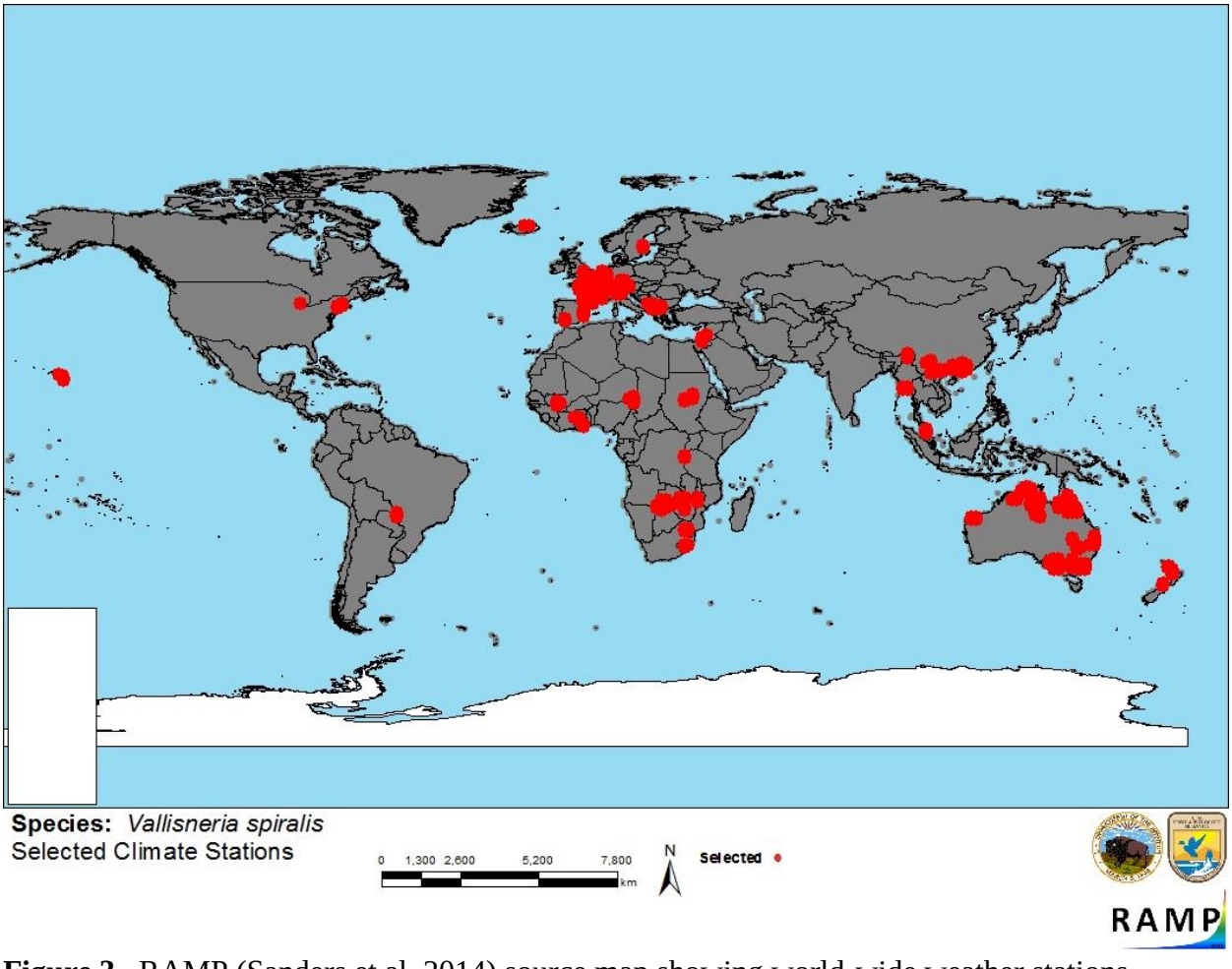

Figure 3. RAMP (Sanders et al. 2014) source map showing world-wide weather stations selected as source locations (red) and non-source locations (grey) for *Vallisneria spiralis* climate matching. Source locations from GBIF Secretariat (2015) and BISON (2016).

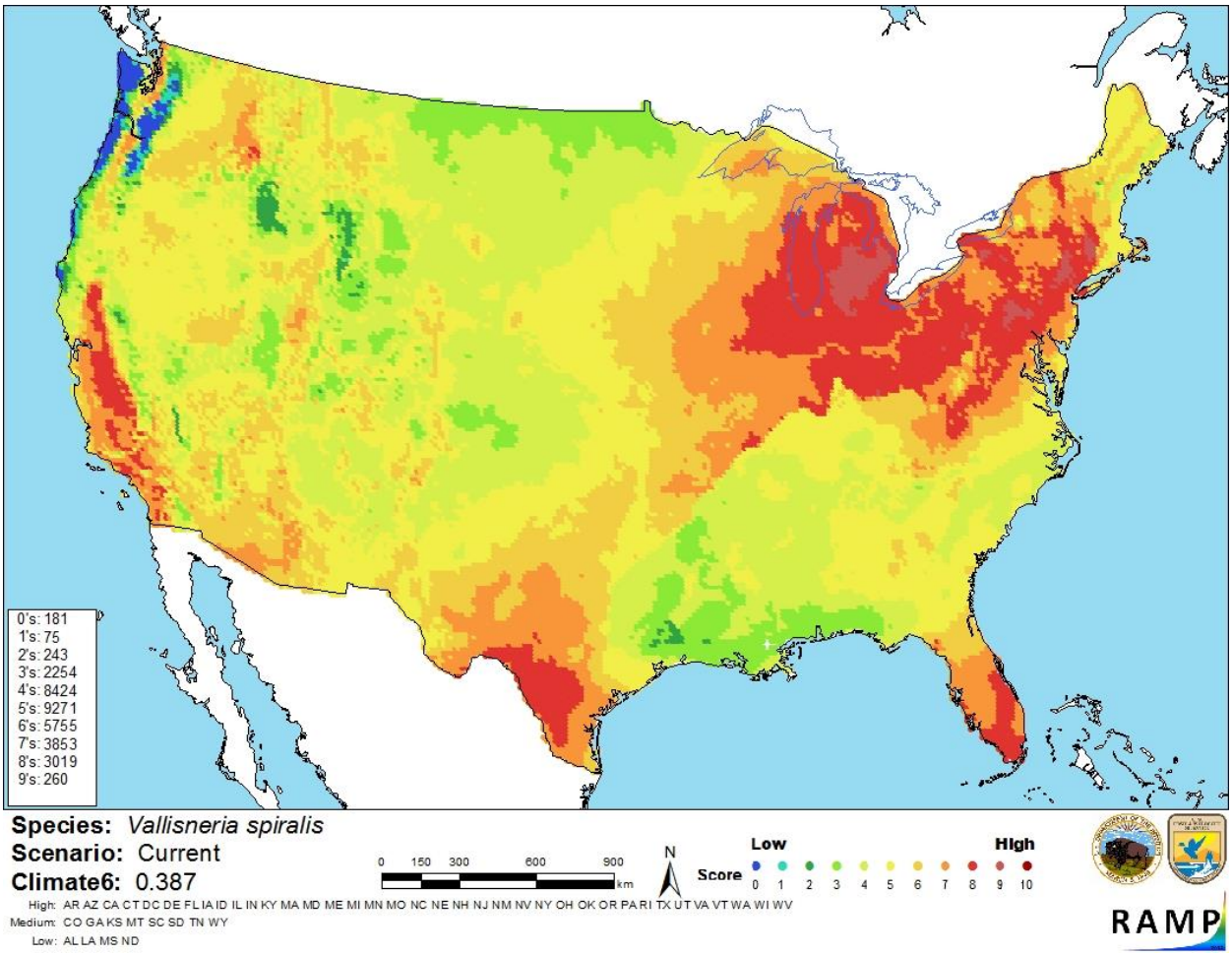

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Vallisneria spiralis* in the contiguous United States based on world-wide source locations reported by GBIF Secretariat (2015) and BISON (2016). 0 = Lowest match, 10 = Highest match. Counts of climate match scores are tabulated on the left side of the map.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

Summary of Climate Matching Analysis 2 – European and Mediterranean Populations

The climate match was very high for California, select areas in other western states, and along the more southern Great Lakes states south into North Carolina and northeast Texas. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.166, high, and individually high in Arizona, Arkansas, California, Connecticut, Delaware, Idaho, Illinois, Indiana, Kentucky, Maryland, Massachusetts, Michigan, Missouri, Nevada, New Jersey, New York, Ohio, Oregon, Pennsylvania, Utah, Virginia, Washington, and West Virginia.

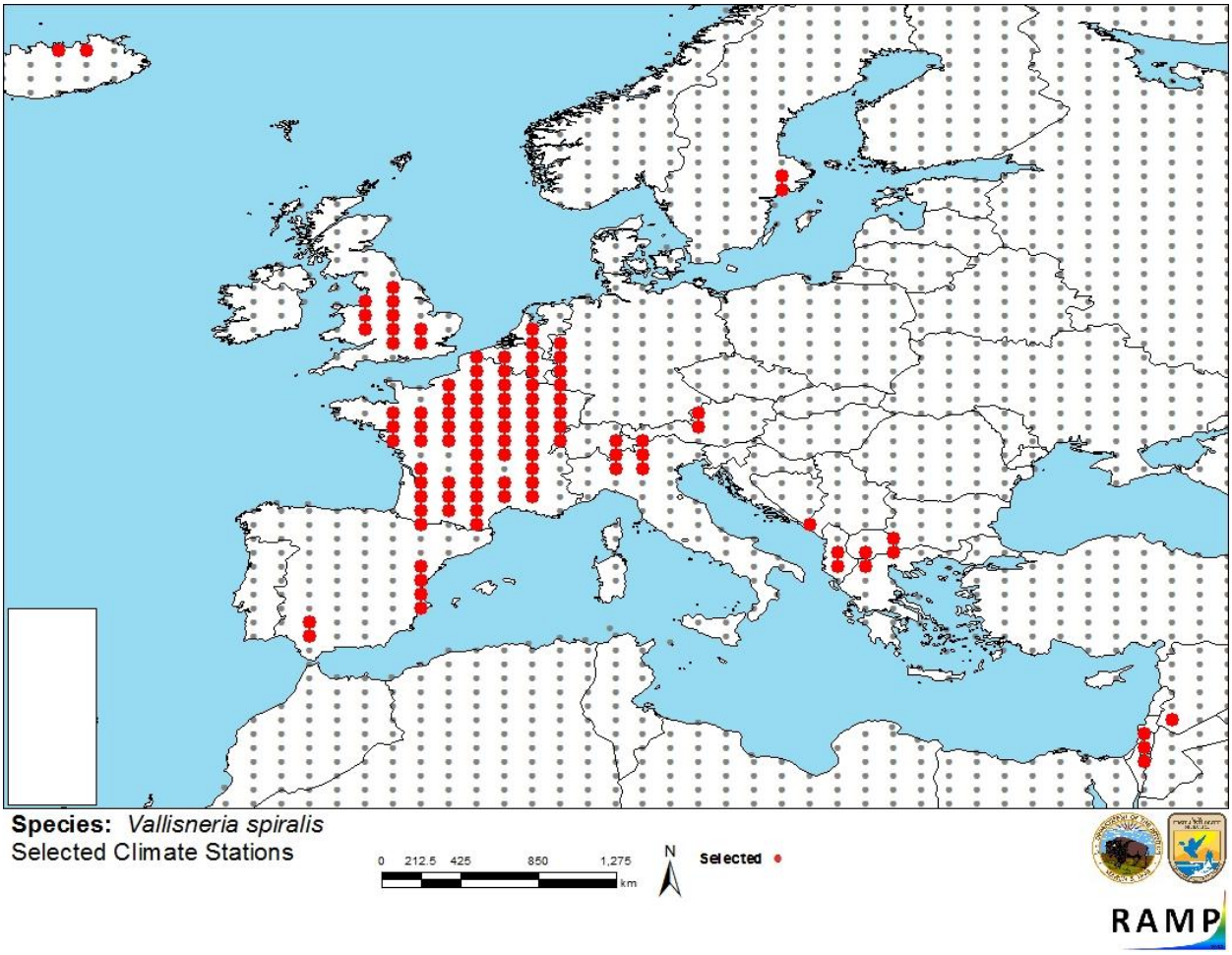

Figure 5. RAMP (Sanders et al. 2014) source map showing European and Mediterranean weather stations selected as source locations (red) and non-source locations (grey) for *Vallisneria spiralis* climate matching. Source locations from CABI (2015), GBIF Secretariat (2015), and BISON (2016). These source locations indicate the area that is potentially the actual range of *V. spiralis* due to new molecular and taxonomic work.

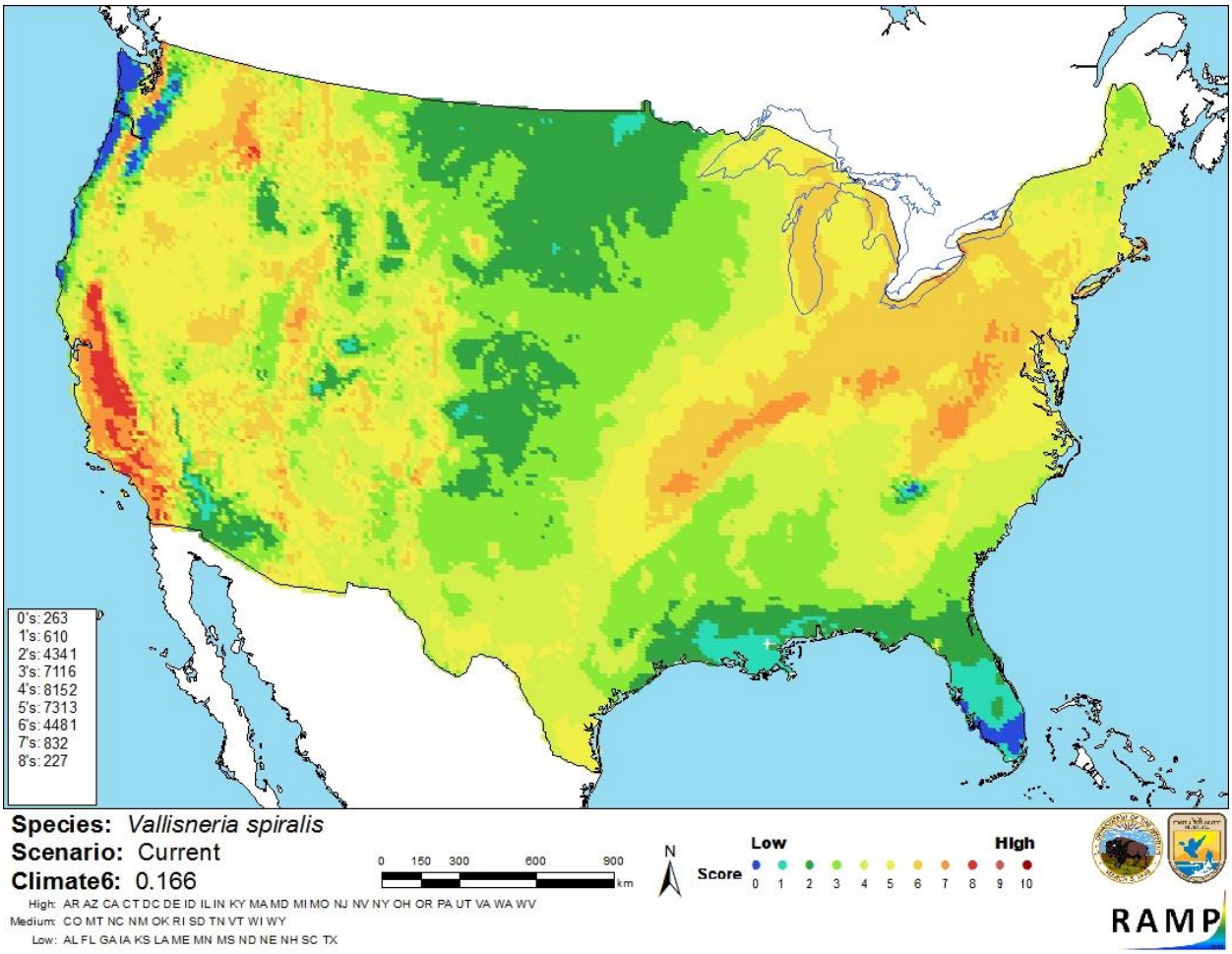

Figure 6. Map of RAMP (Sanders et al. 2014) climate matches for *Vallisneria spiralis* in the contiguous United States based on the European and Mediterranean source locations reported by CABI (2015), GBIF Secretariat (2015), and BISON (2016). 0 = Lowest match, 10 = Highest match. See table on page 11 for climate score categories.

7 Certainty of Assessment

The certainty of assessment is low. There is more than adequate biological and ecological information available but the confusion in taxonomy created by the newer genetic analyses prevents a higher level of confidence in the history of invasiveness or the climate match.

8 Risk Assessment

Summary of Risk to the Contiguous United States

The history of invasiveness is uncertain. There are records of introductions attributed to *Vallisneria spiralis* around the world but recent molecular and taxonomic work has thrown uncertainty on the identifications of these populations outside of a European and Mediterranean range. There are records of generalized negative impacts, mostly replacement of native species as well as records of no impact and of beneficial impacts. Currently there is no way to determine if that range of impacts is the result of one species or different species in different locations. The

climate match is high for both scenarios; however, the scenario using the more restricted range has a lower climate 6 score than the one using all potential populations as source points. The areas of highest climate match within the country change between the scenarios. The certainty of assessment is low due to the uncertainty in taxonomic classification and identification of populations. The uncertain history of invasiveness and low certainty in the assessment preclude a definitive risk assessment, combined with a high climate match it results in an overall risk assessment category of uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): Uncertain**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Low**
- **Remarks/Important additional information** Identification of populations around the world, including potentially introduced populations is in question with new genetic and taxonomic work.
- **Overall Risk Assessment Category: Uncertain**

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

BISON. 2016. Biodiversity Information Serving Our Nation (BISON). United States Geological Survey. Available: https://bison.usgs.gov. (December 2016).

CABI. 2015. *Vallisneria spiralis* [original text by J. Lewis]. *In* Invasive Species Compendium. CAB International, Wallingford, UK. Available: http://www.cabi.org/isc/datasheet/56573. (December 2015).

Foggi, B., I. Bazos, P. García Murillo, P. Grillas, and T. Abeli. 2010. *Vallisneria spiralis.* The IUCN Red List of Threatened Species 2010: e.T164121A5731437. Available: http://www.iucnredlist.org/details/full/164121/3. (December 2015).

GBIF Secretariat. 2015. GBIF backbone taxonomy: *Vallisneria spiralis* L. Global Biodiversity Information Facility, Copenhagen. Available: http://www.gbif.org/species/2865526. (December 2015).

GISD (Global Invasive Species Database). 2011. Species profile: *Vallisneria spiralis*. Invasive Species Specialist Group, Gland, Switzerland. Available: http://www.issg.org/database/species/ecology.asp?si=878&fr=1&sts=sss&lang=EN. (March 2011).

Gupta, A. K. 2014. *Vallisneria spiralis*. The IUCN Red List of Threatened Species 2014. Available: http://www.iucnredlist.org/details/full/164121/0. (December 2015).

ITIS (Integrated Taxonomic Information System). 2014. *Vallisneria spiralis* L. Integrated Taxonomic Information System, Reston, Virginia. Available: http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=817914. (March 2014).

Matthews, J., R. Beringen, F. P. L. Collas, K. R. Koopman, B. Odé, R. Pot, L. B. Sparrius, J. L. C. H. van Valkenburg, L. N. H. Verbrugge, and R. S. E. W. Leuven. Risk analysis of non-native tapegrass (*Vallisneria spiralis*) in the Netherlands. Draft report for Netherlands Food and Consumer Product Safety Authority, Utrecht, The Netherlands.

New Zealand Ministry of Agriculture and Forestry, Biosecurity Division. 2008. Available: http://www.biosecurity.govt.nz/pests/vallisneria-spiralis. (March 2011).

NOBANIS. 2016. *Vallisneria spiralis*. Available: https://www.nobanis.org/species-info/?taxaId=2191. (December 2016).

PIER (Pacific Island Ecosystems at Risk). 2006. *Vallisneria spiralis.* Available: http://www.hear.org/pier/species/vallisneria_spiralis.htm. (March 2011).

Sanders, S., C. Castiglione, and M. Hoff. 2014. Risk assessment mapping program: RAMP. U.S. Fish and Wildlife Service.

USDA, NRCS. 2015. *Vallisneria americana*. The PLANTS database. National Plant Data Team, Greensboro, North Carolina. Available: http://plants.usda.gov/core/profile?symbol=VAAM3. (December 2015).

10 References Quoted But Not Accessed

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

Ali, M. M., K. J. Murphy, and J. Langendorff. 1999. Interrelationships of river ship traffic with aquatic plants in the river Nile, Upper Egypt. Hydrobiologia 415:93–100.

Champion, P. 2010. NIWA, New Zealand.

de Winton, et al. 2009. [Source material did not give full citation for this reference]

Government of British Columbia. 2009. Identification keys to the aquatic plants of British Columbia. Environment Protection Division, Ministry of Environment, Government of British Columbia. Available: http://www.elp.gov.bc.ca/wat/wq/plants/plantkey/key.html.

Greater Wellington Regional Council. 2004b. Eelgrass. (February 2005).

Holm, L., J. Doll, E. Holm, J. Pancho, and J. Herberger. 1997. World weeds: natural histories and distribution. John Wiley and Sons.

Hussner, A., and R. Lösch. 2005. Alien aquatic plants in a thermally abnormal river and their assembly to neophyte-dominated macrophyte stands. Limnologica 35:18–30.

Hutorowicz, A. 2006. *Vallisneria spiralis* L. (Hydrocharitaceae) in lakes in the vicinity of Konin (Kujawy Lakeland). Biodiversity: Research and Conservation 1-2:154–158.

Hutorowicz, A., and J. Hutorowicz. 2008. Seasonal development of *Vallisneria spiralis* L. in a heated lake. Ecological Questions 9:79–86.

Jana, S., and M. A. Choudhuri. 1979. Photosynthetic, photorespiratory and respiratory behaviour of three submersed aquatic angiosperms. Aquatic Botany 7(1):13–19.

Les, D. H., S. W. L. Jacobs, N. P. Tippery, L. Chen, M. L. Moody, and M. Wilstermann-Hildebrand. 2008. Systematics of *Vallisneria* (Hydrocharitaceae). Systematic Botany 33:49–65.

Lowden, R. M. 1982. An approach to the taxonomy of *Vallisneria* L. (Hydrocharitaceae). Aquatic Botany 13:269–298.

MacKee, H. S. 1994. Catalogue des plantes introduites et cultivées en Nouvelle-Calédonie. Muséum National d'Histoire Naturelle, Paris.

MAF Biosecurity New Zealand. 2010. Eelgrass: *Vallisneria spiralis*. Available: http://www.biosecurity.govt.nz/pests/vallisneria-spiralis.

Rai, U. N., S. Sinha, R. D. Tripathi, and P. Chandra. 1995. Wastewater treatability potential of some aquatic macrophytes: removal of heavy metals. Ecological Engineering 5:5–12.

Staples, G. W., C. T. Imada, and D. R. Herbst. 2003. New Hawaiian plant records for 2001. Records of the Hawaii Biological Survey for 2001–2002. Part 2: Notes. Bishop Museum Occasional Papers 74:7–21.

Vajpayee, et al. 2001. [Source material did not give full citation for this reference]

Warrington, P. D. 1994. Identification keys to the aquatic plants of British Columbia. Identification keys to the aquatic plants of British Columbia. Resource Information Standards Committee, Government of British Columbia. Available: http://www.ilimb.gov.bc.ca/risc/o_docs/aquatic/029/index.htm.