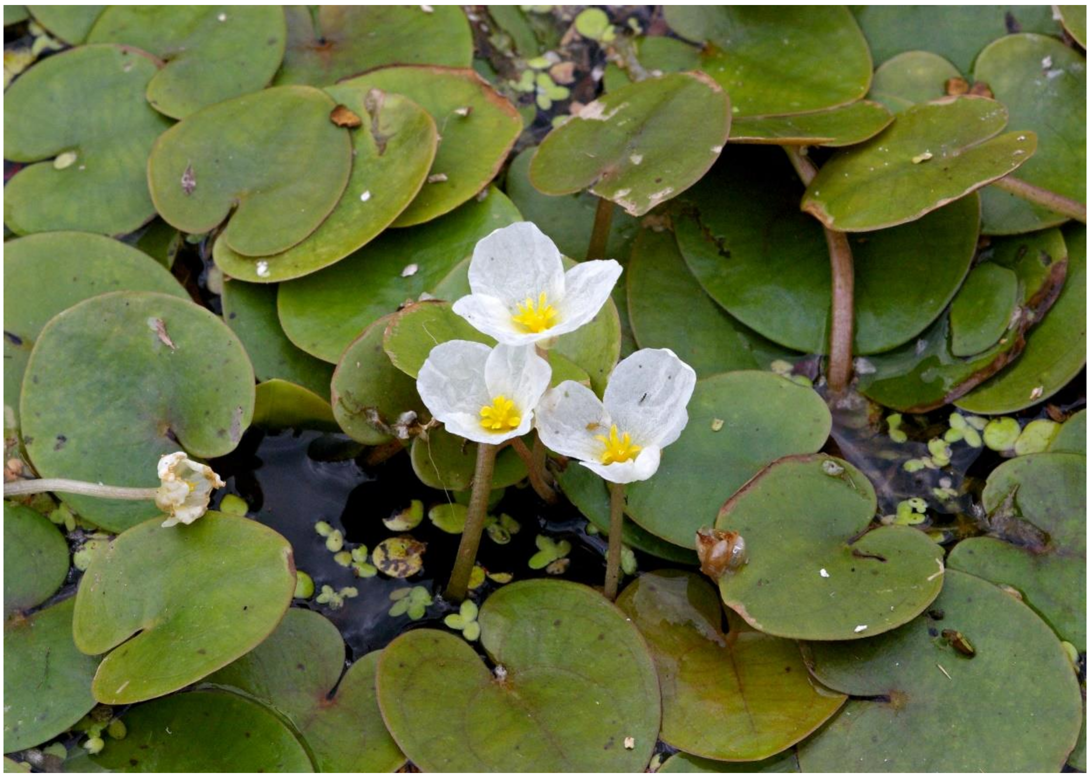
U.S. Fish & Wildlife Service

# European Frogbit (*Hydrocharis morsus-ranae*)
## Ecological Risk Screening Summary

**U.S. Fish & Wildlife Service, June 2015**
**Revised, March 2018, May 2018, June 2018**
**Web Version, 5/1/2019**



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# 1 Native Range and Status in the United States

## Native Range

From Jacono and Berent (2018a):

"Native Range: Europe and northern Asia. Threatened in parts of its native range; endangered in Switzerland (Sager and Clerc 2006)."

GISD (2018) lists *Hydrocharis morsus-ranae* as native in Austria, Azerbaijan, Belarus, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Ex-Yugoslavia, Finland, Georgia, Germany, Iran, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Russian Federation, Spain, Sweden, Turkey, Ukraine, United Kingdom, and Uzbekistan.

From Lansdown (2014):

"Native:
Albania; Algeria; Austria; Belarus; Belgium; Bosnia and Herzegovina; Bulgaria; Croatia; Czech Republic; Denmark; Estonia; Finland; France (France (mainland)); Georgia (Abkhaziya, Adzhariya, Gruziya); Germany; Greece (Greece (mainland)); Hungary; Ireland; Kazakhstan; Latvia; Liechtenstein; Lithuania; Luxembourg; Macedonia, the former Yugoslav Republic of; Moldova; Montenegro; Morocco; Netherlands; Norway; Palestinian Territory, Occupied; Poland; Portugal (Portugal (mainland)); Romania; Russian Federation (Central European Russia, Eastern Asian Russia, East European Russia, European Russia, Irkutsk, Kaliningrad, Krasnodar, North European Russia, Northwest European Russia, South European Russia, West Siberia); Serbia; Slovakia; Slovenia; Spain (Spain (mainland)); Sweden; Switzerland; Turkey (Turkey-in-Asia, Turkey-in-Europe); Ukraine (Ukraine (main part)); United Kingdom"

"*H. morsus-ranae* is classed as Critically Endangered in Spain and the Czech Republic, Endangered in Switzerland and Norway and Vulnerable in the United Kingdom. In France, it is protected at regional level in Alsace, Midi-Pyrénées, Provence-Alpes-Côte d'Azur, Rhône-Alpes and Limousin."

## Status in the United States

From Nault and Mikulyuk (2009):

"*H. morsus-ranae* was first discovered in the United States in 1974 from the Oswegatchie River, just off the St. Lawrence River, in northern New York (Jacono, 2009). By the early 1980s populations had spread and increased at several inland sites south of the St. Lawrence River; by the 1990s it had spread into bays and marshes of Lake Ontario (Catling and Dore, 1982)."

"*H. morsus-ranae* was first discovered in Vermont during 1993 at the northern portion of Lake Champlain near the town of Grande Isle. By 1999-2000 it had spread to the southern portion of the lake near Benson, Orwell, and West Haven, Vermont, as well as Mill Bay in eastern New York (Jacono, 2009)."

"In Michigan, unidentified plants were first observed in 1996 during dredging of a slough at Lake St. Clair, and within two years the plants had become abundant throughout the marsh and formed dense mats in cut ponds. In 2000 the plants were identified as *H. morsus-ranae* and established populations were observed in marshes of the Detroit River and Lake St. Clair, both of which flow into Lake Erie (Jacono, 2009)."

"*H. morsus-ranae* was first discovered in the western coast of the United States in 2001, where an established population was discovered in Snohomish County, Washington, in the wetlands surrounding Meadow Lake (Jacono, 2009; Catling et al., 2003)."

From Catling et al. (2003):

"State laws in both Minnesota and Maine (Chapter 722, H.P. 1843 - L.D. 2581) prohibit possession, import, sale, and transport (including accidental transport on boats and boat trailers)."

According to USDA, NRCS (2018) *Hydrocharis morsus-ranae* is an A list (noxious weed) species in California, a Class B noxious weed in Vermont, and a wetland and aquatic weed quarantine species in Washington.

GISD (2018) lists *Hydrocharis morsus-ranae* as alien, invasive, and established California, Maine, Michigan, New York, Vermont, and Washington.

From Jacono and Berent (2018b):

"Regulations (pertaining to the Great Lakes)
Prohibited in Illinois, Michigan, Minnesota, and Wisconsin (GLPANS 2008). In Minnesota¸ possession, import, purchase, transport, or introduction of *H. morsus-ranae* will result in a misdemeanor (MN DNR) 2013)."

"The New York Invasive Species Council ranks this species as posing a very high ecological threat and recommends that it be regulated (New York Invasive 2010)."

From NatureServe (2018):

"A popular water garden plant available for purchase through the commercial aquatic plant trade (Hamel and Parsons 2001, INDNR 2005); plants were ordered and received in Minnesota even though possession, import, purchase, transport, or introduction of the species is prohibited there by state law (Maki and Galatowitsch 2004)."

## Means of Introductions in the United States

From Jacono and Berent (2018a):

"Means of Introduction: 1972, unintentional release into Lake Superior (U.S. EPA 2008). Plant dispersal (aided by motor boats) through aquatic systems; entering from Canada, where in the 1930s it first escaped ornamental cultivation."

## Remarks

No additional remarks.

# 2 Biology and Ecology

## Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2018):

"Taxonomic Status:
Current Standing: accepted"

"Kingdom Plantae
Subkingdom Viridiplantae
Infrakingdom Streptophyta
Superdivision Embryophyta
Division Tracheophyta
Subdivision Spermatophytina
Class Magnoliopsida
Superorder Lilianae
Order Alismatales
Family Hydrocharitaceae
Genus *Hydrocharis*
Species *Hydrocharis morsus-ranae* L."

## Size, Weight, and Age Range

From Nault and Mikulyuk (2009):

"*H. morsus-ranae* […] can grow to be 0.1-1.5m across, with individual rosettes measuring 1-30 cm (Catling et al., 2003)."

## Environment

From Catling et al. (2003):

"Increased turbidity resulting from sewage, fertilizer eutrophication, or top-soil erosion, would limit necessary light and therefore inhibit germination (Richards and Blakemore 1975). Cook and Lüönd (1982) indicate that it favors calcium-poor water, often occurring on peaty soil types, but is not found in oligotrophic conditions and should probably be considered characteristic of mesotrophic waters. The plant tolerates high concentrations of hydrogen ions (Minshall and Scarth 1952). Cook and Lüönd (1982) agree with Richards and Blakemore (1975) that it is sensitive to most kinds of pollution but point out that Suominen (1968) observed its invasion of Lake Rautavesi in southwest Finland after the lake became eutrophic. Catling and Dore (1982) refer to colonies in nutrient-rich waters with pH 6.5–7.8."

## Climate/Range

From Catling et al. (2003):

"*Hydrocharis morsus-ranae* is a common plant in temperate regions of Eurasia."

"The very erratic flowering of *H. morsus-ranae* (Gurney 1949) is influenced by relatively small variations in climate (Overton 1899). A cold spring may retard the germination of the turions and plants that are late maturing may not initiate flowering (Cook and Lüönd 1982). Turions that remain floating near the surface are susceptible to freezing and Guppy (1893) noted that turions withstood freezing for several weeks. In contrast, Gluck (1906) recorded that they could tolerate only brief exposure to freezing, amounting to less than 10 d."

## Distribution Outside the United States

### Native

From Jacono and Berent (2018a):

"Native Range: Europe and northern Asia. Threatened in parts of its native range; endangered in Switzerland (Sager and Clerc 2006)."

GISD (2018) lists *Hydrocharis morsus-ranae* as native in Austria, Azerbaijan, Belarus, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Ex-Yugoslavia, Finland, Georgia, Germany, Iran, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Russian Federation, Spain, Sweden, Turkey, Ukraine, United Kingdom, and Uzbekistan.

From Lansdown (2014):

"Native:
Albania; Algeria; Austria; Belarus; Belgium; Bosnia and Herzegovina; Bulgaria; Croatia; Czech Republic; Denmark; Estonia; Finland; France (France (mainland)); Georgia (Abkhaziya, Adzhariya, Gruziya); Germany; Greece (Greece (mainland)); Hungary; Ireland; Kazakhstan; Latvia; Liechtenstein; Lithuania; Luxembourg; Macedonia, the former Yugoslav Republic of; Moldova; Montenegro; Morocco; Netherlands; Norway; Palestinian Territory, Occupied; Poland; Portugal (Portugal (mainland)); Romania; Russian Federation (Central European Russia, Eastern Asian Russia, East European Russia, European Russia, Irkutsk, Kaliningrad, Krasnodar, North European Russia, Northwest European Russia, South European Russia, West Siberia); Serbia; Slovakia; Slovenia; Spain (Spain (mainland)); Sweden; Switzerland; Turkey (Turkey-in-Asia, Turkey-in-Europe); Ukraine (Ukraine (main part)); United Kingdom"

"*H. morsus-ranae* is classed as Critically Endangered in Spain and the Czech Republic, Endangered in Switzerland and Norway and Vulnerable in the United Kingdom. In France, it is protected at regional level in Alsace, Midi-Pyrénées, Provence-Alpes-Côte d'Azur, Rhône-Alpes and Limousin."

### Introduced

From Catling et al. (2003):

"Apparently the reports of *H. morsus-ranae* from Australia and Japan (Holm et al. 1979) are based on material referable to *H. dubia*."

"It was introduced to ponds in the arboretum beside Dows Lake, Ottawa, in 1932, the stock having originated from the Zürich Botanical Garden in Switzerland (Dore 1968)."

GISD (2018) lists *Hydrocharis morsus-ranae* as alien, invasive, and established in Canada.

## Means of Introduction Outside the United States

From Nault and Mikulyuk (2009):

"The population grew at the original site without incident until 1939, when Minshall (1940) noticed that it had spread to nearby sections of the Rideau Canal and Brown's Inlet, a nearby artificial pond with underwater connections to the Canal. By 1952 a population was collected from the Ottawa River at Montreal Island, either as a result of floating plant material traveling and establishing downstream, or perhaps the result of a separate introduction from specimens which escaped confinement from the Montreal Botanic Garden or McGill University (Minshall and Scarth, 1952; Catling and Dore, 1982; Dore, 1968)."

"*H. morsus-ranae* can be spread accidentally to new locations by the movement of boats, trailers, nets, sea planes, and other recreational equipment between water bodies (Jacono, 2009). Taking plants from an existing wetland in order to restore another wetland may also possibly introduce exotic species to a new location (Catling et al., 2003). *H. morsus-ranae* can also be a 'hitchhiker' plant with other species ordered through water garden catalogs. Plants can also be accidentally introduced to new locations by ornamental ponds flooding into surrounding natural waterways. In addition, it is possible that *H. morsus-ranae* has been introduced through hobbyists emptying unwanted aquarium species directly into surrounding waterways."

"The trade of this plant as an aquarium plant through the internet and mail order has greatly increased its availability and ease of spread into new environments. In addition, some new colonies of *H. morsus-ranae* may have been started intentionally by duck hunting clubs, which introduced the plant to provide food and cover for waterfowl (Catling and Dore, 1982)."

## Short Description

From Nault and Mikulyuk (2009):

"*H. morsus-ranae* is a free-floating stoloniferous herbaceous perennial aquatic plant that can grow to be 0.1-1.5m across, with individual rosettes measuring 1-30 cm (Catling et al., 2003). […] The roots are usually unbranched, unattached to the substrate, up to 50 cm long, and change color from green to white as they develop and form numerous long root hairs. […] winter buds (turions) are […] ellipsoidal to oval, 5-7 (-9) mm long with a distinct abscission layer. The leathery circular to heart shaped floating leaves are entire, have an indented (cordate) base, and are often dark purple underneath. The floating leaves are 1.2-6 cm long, 1.3-6.3 cm wide, and have a conspicuous aerenchyma on the undersurface near the midvein, with all veins arising from the base. The petioles are slender, 6-14 cm long, with two free lateral stipules up to 2.5 cm long at the petiole base."

"The flowers are unisexual, with the male flower arising from a spathe consisting of two bracts, each 1-1.2 cm long on a 0.7-5.5 cm long peduncle. The (1-) 2-5 flowers within each spathe have pedicels up to 4 cm long, white to greenish-white sepals 4-5.5 mm long, and broadly obovate to orbicular white petals 9-19 mm long. Each flower has 9-12 stamens, each 2-3.5 mm long in four whorls, with the two outer whorls being fully fertile, and the inner whorls sterile or partly sterile. The anthers are each 1 mm long, with the pollen approximately 15 Fm (Scribailo and Posluszny, 1984) to 21-39 Fm in diameter (Cook and Lüönd, 1982). The pollen is rounded, radiosymetric, without apertures, and covered with spines."

"The female flowers are borne on peduncles up to 9 cm long, with greenish-white sepals 4-5mm long, and obovate to orbicular pinkish-white petals 10-15 mm long. The flowers have simple bifurcate or bifid staminodes, and 6 stigmas up to 5 mm long, divided to ¼-⅔ of their length. The seeds are approximately 1 mm long, transversely elliptic, covered with stout blunt processes, each with a spiral pattern on the outer surface (Cook and Lüönd, 1982)."

## Biology

From Catling et al. (2003):

"Generally, the peak period of flowering in North America is from the middle of July to the middle of August, based on herbarium data. Scribailo and Posluszny (1984) observed first flowering by June 15th at Rondeau Park (at the southern limit of the present North American range) with maximum flowering in mid-July, and little after mid-August."

"In natural situations the turions germinate from late April to early May in southeastern Ontario and small rosettes rise to the surface (Ridley 1930; Sculthorpe 1967; Dore 1968a; Richards and Blakemore 1975; Catling and Dore 1982; Cook and Lüönd 1982). By mid-May plants are well developed or fully grown rosettes. Large clonal mats are then produced by elongation of flexible, tough stolons and rapid development of terminal buds into new rosettes, which in turn send out more stolons (Scribailo and Posluszny 1983). By early June most plants have developed into three rosettes joined by stolons and by mid- to late June the original turion will often have given rise to six rosettes. Stolons elongate rapidly during the summer and turions 5–7 mm long (modified overwintering stolon buds) develop in late summer and autumn at the tips of short appendages arising from nodes along the stolon. These turions separate from the plant in the late fall and descend to the bottom where they overwinter for seven months (beneath ice for three and one-half months) before germinating in April (Ridley 1930; Sculthorpe 1967; Dore 1968a; and Catling and Dore 1982)."

"The conspicuous white flowers, which last for a single day, are emergent and unisexual, the males arising consecutively in a cymose inflorescence and the females solitary. […] Both male and female flowers produce a sweet nectar and scent, and are visited by a wide variety of insects (Scribailo and Posluszny 1984)."

"Flowering is irregular and some colonies fail to flower in certain years. Often only one sex is represented in an entire colony so the chance of producing seeds is very limited (Catling and Dore 1982). There is also evidence that as the mat of floating plants becomes denser more flowers are produced and that there is a skewing of the sex ratio toward the production of male inflorescences (Burnham 1999). However, Dore (1968) has observed some colonies near Ottawa where both sexes were plentiful and abundant fruits were forming in mid-August, presumably yielding good seeds by autumn. Burnham (1999) also reported high seed production (2000–3000 seeds per $m^2$) in the Lake Opinicon population near Kingston, but he confirmed the earlier study by Scribailo and Posluszny (1983) that few seedlings were incorporated into the population and if they did survive they tended to grow rather poorly compared to the turions. Even though the Lake Opinicon population produced less than half as many turions as seedlings (Burnham 1999) it is clear that most production of new plants in the spring, is from turions (Catling and Dore 1982; Cook and Lüönd 1982)."

From Nault and Mikulyuk (2009):

"*H. morsus-ranae* reproduces primarily vegetatively by means of strong stolons and the productions of turion winter buds. It is estimated that a single plant can form approximately 100 to 150 turions (Scribailo and Posluszny, 1984; Dore, 1968). *H. morsus-ranae* also has the ability to reproduce sexually, though reproduction by seeds is rarely reported (Catling et al., 2003), and probably is of limited importance in the spread of the species (Scribailo and Posluszny, 1984). The fruit is a globose berry containing up to 74 seeds, with an average of 26-42 seeds (Scribailo and Posluszny, 1985)."

## Human Uses

From Catling et al. (2003):

"*Hydrocharis morsus-ranae* has proven to be a useful experimental plant for physiological and developmental studies because of its large, clear, unicellular root hairs, ease of cultivation, and regular organogensis (Minshall and Scarth 1952, Minshall 1959, Cutter 1963, Cutter 1964, Cutter and Feldman 1970a, b). Its significance in phytosociological work as an indicator species is summarized by Weber-Oldecop (1969) and Podbielkowski and Tomaszewicz (1974). It is readily eaten by grass or amur carp (*Ctenopharyngodon idella* Val.), ducks and other water birds, rodents, and water snails, and is a food plant for numerous insects (Bernatowicz and Wolny 1969; Catling and Dore 1982; Catling and Spicer, personal observation). In Europe it is reported to be eaten by beavers (*Castor fiber*) and a Russian study found that chemical elements in the plants did not reach toxic levels (Sviridenko et al. 1988), but toxicity could depend on the extent of water pollution. In association with other aquatic vegetation it provides cover for insects and fish (Nichols and Shaw 1986). Unlike the situation in North America, where community dominance may be permitted by escape from pathogens and predators, *H. morsus-ranae* has declined or is extirpated in parts of its European range and is a conservation concern for reintroduction. In the UK, it has declined in natural habitats but has been reported in canals well outside its native range (Preston and Croft 1997)."

"Material of *Hydrocharis morsus-ranae* collected in early June had crude protein levels of 22–24%, suggesting a potential value as a forage and compost. Along with other aquatics, it may have a potential for use in removal of nitrogen and phosphorus from waste water (Reddy 1984), and in the general protection of water quality (e.g., Karpati et al. 1985)."

From GISD (2018):

"The Canadian Wildlife Service (2003) states that, \"In 1932 *H. morsus-ranae* was intentionally introduced for horticultural purposes to a trench or aquatic pond in the Arboretum of the Central Experimental Farm in Ottawa.\" Catling et al. (2003) states that, \"*Hydrocharis morsus-ranae* is a food plant for several water birds, rodents, fish and insects.\""

## Diseases

From Catling et al. (2003):

"No plant disease fungi were listed on *H. morsusranae* in Canada by Ginns (1986). *Hydrocharis morsusranae* is reported as a host to a number of rusts, smuts and molds (including *Aecidium hydrocharidis* Rab., *Doassansia reukaufii* P. Henn., *Tracya hydrocharitis* Lagerh., *Dactylium morsus-ranae* (Cda) Sacc. and *Penicillium morsus-ranae* Cda) in the older literature (see Oudemans 1919, p. 680 for details). Other fungi (e.g., *Mollisia poae* (Fuck.) Sacc. and *Sclerotium hydrophilum*) reported on the plant in early literature may be non-parasitic or misidentified. *Ascochyta kirulisii* Rupprecht has been described from *H. morsus-ranae* in Latvia (Rupprecht 1959, Punithalingam 1988). *Tracya hydrocharidis* was recently reported on *H. morsus-ranae* throughout much of the Eurasian range including Czechoslovakia (Zundel 1953), Finland (Zundel 1953, Kari 1957), Germany (Zundel 1953; Vanky 1985; Scholz and Scholz 1988; Hirsch and Braun 1980), Iran (Vanky and Ershad 1993), Romania (Mordue 1986), Sweden (Zundel 1953; Vanky 1985; Lindeberg 1959; Mordue 1986) and Switzerland (Hirsch and Braun 1980)."

## Threat to Humans

No information on threats to humans from *Hydrocharis morsus-ranae* was found.

# 3 Impacts of Introductions

From Halpern (2017):

"When samples from all the wetland sites were combined, the negative correlations between *H. morsus-ranae* and diversity and species richness were significant, but very weak."

"These findings contradict the experiment conducted by Catling et al. (1988), which found that diversity and surface coverage of submerged macrophytes was lower under mats of *H. morsus-ranae*. The discrepancy between experimental and observed effects of *H. morsus-ranae* on species richness and diversity may simply be a function of surface coverage. In this survey, *H. morsus-ranae* coverage was predominantly less than 75%, whereas the experiment conducted by Catling et al. (1988) utilized floating *H. morsus-ranae* mats that typically have a 100% surface coverage, which block available light to submerged macrophytes."

From Catling et al. (2003):

"Detrimental effects include those relating directly to human activities and those influencing native biodiversity. In Ontario, Quebec and northern New York, *H. morsus-ranae* has become a nuisance in some areas as a result of the development of large free-floating mats of intertwining plants that limit water traffic and inhibit recreational activities such as swimming and fishing. It also limits water flow in ditches, slow rivers and streams. Negative impacts on humans can result in additional detrimental effects as a result of attempted control, especially through the use of chemicals (Cassie 1966; Newman 1968; Wilson and Bond 1969; Robinson 1971; Walsh et al 1971; Way et al 1971; Brooker and Edwards 1973; Arthofer 1974; Newbold 1975; Watkins et al. 1983). All aquatic plants at a site, including beneficial species, may be eliminated through chemical treatment. Species of fauna dependent on vegetation cover to avoid predation become vulnerable when that cover is destroyed (Huffaker 1958). Removal of vegetation over a long period lowers oxygen tensions of the water, sometimes below levels that certain vertebrate and invertebrate animals are able to tolerate (Newbold 1975). Some herbicides persist in the substrate resulting in accumulation of residues (e.g., Coats 1965; Frank and Comes 1967; Burns and Audus 1970; and Ogg 1972). Other problematic aspects of aquatic plant control using herbicides have been discussed in earlier Biology of Canadian Weeds articles (i.e., Catling and Dobson 1985; Spicer and Catling 1987a). In most Canadian provinces a license or permit is required to control aquatic weeds with herbicides. Other control measures, including drawdown and mechanical harvesting (see section 12) may also be accompanied by adverse environmental effects."

"*Hydrocharis morsus-ranae* was one of the first invasive aquatics to be studied with regard to biodiversity impacts. It was shown that dense floating mats of *H. morsus-ranae* reduced growth of native submersed aquatic plants (Catling et al. 1988). Furthermore, the native flora appeared to support a greater diversity of native aquatic animals than the floating mats of *H. morsus-ranae* that replaced it (personal observation). It has been frequently observed that *H. morsus-ranae* is often dominant where it occurs, evidently occupying space that would otherwise be occupied by a variety of native species (e.g., Dore 1968a, Catling and Dore 1982, White 1985, 1989; Catling et al. 1988, Catling, personal observation)."

From GISD (2018):

"The Canadian Wildlife Service (2003) states that, \"Because of the dense floating mat of vegetation produced by *H. morsus-ranae*, available light, dissolved gases, and nutrients were restricted to submerged aquatics attempting to grow beneath this mat. The plant is often a dominant species in the wetlands within which it occurs. By dominating wetlands with its thick mats, *H. morsus-ranae* displaces native flora and is perhaps impacting the fauna. With *H. morsus-ranae* dominating the open water portions of a wetland and purple loosestrife dominating the relatively drier portions, such wetlands are receiving a double blow that could dramatically reduce their original biodiversity.\"
Catling et al. (2003) states that, \"Extremely rapid stoloniferous growth during the summer months results in the formation of large masses of interlocking plants that diminish native submerged aquatic plant communities by reducing available light. It is also of importance in limiting water flow in irrigation systems and restricting water traffic, thereby hindering recreational activity.\""

From Jacono and Berent (2018b):

"The free-floating form can lead to densely tangled floating mats, which can crowd and shade out native aquatic vegetation (Catling et al. 2003, Grant 2013). Populations of *H. morsus-ranae* can also compete for nutrients and gases; further reducing the growth of nearby vegetation (Lui et al. 2010). There was a 95% decline submerged vegetation species below mats of *H. morsus-ranae* (Catling et al. 1988 in Mudrzynski et al. 2011)."

"As colonies *H. morsus-ranae* displace native plants; other native aquatic life experience a reduction in food and habitat (Environment Canada 2003, WI DNR 2012). Dense mats can inhibit the movement of waterfowl or larger fish; which could alter predator/prey cycles as the waterfowl and fish move to other locations to find food (O'Neill Jr. 2007, University of Minnesota, Wisconsin Sea Grant Institute 2012). Catling et al. (1988) surveyed live *H. morsus-ranae* mats and found a decline in snails, crustacean, and insect larvae (in Mudrzynski et al. 2011)."

"Large infestations of *H. morsus-ranae* have reduced water currents in canals and irrigation systems (Catling et al. 2003). Dense layers of tangled stems and roots can wrap about boat propellers and impede water traffic (Lui et al. 2010, University of Minnesota Wisconsin Sea Grant Institute 2012). Large populations of common frogbit also limit recreational activities such as swimming, fishing, and waterfowl hunting (Grant 2013, Lui et al. 2010, University of Minnesota Wisconsin Sea Grant Institute 2003)."

From NatureServe (2018):

"Catling et al. (1988) provided statistical evidence showing that mats cause significant declines in co-occurring native plant species. The cover value for aquatic animals greatly declines in infested areas because of suppressed growth of submerged vegetation (INDNR 2005), and mats can also hinder the movement of fish and waterfowl (WIDNR 2005)."

# 4 Global Distribution

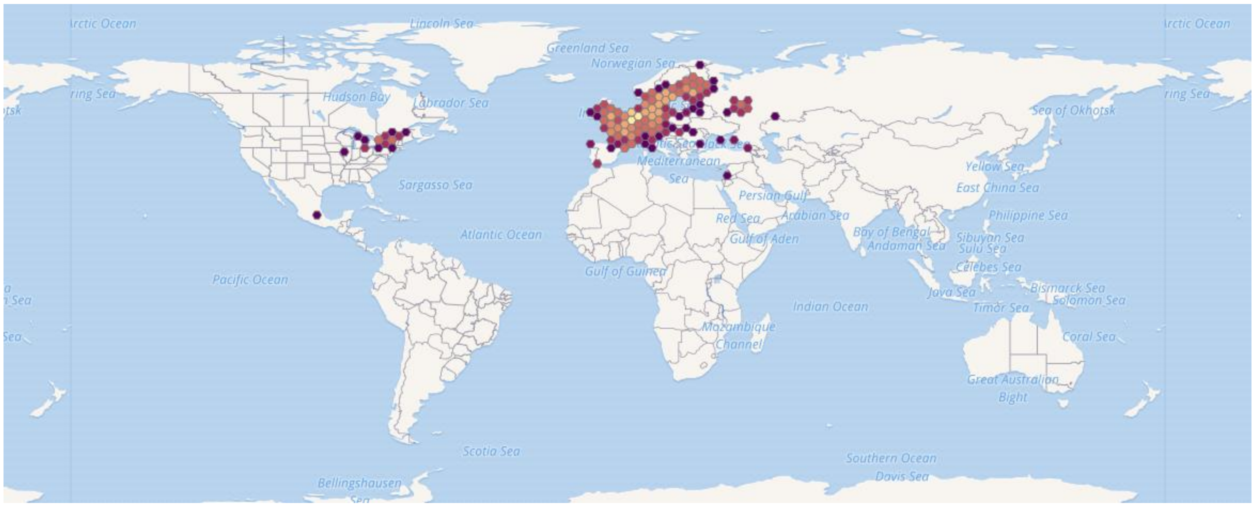


**Figure 1**. Known global distribution of *Hydrocharis morsus-ranae*. Locations are in North America, Europe, and western Asia. Map from GBIF Secretariat (2018).

The location in Mexico was not used as a source point for the climate match. The record is from a citizen scientist biodiversity program and the accompanying images could not be used to definitely identify the species (GBIF Secretariat 2018). There are no other records of this species present in the wild in Mexico.

# 5 Distribution Within the United States

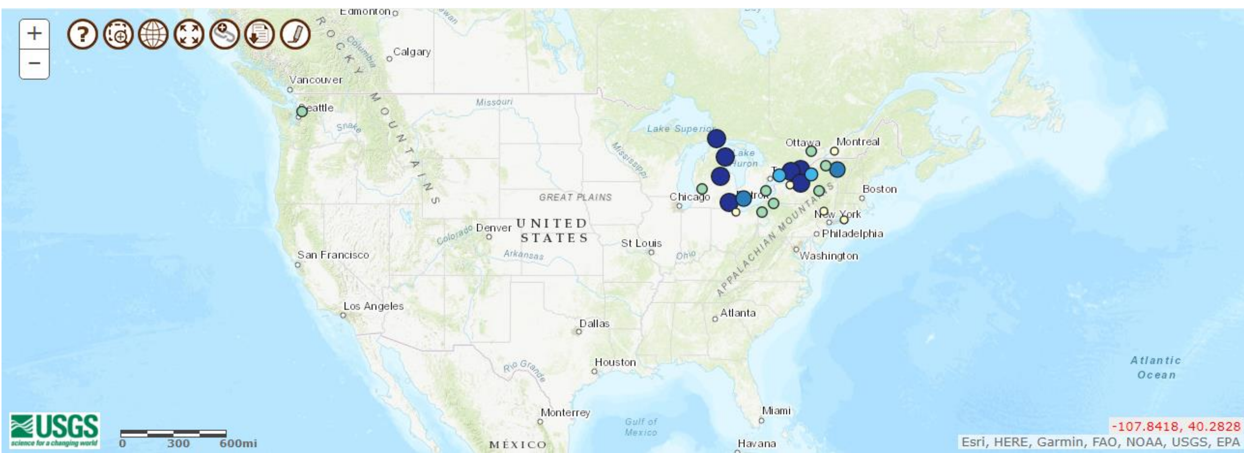


**Figure 2**. Known distribution of *Hydrocharis morsus-ranae* in the United States. Map from Jacono and Berent (2018a).

# 6 Climate Matching

## Summary of Climate Matching Analysis

The climate match for *Hydrocharis morsus-ranae* was high in the Northeast and Great Lakes Basin. There are already established populations in much of the Northeast. It was also high in small areas of the Great Plains and West Coast. Florida, areas of southern Texas, and parts of the southwest had a low match. All other areas had a medium match. The Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.496, high. The range for a high climate score is 0.103 and higher. All States had high individual climate scores except for Alabama, Florida, Georgia, Mississippi and South Carolina which had medium individual scores, and Louisiana and Texas which had low individual scores.

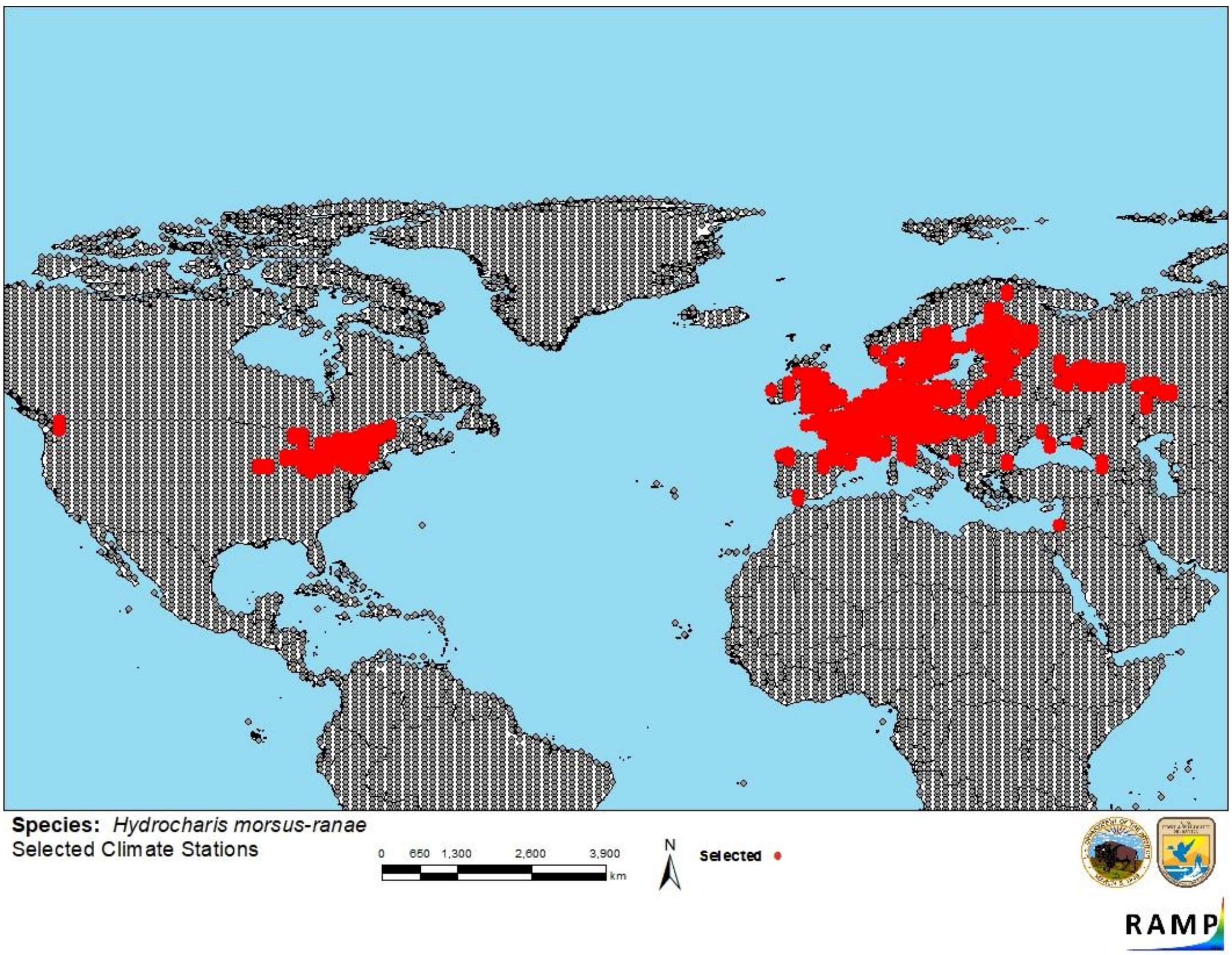


**Figure 3**. RAMP (Sanders et al. 2018) source map showing weather stations in North America, Europe, and western Asia selected as source locations (red) and non-source locations (gray) for *Hydrocharis morsus-ranae* climate matching. Source locations from GBIF Secretariat (2018) and Jacono and Berent (2018a).

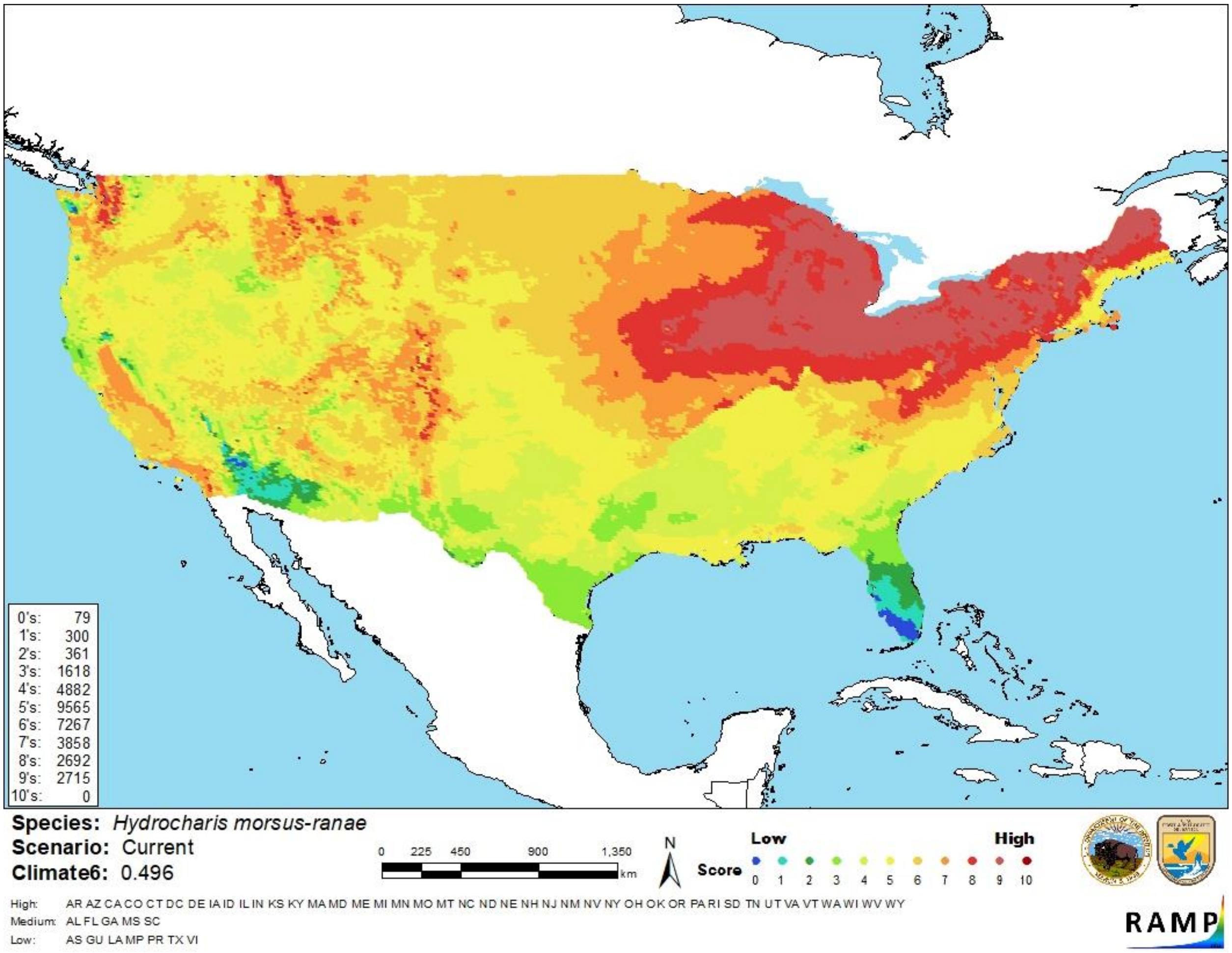


**Figure 4**. Map of RAMP (Sanders et al. 2018) climate matches for *Hydrocharis morsus-ranae* in the contiguous United States based on source locations reported by GBIF Secretariat (2018) and Jacono and Berent (2018a). 0 = Lowest match, 10 = Highest match.

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

| Climate 6: Proportion of<br>(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 |

# 7 Certainty of Assessment

Certainty of assessment is medium. Information on the biology, invasion history and impacts of this species is minimal, source from a combination of peer-reviewed literature and agency reports. The impact information comes from some peer-reviewed literature and scientific databases. Some results presented in the literature are contradictory in the magnitude of impact but mainly indicate that magnitude of impact is directly related to the extent of the invasion.

# 8 Risk Assessment

## Summary of Risk to the Contiguous United States

European frogbit (*Hydrocharis morsus-ranae*) is a floating-leaved aquatic plant native to parts of Europe and Asia that is popular in water gardens. The history of invasiveness for *H. morsus-ranae* is high; it has been introduced in Canada and the United States as an ornamental plant. *H. morsus-ranae* is capable of supplanting native plants to create monocultures in some areas. Those monocultures remove habitat and food sources for native animals and may have an impact on water quality. Dense, invasive populations also hinder commercial and recreational uses of waterways. The climate match is high. The areas of highest match are centered on already established *H. morsus-ranae* populations in the Northeast, Great Lakes, and Pacific Northwest. However, the climate match did show areas of high match that do not have currently established populations, indicating that the climate exists to support further spread of this species. The certainty of assessment is medium. The overall risk assessment category is high.

## Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Medium**
- **Remarks/Important additional information:** No additional information.
- **Overall Risk Assessment Category: High**

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


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