Taxon: Hydrocharis morsus-ranae **Family:** Hydrocharitaceae

Common Name(s): common frogbit
European frog's-bit

Synonym(s): Hydrocharis asarifolia Gray
Hydrocharis batrachyodegma St.-Lag.
Sagittaria triflora Miq.

Assessor: Chuck Chimera **Status:** Assessor Approved **End Date:** 22 Sep 2015

WRA Score: 18.0 **Designation:** H(HPWRA) **Rating:** High Risk

Keywords: Naturalized, Aquatic Weed, Smothering, Vegetative, Water-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	Intermediate
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	y
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	n
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	y
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	y
302	Garden/amenity/disturbance weed	n=0, y = 1*multiplier (see Appendix 2)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	y
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	y
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic	y=1, n=0	n
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals		
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
408	Creates a fire hazard in natural ecosystems	y=1, n=0	n
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	n
411	Climbing or smothering growth habit	y=1, n=0	y
412	Forms dense thickets	y=1, n=0	y
501	Aquatic	y=5, n=0	y
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	y
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally		
604	Self-compatible or apomictic	y=1, n=-1	n
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	1
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	y
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant		
704	Propagules adapted to wind dispersal	y=1, n=-1	n
705	Propagules water dispersed	y=1, n=-1	y
706	Propagules bird dispersed		
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut		
801	Prolific seed production (>1000/m2)		
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	**Is the species highly domesticated?**	**n**
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	No evidence

102	**Has the species become naturalized where grown?**	
	Source(s)	**Notes**
	WRA Specialist. 2015. Personal Communication	NA

103	**Does the species have weedy races?**	
	Source(s)	**Notes**
	WRA Specialist. 2015. Personal Communication	NA

201	**Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"**	**Intermediate**
	Source(s)	**Notes**
	USDA, ARS, National Genetic Resources Program. 2015. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov/. [Accessed 22 Sep 2015]	"Native: AFRICA Northern Africa: Algeria; Morocco ASIA-TEMPERATE Western Asia: Iran; Turkey Caucasus: Azerbaijan Siberia: Russian Federation - Eastern Siberia, Western Siberia Middle Asia: Uzbekistan EUROPE Northern Europe: Denmark; Finland; Norway; Sweden; United Kingdom Middle Europe: Austria; Belgium; Czech Republic; Germany; Hungary; Netherlands; Poland; Slovakia East Europe: Belarus; Estonia; Latvia; Lithuania; Moldova; Ukraine Southeastern Europe: Albania; Bulgaria; Croatia; Greece; Italy; Macedonia; Romania; Serbia; Slovenia Southwestern Europe: Portugal; Spain"

Qsn #	Question	Answer
202	**Quality of climate match data**	**High**
	Source(s)	**Notes**
	USDA, ARS, National Genetic Resources Program. 2015. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov/. [Accessed 22 Sep 2015]	

203	**Broad climate suitability (environmental versatility)**	**y**
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Climatic requirements—With its wide Eurasian distribution (Cook and Lüönd 1982), H. morsus-ranae is clearly adapted to a wide range of climatic conditions. Since it already occurs in North America from Point Pelee to Quebec City, the genotype(s) of European Frogbit established in North America appear to have a broad climatic tolerance. It has now colonized portions of two major ecozones of Canada and 5 ecoregions (Wiken 1986, National Atlas Information Service 1993; Ecological Stratification Working Group 1995)."

204	**Native or naturalized in regions with tropical or subtropical climates**	**n**
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Hydrocharis morsus-ranae is a common plant in temperate regions of Eurasia. Cook and Lüönd (1982) defined its native distribution as including western and central Europe extending from Portugal, western France and the British Isles, north to southern Sweden and southern Finland, and south to northern Italy. In eastern Europe, there are scattered records to 40°E, while in neighbouring Asia it is sparingly represented in Turkey, the Caucasus and south shore of the Caspian Sea (Assadi and Wendelbo 1977). Isolated collections have been reported from central Siberia and Kazakhstan (Cook and Lüönd 1982). Apparently the reports of H. morsus-ranae from Australia and Japan (Holm et al. 1979) are based on material referable to H. dubia."

205	**Does the species have a history of repeated introductions outside its natural range?**	**y**
	Source(s)	**Notes**

Qsn #	Question	Answer
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"The introduction and dramatic spread of H. morsus-ranae in North America are well documented (Minshall 1940; Louis-Marie 1958; Dore 1968a, b; Reddoch 1976; Scoggan 1978; Roberts et al. 1981; Catling and Dore 1982; Cook and Lüönd 1982; Cook 1985; Fleurbec 1987; Lumsden and McLachlin 1988; Gleason and Cronquist 1991; Catling and Porebski 1995; Crowe and Hellquist 2000; Daniels 2000; United States Geological Survey 2000). Its present North American distribution (Fig. 4) extends from Quebec City, south along the St. Lawrence to Lake Ontario, Lake Erie and Lake St. Clair, to the Lake Champlain area of Vermont, and west along the Trent, Rideau and Ottawa Rivers, and inland in lakes and marshes up to 50 km from these major water bodies. Its range extends over southwestern Quebec, southern Ontario, southeastern Michigan, northern New York and northern Vermont (United States Geological Survey 2000). It is also established in the state of Washington (J. Parsons, personal communication). A location in central Quebec shown by a Flora of North America volume (Haynes 2000) actually represents occurrence along the southern border of the province."

301	Naturalized beyond native range	y
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"European frog-bit (Hydrocharis morsus-ranae L.), a free-floating, stoloniferous aquatic, is native to Europe and parts of Asia and Africa. It was discovered in Canada in 1932 in Ottawa, but earlier introduction is possible. By 1955 its North American distribution extended from Ottawa to Montreal. By 1980 it had extended southwest to Lake Ontario and northeast to Quebec City. Recently it has spread throughout much of the central and southwestern parts of southern Ontario, and further into northern New York and Vermont and eastern Michigan."

302	Garden/amenity/disturbance weed	n
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	Weed with economic & environmental impacts

303	Agricultural/forestry/horticultural weed	y
	Source(s)	**Notes**

Qsn #	Question	Answer
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Impacts fisheries & recreation] "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."

304	Environmental weed	y
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Detrimental effects include those relating directly to human activities and those influencing native biodiversity." ... "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)." ... "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). The impact of H. morsus-ranae has been recognized by many agencies at both provincial and national levels. It is one of five invasive alien plants that has been reported to have had a major impact on natural ecosystems in Canada (Mosquin and Whiting 1992). It was also featured as one of six principal invasive aliens (including Myriophyllum spicatum, Butomus umbellatus, Rhamnus frangula, Lythrum salicaria and Phalaris arundinacea) of wetland habitats in Canada (White et al. 1993). Several recent reports have considered it a high priority for management due to exclusion of native species and potential impacts on native ecosystems (e.g., Dunster 1990)."

305	Congeneric weed	y
	Source(s)	**Notes**

Qsn #	Question	Answer
	Randall, R.P. 2012. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	"Hydrocharis dubia (Blume) Backer Hydrocharitaceae Cultivated Aquatic - Refs: 10 1207-A, 914-N, 648-A, 431-W, 297- EW, 286-W, 275 -AE, 209-A, 204-EW, 87-W"
	Bean, A. R. (2011). Hydrocharis dubia (Blume) Backer (Hydrocharitaceae) is an alien species in Australia. Austrobaileya, 8(3): 435-437	[Impacts unspecified] "Hydrocharis dubia fails all of the ecological criteria for an indigenous species, and the historical criteria are equivocal. In the key of Bean (2007) it readily keys to "alien" (1x, 2). In conclusion, there is a strong weight of evidence to support an alien status for Hydrocharis dubia with regard to its occurrences in Australia. I recommend that this species be recorded as naturalised for Australia, and de-listed from the Queensland Nature Conservation Act 1992, and the Environment Protection and Biodiversity Conservation Act 1999."

401	Produces spines, thorns or burrs	n
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[No evidence] "Description. Free-floating, perennial, stoloniferous aquatic 0.1–1.5 m across, the individual rosettes 1–30 cm. The plant is mostly dioecious, rarely with both sexes on the same rosette but on different ramets within a genet (Scribailo and Posluszny 1984). Roots are usually unbranched, up to 50 cm long, green initially, becoming white and developing numerous long root hairs. Stolons do not fragment readily. Winter buds (turions) are produced in the autumn on the stolons, ellipsoidal, 5–7 (–9) mm long with a distinct abscission layer, detaching and sinking before winter, overwintering and germinating in the spring (Catling, personal observation; see also Rüter 1918). Turions develop into a single root initially. Leaves are floating, circular in shape with an indented (cordate) base, entire, 1.2–6 cm long, 1.3–6.3 cm wide, with conspicuous aerenchyma on the undersurface near the midvein, and with all venation arising from the base. Petioles are slender, 6–14 cm long, with two free, lateral stipules up to 2.5 cm long at the petiole base."

402	Allelopathic	n
	Source(s)	**Notes**

Qsn #	Question	Answer
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[No evidence] "(c) Communities in which the species occurs—Aquatic habitats containing emergent plants such as rushes and cattails and other plants with floating leaves (Fig. 5) are favored because they offer a measure of protection from currents, winds and waves (Gurney 1949; Podbielkowski and Tomaszewicz 1974; Catling and Dore 1982). Plants commonly associated with H. morsus-ranae include Typha spp., Phragmites australis (Cav.)Trin., Sparganium spp., Lemna spp., Nymphaea spp., Hottonia inflata Ell., Pontedaria cordata L., Nuphar variegata L., Butomus umbellatus L. Sagittaria spp., Equisetum fluviatile L., and Myriophyllum spp. (Dore 1954; Weber-Oldecop 1969; Podbielkowski and Tomaszewicz 1974; Catling and Dore 1982; Cook and Lüönd 1982; Lumsden and McLachlin 1988). In eastern Ontario the plants most frequently associated with H. morsus- ranae are Lemna minor L., Myriopyllum sibiricum Kom., Myriophyllum spicatum L., Potamogeton pusillus L., Potamogeton vaseyi Robb., Spirodela polyrhiza (L.) Schleid., Typha latifolia L. and Utricularia vulgaris L. (Catling et al. 1988, Spicer and Catling 1987b). The syntaxonomic position of communities dominated by European frogbit, i.e., Hydrocharitetum morsus-ranae, is discussed by Podbielkowski and Tomaszewicz (1974), who classified it in the alliance Nympaeion—class Potametea."

403	Parasitic	n
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Description. Free-floating, perennial, stoloniferous aquatic 0.1–1.5 m across, the individual rosettes 1–30 cm." [Family: Hydrocharitaceae. No evidence of parasitism]

404	Unpalatable to grazing animals	n
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"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."

405	Toxic to animals	
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[May depend on water pollution] "...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."

406	Host for recognized pests and pathogens	

Qsn #	Question	Answer
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Impacts of fungi on other plants unknown] "Fungi—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). (b) Bacteria— No bacteria have been recently recorded on H. morsus-ranae. (c) Viruses— No viruses have been recently recorded on H. morsus-ranae. Higher Plant Parasites—There are no reports of higher plant parasites on H. morsus-ranae."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"...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."
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[No evidence. Aquatic] "Free-floating, perennial, stoloniferous aquatic 0.1–1.5 m across, the individual rosettes 1–30 cm."

Qsn #	Question	Answer
409	**Is a shade tolerant plant at some stage of its life cycle**	**n**
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Investigations into the effect of light on the extension growth of roots of H. morsus-ranae by Minshall (1959) indicated a 90% growth reduction when light was excluded. He suggested that the major source of energy for root growth, the photosynthetic assimilation of carbon, originates from green roots and these roots therefore, unlike roots of most plants, may prove to be autotrophic for their supply of carbohydrates."

410	**Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)**	**n**
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Substratum—Podbielkowski and Tomaszewicz (1974) maintain that an organic substrate is necessary for development and there is an avoidance of waters with a mineral substrate, such as clay pits or fish ponds. Because it is essentially a free-floating aquatic plant, although sometimes rooting in soft mud or lodged in shoreline debris (Gluck 1906), H. morsus-ranae is usually found in sheltered bays or inlets of larger lakes and rivers, ponds, beaver dams, sluggish creeks, canals, ditches and other sites protected from wind and wave action (Catling and Dore 1982; and Cook and Lüönd 1982)."

411	**Climbing or smothering growth habit**	**y**
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Smothering habit] "Cook and Lüönd (1982) describe frogbit as usually gregarious, often found in large numbers covering the surface of the water and occasionally overlapping in dense mats"

412	**Forms dense thickets**	**y**
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Forms dense mats] "Cook and Lüönd (1982) describe frogbit as usually gregarious, often found in large numbers covering the surface of the water and occasionally overlapping in dense mats. From a single turion a plant may grow to cover an area of approximately 1 m2 in diameter in only one season (Cook and Lüönd 1982; P. Catling, personal observation). The tough and flexible stolons of H. morsus-ranae become interwoven, effectively binding large masses of plants into a network (Fig. 3) that excludes light and probably also nutrients from submerged species (Dore 1968a; Catling et al. 1988), possibly reducing competition and thus explaining the observed population stability."

501	**Aquatic**	**y**

Qsn #	Question	Answer
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Description. Free-floating, perennial, stoloniferous aquatic 0.1–1.5 m across, the individual rosettes 1–30 cm."

502	Grass	n
	Source(s)	**Notes**
	USDA, ARS, National Genetic Resources Program. 2015. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov/. [Accessed 22 Sep 2015]	"Family: Hydrocharitaceae subfamily: Hydrocharitoideae"

503	Nitrogen fixing woody plant	n
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Free-floating, perennial, stoloniferous aquatic 0.1–1.5 m across, the individual rosettes 1–30 cm."

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Roots are usually unbranched, up to 50 cm long, green initially, becoming white and developing numerous long root hairs. Stolons do not fragment readily."

601	Evidence of substantial reproductive failure in native habitat	y
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"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)."

602	Produces viable seed	y
	Source(s)	**Notes**

Qsn #	Question	Answer
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"...H. morsus-ranae does not depend on seed formation as a principal means of reproduction and dispersal. The plant dies in the autumn, overwintering as either an oval or ellipsoidal turion or less often as a seed (Cook and Lüönd 1982)." ... "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." ... "Viability of seeds and germination—When the temperature reaches 15°C or above, seed germination takes place (Serbanescu-Jitariu 1972). Information regarding germination and viability of seeds is not available. Scribailo and Posluszny (1985a) germinated seeds under experimental conditions but they reported only two seedlings in the wild. Similar seed germination experiments were attempted by Burnham (1999) and he found that the most successful germination (69%) occurred after the seeds were stored for 16 months and then exposed to high light levels. As with Scribailo and Posluszny, Burnham found few germinated seedlings in the wild. Floating seedlings are difficult to distinguish from the duckweeds, Lemna minor and Spirodela polyrhiza, and may be overlooked easily."

603	Hybridizes naturally	
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Unknown. Do not occur together naturally] "Hydrocharis morsus-ranae is a recent introduction to North America and is the only species of Hydrocharis naturalized in Canada and the United States. In fact, Cook and Lüönd (1982) have shown that the three species, H. morsus-ranae L., H. dubia (Blume)Backer, and H. chevalieri (DeWildeman) Dandy, although widely distributed throughout the world, are widely separated geographically, allowing no opportunity for hybridization."

604	Self-compatible or apomictic	n
	Source(s)	**Notes**
	Scribailo, R. W., & Posluszny, U. (1984). The reproductive biology of Hydrocharis morsus-ranae. I. Floral biology. Canadian Journal of Botany, 62(12): 2779-2787	"Fruit-sets were 38.3% in naturally pollinated flowers, 96.5% in bagging experiments with hand pollinations, and absent in bagging experiments for agamospermy with unopened flowers. These results substantiated that poor fruit-set in some populations was caused by a lack of effective pollinators."
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"The plant is mostly dioecious, rarely with both sexes on the same rosette but on different ramets within a genet (Scribailo and Posluszny 1984)."

605	Requires specialist pollinators	n

Qsn #	Question	Answer
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Floral Biology—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. Corollas begin opening soon after dawn and are fully open by late morning, with both anther dehiscence and stigma receptivity reaching a maximum by midday. Both male and female flowers produce a sweet nectar and scent, and are visited by a wide variety of insects (Scribailo and Posluszny 1984). At a study site in Rondeau Park, southwestern Ontario, the most abundant visitors were Homoptera (Aphidae) and Hydrellia and Notiphila spp. (Diptera:Syrphidae), but more specialized hover flies (Toxomerus marginatus Say (Diptera : Syrphidae)) and solitary bees (Dialictus spp. (Hymenoptera: Halictidae)) were considered to be the primary pollinators (Scribailo and Posluszny 1984). Once flowering is initiated, flowers are produced at the same rate as stolons (Brunaud 1977). See Dauman (1931, 1970) for additional information on floral biology."
	Kubitzki, K. (ed.). 1998. The Families and genera of vascular plants. Volume IV. Flowering plants, Monocotyledons: Alismatanae and Commelinanae (except Gramineae). Springer-Verlag, Berlin, Heidelberg, New York	"Insect-pollinated with enticement. The flowers have large showy petals, osmophores and nectaries; the male and female flowers are essentially alike. The genera Apalanthe, Egeria, Hydrocharis and Ottelia (Fig. 62) have sweet-smelling flowers while Stratiotes has a foul smell not unlike rotting meat. Hydrocharis is described in detail by Scribailo and Poluszny {1983)."

606	Reproduction by vegetative fragmentation	y
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"A general absence of sexual reproduction has been noted for H. morsus-ranae populations, particularly in Europe (Parlatore 1855; Lindberg 1873; Cook and Lüönd 1982). The principal means of reproduction is vegetative, through the development of stolon buds and turions (modified overwintering stolon buds) that are formed in the axil of every second leaf (Irmisch 1859; Rohrbach 1871; Loiseau and Nougarède 1963; Cutter 1964)."

607	Minimum generative time (years)	1
	Source(s)	**Notes**

Qsn #	Question	Answer
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Reproduces vegetatively in <1 year] "Turions collected in the fall and kept at room temperature over winter, germinated naturally in March of the following spring but were comparable in size to those collected outdoors one month later (P. Catling personal observation). 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). Catling and Dore (1982) refer to three localities near Ottawa and another in Ogdensberg in New York State, each having hundreds of plants per colony, in which the entire populations developed from overwintering turions rather than germinating seeds."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Various aquatic plants are spread from one water body to another on the anchors, ropes and motors of boats and on boat trailers. Hydrocharis morsus-ranae is particularly prone to this kind of spread because of its dense intertwining surface mats (Figs. 2 and 3). In order to prevent infestations of invasive aquatic plants, the state of Maine has alerted boaters by placing signs at boat launch locations and notifying them with pamphlets that they are subject to fines of up to $500 for transporting H. morsus-ranae on boats and boat trailers. It is suggested that boaters remove all plants from boats, motors, trailers and fishing equipment, before and after launching, and that plants be discarded in a trash receptacle on high, dry land away from the water. Plants may also be spread by dumping bait buckets containing water from infested locations into non-infested waters. In bait buckets, the plants may be inconspicuous in the form of turions or seeds. Anglers are advised not to dump bait buckets and some sports fishing organizations have advertised the problem (Ontario Federation of Anglers and Hunters 2001)."

702	Propagules dispersed intentionally by people	y
	Source(s)	**Notes**

Qsn #	Question	Answer
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Hydrocharis morsus-ranae is also spread through the aquarium and gardening industries. It is advertised as available in various online catalogues of plants used for landscaping with water gardens, and some of the suppliers are based in North America. It is listed with 19 non-indigenous plant species of the aquarium industry that have been released into United States waters (Marine Conservation Biology Institute 1998)."

703	Propagules likely to disperse as a produce contaminant	
	Source(s)	**Notes**
	Nault, M.E. & Mikulyuk, A. 2009. European Frog-bit (Hydrocharis morsus-ranae): A Technical Review of Distribution, Ecology, Impacts, and Management. PUB-SS-1048 2009. Wisconsin Department of Natural Resources Bureau of Science Services. Madison, Wisconsin	"H. morsus-ranae can also be a 'hitchhiker' plant with other species ordered through water garden catalogs."
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Could possibly be dispersed as a produce contaminant if established with rice or taro crops, or as a contaminant of other aquatic plants] "Taking plants from an existing wetland to create or restore a wetland somewhere else may result in inadvertent movement of exotic species from an infested wetland to a new location. Consequently, some recent guides to wetland restoration draw attention to the danger of using exotics accidentally in restoration (e.g., Hagen 2001). Some new colonies of H. morsusranae may have been begun intentionally by duck-hunting clubs, which introduced them to provide food and cover for waterfowl (Catling and Dore 1982)." ... "Plants may also be spread by dumping bait buckets containing water from infested locations into non-infested waters. In bait buckets, the plants may be inconspicuous in the form of turions or seeds. Anglers are advised not to dump bait buckets and some sports fishing organizations have advertised the problem (Ontario Federation of Anglers and Hunters 2001)."

704	Propagules adapted to wind dispersal	n
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Wind drives water dispersal] "Dispersal of plants, stolon buds, and turions is achieved by winds and currents (Lumsden and McLachlin 1988) and the relatively small size of turions (ca. 1 cm long) facilitates such transport (Catling and Dore 1982)."

705	Propagules water dispersed	y
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Dehiscence takes place when internal pressure caused by the production of a thick mucilaginous substance causes the sides of the fruit to split vertically, releasing the seeds (Scribailo 1984; Scribailo and Posluszny 1984, 1985a). Seeds then float to the surface. Five weeks after peduncle recurvation, 66% of fruits in a marsh plot at Rondeau Park, Ontario, had opened, releasing the seeds."

Qsn #	Question	Answer
	Kubitzki, K. (ed.). 1998. The Families and genera of vascular plants. Volume IV. Flowering plants, Monocotyledons: Alismatanae and Commelinanae (except Gramineae). Springer-Verlag, Berlin, Heidelberg, New York	"The seeds of Hydrocharis and Limnobium germinate at the water surface; at first, the testa is shed and the seedling floats on the surface."

706	Propagules bird dispersed	
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Unknown. Possible internal dispersal by birds] "The very similar seeds of the closely related species, Limnobium spongia have been identified in the stomachs of several species of ducks but the capability of H. morsus ranae seeds to pass through the digestive tracts of waterfowl without damage is unknown (Catling and Dore 1982)." ... "Turions were found in the gullets of black ducks (Anas rubripes) but viability of turions after passing through the digestive tract was not confirmed (F.H. Uhler, personal observation)."

707	Propagules dispersed by other animals (externally)	y
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Whole plants, turions, & possibly seeds] "The viscid coating possibly promotes adhesion to waterfowl and aids in dispersal to other locations (Ridley 1930)." ... "Whole plants or portions with turions may be transported to new localities, in the feet or bills of ducks and other waterfowl (Catling and Dore 1982). Great blue herons (Ardea herodias) have been observed flying distances of 2 km with interlocking plants of H. morsus-ranae attached to their feet (P. Catling, personal observation)."

708	Propagules survive passage through the gut	
	Source(s)	**Notes**
	Kubitzki, K. (ed.). 1998. The Families and genera of vascular plants. Volume IV. Flowering plants, Monocotyledons: Alismatanae and Commelinanae (except Gramineae). Springer-Verlag, Berlin, Heidelberg, New York	"In Halophila, Hydrocharis, Limnobium, and Stratiotes the fruit is somewhat fleshy and is perhaps eaten by animals."
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Unknown] "The very similar seeds of the closely related species, Limnobium spongia have been identified in the stomachs of several species of ducks but the capability of H. morsus ranae seeds to pass through the digestive tracts of waterfowl without damage is unknown (Catling and Dore 1982)." ... "Turions were found in the gullets of black ducks (Anas rubripes) but viability of turions after passing through the digestive tract was not confirmed (F.H. Uhler, personal observation)."

801	Prolific seed production (>1000/m2)	
	Source(s)	**Notes**

Qsn #	Question	Answer
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Prolific seed production possible, but limited recruitment from seeds] "Burnham (1999) also reported high seed production (2000–3000 seeds per m2) 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)." ... "In their intensive study into the reproductive floral biology of H. morsus-ranae, Scribailo and Posluszny (1984) estimated that a minimum of 250 seeds per m2 were produced within a plot during the season at Rondeau Park, Ontario. This was based on fruit set (38.3%), floral sex ratio (8.5:1, male: female), floral density (105 m–2), average numbers of seed/fruit (32.7) and by conservatively assuming that each female ramet produced a minimum of two fruits in a season."

802	Evidence that a persistent propagule bank is formed (>1 yr)	
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Possibly. Turions persist in aquatic habitats, but longevity unknown] "The plant dies in the autumn, overwintering as either an oval or ellipsoidal turion or less often as a seed (Cook and Lüönd 1982)."

803	Well controlled by herbicides	y
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	"Hydrocharis morsus-ranae is susceptible to the herbicides Diquat, Paraquat, Chlorthiamid, Terbutryne and Cyanatryn (Newbold 1975, 1977; Anon 1976; Thayer 1984). Newbold (1977) states that the first three are potentially destructive chemicals, changing plant community structures and reducing species diversity rather than eradicating all plant life and are more efficient in non-flowing waters. Cyanatryn, used in flowing water, is provided in the form of a slow-release granule. Breakdown of herbicides in water generally occurs after 2–11 days (Magee and Colmer 1959; Coats 1965; Frank and Comes 1967; Yeo 1967; Cope et al. 1969; Way et al. 1971; Ogg 1972), depending on bacteria present and sometimes light (Newbold 1975) ."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	
	Source(s)	**Notes**

Qsn #	Question	Answer
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	[Manual control may be effective, but labor intensive] "Newbold (1975) described how aquatic weed control in England had been accomplished manually, but as labour became expensive, mechanical controls, using weed-cutting boats, weed rakes, and dredgers came into use and more recently herbicides were developed. Newbold (1977) compared the lower cost of treating a channel in Britain with the herbicide Terbutryne to the more expensive mechanical measures and suggested that a healthy economy plus a low unemployment rate seem to reinforce the trend away from mechanical methods despite the obvious advantage to the unemployed and to the economy."

805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	
	Source(s)	**Notes**
	Catling, P. M., Mitrow, G., Haber, E., Posluszny, U., & Charlton, W. A. (2003). The biology of Canadian weeds. 124. Hydrocharis morsus-ranae L. Canadian Journal of Plant Science, 83(4): 1001-1016	Unknown

Summary of Risk Traits:

High Risk / Undesirable Traits
• Broad climate suitability
• Naturalized in North America from Ottawa, Montreal, Lake Ontario, Quebec City, central and southwestern parts of southern Ontario, and northern New York, Vermont and eastern Michigan
• A weed of aquatic habitats that can impact fisheries, recreation, and biodiversity
• Other Hydrocharis species have become weeds
• Smother water surfaces
• Forms dense mats
• Reproduces by weeds & vegetatively
• Can reproduce in one growing season
• Seeds & vegetative parts dispersed by water, intentionally by people, attached to boats, waterbirds, & possibly internally by birds
• Vegetative propagules (turions) may persist over one growing season

Low Risk Traits
• Primarily in temperate climates. May only be invasive at higher elevations of tropical climates
• Unarmed (no spines, thorns or burrs)
• Palatable to aquatic animals
• Dioecious or self-incompatible
• Herbicides may provide effective control