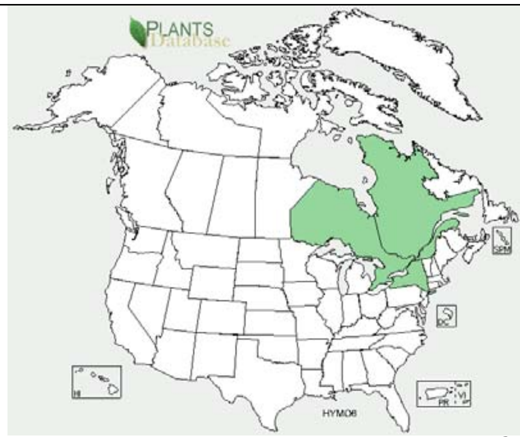
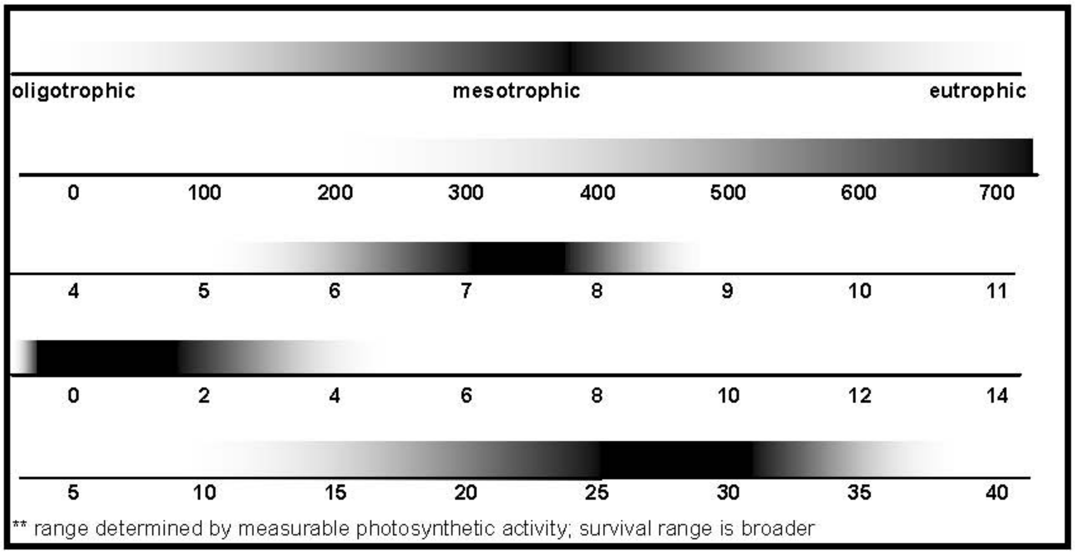
Aquatic Plant		European Frog-bit
I. Current Status and Distribution		***Hydrocharis morsus-ranae***
a. Range	**Global/Continental**	**Wisconsin**
Native Range Europe, Asia, Africa[1,3]	 *Figure 1: U.S and Canada Distribution Map[2]*	Not recorded in Wisconsin
Abundance/Range Widespread: Locally Abundant: Sparse:	 Southeastern Canada, northern New York, eastern Michigan, Vermont[3], Washington[4] Slow moving, mesotrophic systems[5] Oligotrophic, acidic, nutrient-poor waters[5]; larger lakes[6]	 Not applicable Not applicable Not applicable
Range Expansion Date Introduced: Rate of Spread:	 Near Ottawa, Canada, 1930s[5] Since 1939, between 5.5-15.6 km/year[(5)]; has spread 644 km from Ottawa origin[5]; can become dominant wetland plant within 5 years[5]; declining in parts of Europe[3]	 Not applicable Not applicable
Density Risk of Monoculture: Facilitated By:	 High[5] Ability to out-shade native plants	 Unknown Unknown
b. Habitat	Quiet, open waters: marshes, small streams, lakes, beaver ponds, sheltered bays, ditches[5,7]	
Tolerance	Chart of tolerances: Increasingly dark color indicates increasingly optimal range	



Preferences	Sites protected from wind and wave action[7]; organic substrate[3]; nutrient and calcium-rich,[7] peaty soils[9]; mildly alkaline conditions
c. Regulation	
Noxious/Regulated[2]:	CA, ME, VT, WA
Minnesota Regulations:	*Prohibited*; One may not possess, import, purchase, propagate, or transport
Michigan Regulations:	*Prohibited*; One may not knowingly possess or introduce
Washington Regulations:	*Secondary Species of Concern*; State Wetland and Aquatic or Noxious Weed Quarantine List
II. Establishment Potential and Life History Traits	
a. Life History	Free-floating, perennial, stoloniferous, mostly dioecious[3]; up to 10% monoecious in some localities, but mostly dioecious male-dominated[10]
Fecundity	High; one plant can produce 100-150 turions[10]
Reproduction Importance of Seeds: Vegetative:	Sexual (uncommon); Asexual[9] Very low[3,7] Stolons do not fragment readily[7]
Hybridization	Undocumented[7]
Overwintering Winter Tolerance: Phenology:	 High[5] Forms hardy overwintering turions[5]; turions rise to surface and germinate from late April to early May[3]; peak flowering from mid-July to mid-August
b. Establishment	
Climate Weather: Wisconsin-Adapted: Climate Change:	 Rapid growth during summer months[3]; broad climatic tolerance[5] Yes[5] Not likely to limit growth and distribution
Taxonomic Similarity Wisconsin Natives: Other US Exotics:	 Medium; family Hydrocharitaceae Medium; family Hydrocharitaceae

Competition	
Natural Predators:	Mice, ducks, snails, some moths[3]
Natural Pathogens:	No fungi, bacteria, or viruses known; some rusts, smuts and molds[3]
Competitive Strategy:	Dense free-floating mats; broad climatic tolerance
Known Interactions:	Can out-compete submerged natives by limiting light penetration[7]
Reproduction	
Rate of Spread:	High[5]
Adaptive Strategies:	Turions; strong stolons; free-floating (mobility)[5]
Timeframe	Can establish and grow to dominance in 5 years[5]
c. Dispersal	
Intentional:	Horticultural/aquarium trade, waterfowl habitat[3]
Unintentional:	Wind and wave currents[3], boats and trailers[3], birds[7]
Propagule Pressure:	Medium; fragments easily introduced and source populations near Wisconsin

Figure 2: Courtesy of John R. Crellin[11]
Figure 3: Courtesy of Thomas Schöepke[12]

III. Damage Potential	
a. Ecosystem Impacts	
Composition	Inhibits native plant growth and decreases diversity[3]; limits available light, nutrients, and dissolved gasses to other organisms; rapid decomposition in autumn may lead to depletion of oxygen[3]; potential to cause fish and invertebrate kills through oxygen depletion[3]
Structure	Tangled, free-floating mats on water surface[3,5]; prohibits light from reaching water column[3,5]
Function	Decreases light penetration[3]
Allelopathic Effects	Undocumented
Keystone Species	Undocumented
Ecosystem Engineer	Yes; inhibits native vegetation and fauna under dense mats[3]
Sustainability	Undocumented
Biodiversity	Decreases[7,13]
Biotic Effects	Impacts native species at multiple trophic levels
Abiotic Effects	Reduced dissolved oxygen during autumn decomposition[3]
Benefits	Provides food and cover for several water birds, rodents, fish, and insects[7]

b. Socio-Economic Effects	
Benefits	Removal of nitrogen and phosphorus from waste water[14]; experimental plant for physiological and developmental studies[3]
Caveats	Risk of release and population expansion outweighs benefits of use
Impacts of Restriction	Increase in monitoring, education, and research costs
Negatives	Dense free-floating plant mats are known to inhibit recreation[3,5]; has potential to become a major weed in irrigation systems[5]
Expectations	More negative impacts can be expected in shallow, sheltered systems[6]
Cost of Impacts	Decreased recreational and aesthetic value; decline in ecological integrity; increased research expenses
"Eradication" Cost	Quite expensive
IV. Control and Prevention	
a. Detection	
Crypsis:	High; confused with native *Limnobium spongia* (American frogbit)[7], *Nuphar* spp., *Nymphaea* spp.; floating seeds look similar to duckweeds[3]
Benefits of Early Response:	Early detection and removal limits turion production[3]
b. Control	
Management Goal 1	Eradication
Tool:	Water drawdown
Caveat:	Only appropriate for small ponds
Cost:	Extremely expensive for larger water bodies
Efficacy, Time Frame:	Drawdown should occur after turions have germinated, but before dense summer growth and turion production
Management Goal 2	Nuisance relief
Tool:	Mechanical[3]
Caveat:	Harvesting causes fragmentation which increases distribution and density; negative impacts on non-target organisms
Cost:	Expensive
Efficacy, Time Frame:	Consistent effort necessary
Tool:	Chemical herbicide (diquat, paraquat, chlorthiamid, cyanatryn)[3,15]
Caveat:	Non-target species can be negatively impacted
Cost:	Can be expensive depending on area being treated
Efficacy, Time Frame:	Herbicide timing needs to effectively avoid treating native macrophytes

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[9] Cook, C.D.K. and R. Lüönd. 1982. A revision of the genus *Hydrocharis* (Hydrocharitaceae). Aquatic Botany 14:177-204.

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[11] Crellin, J.R. 2006. *Hydrocharis morsus-ranae*. Retrieved December 22, 2010 from: http://www.floralimages.co.uk

[12] Schöepke, T. Retrieved December 22, 2010 from: http://www.plant-pictures.com

[13] Catling, P.M., K.W. Spicer and L.P. Lefkovitch. 1988. Effects of the introduced floating vascular aquatic, *Hydrocharis morsus-ranae* (Hydrocharitaceae), on some North American aquatic macrophytes. Naturaliste Canadien 115:131-137.

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[15] Newbold, C. 1977. Aquatic herbicides: possible future developments. In: Ecological Effects of Pesticides (ed. Perring, F.H. and K. Mellanby), Academic Press, London. Linnean Society Symposia Series No. 5:119-131.