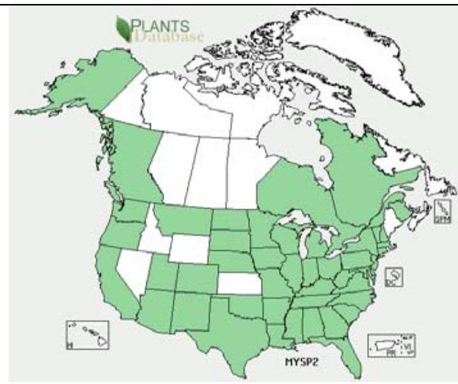
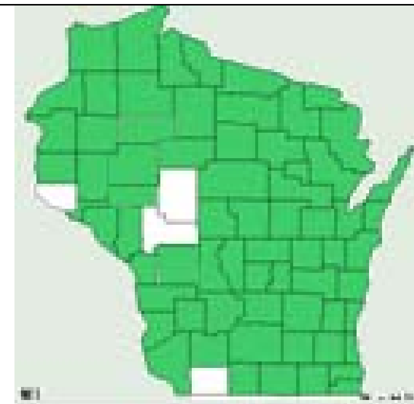
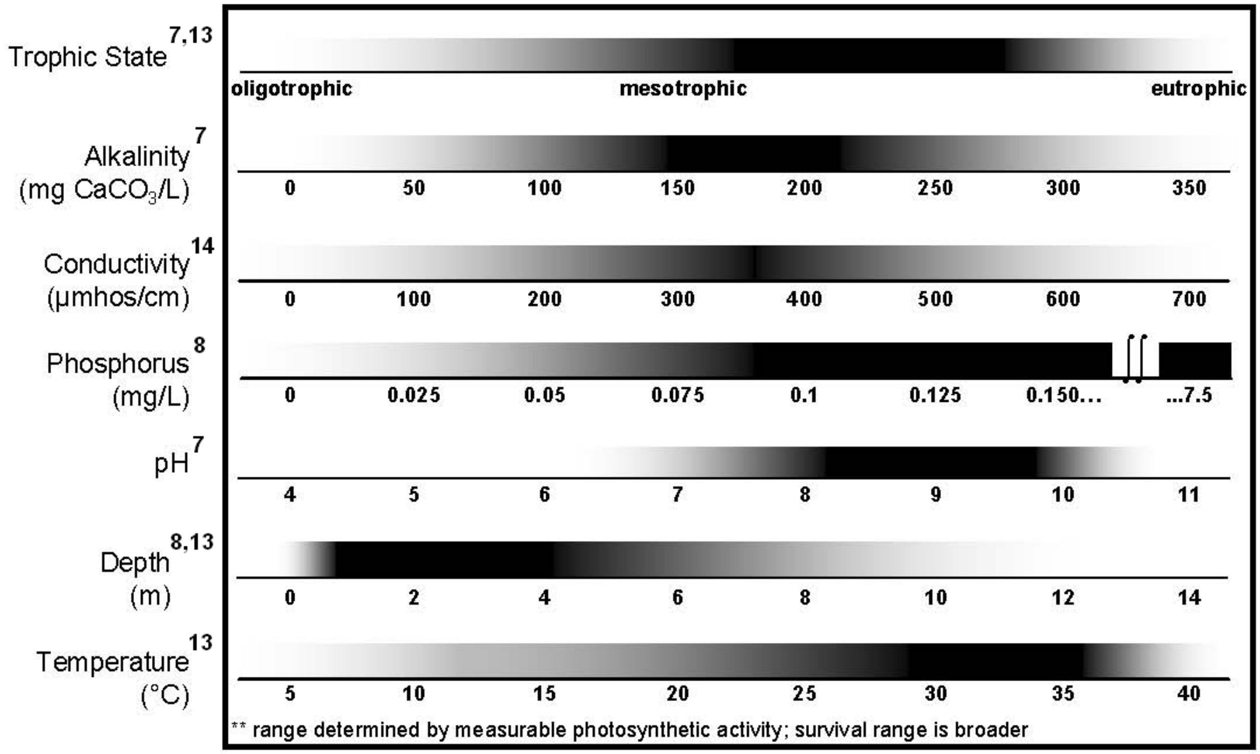
Aquatic Plant		Eurasian watermilfoil (and hybrids)
I. Current Status and Distribution		***Myriophyllum spicatum*** + hybrids
a. Range	**Global/Continental**	**Wisconsin**
Native Range Eurasia[1], northern Africa[5]	 *Figure 1: U.S and Canada Distribution Map[2]* *Also reported from KS, ID, and NV[5]*	 *Figure 2: WI Distribution Map[3,4]*
Abundance/Range Widespread: Locally Abundant: Sparse:	Northeastern United States[2,5,6] Meso-eutrophic systems[7] Oligotrophic systems[7]	Southeastern Wisconsin Eutrophic and mesotrophic waters Northern Wisconsin
Range Expansion Date Introduced: Rate of Spread:	Chesapeake Bay, 1880s[8] Among fastest recorded rates; can grow to dominance in 2 years[9,10]	Southern Wisconsin, 1960s[3] Slowing in the south, rapid expansion in north; can displace natives in 2-3 years[11]
Density Risk of Monoculture: Facilitated By:	High Intermediate trophic state index, total phosphorous[7]; fine organic sediment[8]	High in certain systems Undocumented
b. Habitat	Lakes, ponds, canals, reservoirs, wetlands, wadeable streams, rivers, low energy systems[5,12]	
Tolerance	Chart of tolerances: Increasingly dark color indicates increasingly optimal range	



Preferences	Moderate eutrophication; fine organic sediments; moderate clarity; high alkalinity; tolerates a wide range of pH and salinity[1,8]
c. Regulation	
Noxious/Regulated[2]:	AL, CO, CT, FL, ID, MA, ME, MT, NV, NM, NC, OR, SC, SD, TX, VT, WA
Minnesota Regulations:	*Prohibited*; One may not possess, import, purchase, propagate, or transport
Michigan Regulations:	*Restricted*; One may not knowingly possess or introduce
Washington Regulations:	*Priority Species of Concern*; Class B Noxious Weed; State Wetland and Aquatic or Noxious Weed Quarantine List
II. Establishment Potential and Life History Traits	
a. Life History	Submersed, perennial[13], dicotyledonous forb[2]
Fecundity	High; can grow up to 2 inches per day in spring and summer
Reproduction	Sexual; Asexual
Importance of Seeds:	Low in-situ, high in laboratory[8,15] (may be crucial in reestablishing managed populations)
Vegetative:	Most important; auto-fragmentation
Hybridization	Hybridizes with native *Myriophyllum sibiricum*
Overwintering	
Winter Tolerance:	High; entire plant can overwinter under ice[8]
Phenology:	Emerges early and senesces late relative to native plants
b. Establishment	
Climate	
Weather:	Explosive growth following major environmental disruptions[8]
Wisconsin-Adapted:	Yes
Climate Change:	Not likely to limit growth and distribution

Taxonomic Similarity	
Wisconsin Natives:	High; genus *Myriophyllum*
Other US Exotics:	High; genus *Myriophyllum*
Competition	
Natural Predators:	*Euhrychiopsis lecontei* (herbivorous weevil)[16]
Natural Pathogens:	Fungal pathogen[17]; celluloytic microorganisms[18]
Competitive Strategy:	Rapid canopy; adaptive seasonality; broad environmental tolerance[8]
Known Interactions:	Many; can outcompete most natives when disturbance is present
Reproduction	
Rate of Spread:	High; can spread from 400 ha to 26,800 ha in one season[8]
Adaptive Strategies:	Fragmentation, auto-fragmentation, stoloniferous
Timeframe	Can establish and grow to dominance in as little as 2 years[19]; established population may rapidly decline after approximately 10-15 years[9]

c. Dispersal	
Intentional:	Aquarium trade, ornamental use, aquaculture[8]
Unintentional:	Wind, water, animals, humans (boats/trailers)[8]
Propagule Pressure:	High; fragments easily transported


Figures 3 and 4: Courtesy of Michelle Nault; Wisconsin Department of Natural Resources

III. Damage Potential

a. Ecosystem Impacts	
Composition	Native plant richness and abundance decreases[5,20,21]; macroinvertebrate biomass and density decreases[22]
Structure	Monocultures; biomass distribution into dense canopies; dense canopies change community architecture; fish respond to change in architecture
Function	Increased nutrient loading; fluctuating dissolved oxygen concentration and temperature; decreased light penetration; less suitable habitat for fish[23]; threat to waterfowl food source due to low nutritional value[23]
Allelopathic Effects	Yes; inhibits cyanobacteria, green algae, duckweed, mosquitoes, midges[24]
Keystone Species	Undocumented
Ecosystem Engineer	Yes; dense canopy decreases light penetration[25]
Sustainability	Undocumented
Biodiversity	Decreases[5]
Biotic Effects	Impacts native species at multiple trophic levels[7]
Abiotic Effects	Increased nutrient loading; fluctuating dissolved oxygen concentration and temperature; decreased light penetration[26]
Benefits	Inhibits algae (increase in clarity), provides habitat for invertebrates and fish

b. Socio-Economic Effects	
Benefits	Provides some habitat; can increase water clarity
Caveats	Dense monocultures provide poor habitat; dissolved oxygen fluctuations; can also decrease water clarity
Impacts of Restriction	Increase in monitoring, education, and research costs
Negatives	Dense canopy growth inhibits recreation and reduce aesthetic value[5]; decreases native diversity and abundance; requires expensive control with non-target species often impacted
Expectations	More negative impacts can be expected in eutrophic to mesotrophic systems
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 *Myriophyllum* spp.[8]
Benefits of Early Response:	Unknown to high (early response may decrease root stock, seed bank)
b. Control	
Management Goal 1	Eradication
Tool:	Various
Caveat:	May be impossible, no confirmed long-term successes; non-target plant species can be negatively impacted
Cost:	Extremely expensive
Efficacy, Time Frame:	May take over 10 years of annual effort
Management Goal 2	Nuisance relief
Tool:	Mechanical harvest
Caveat:	Harvesting causes fragmentation which increases distribution and density; non-target plant species are negatively impacted
Cost:	Undocumented
Efficacy, Time Frame:	Annual effort necessary
Tool:	Small-scale chemical
Caveat:	Non-target plant species can be negatively impacted
Cost:	Varies depending on scale
Efficacy, Time Frame:	Depends on ecological conditions
Tool:	Drawdown
Caveat:	Only feasible on systems where water levels can be manipulated
Cost:	Undocumented
Efficacy, Time Frame:	Depends on ecological conditions
Tool:	Biological control – *Euhrychiopsis lecontei* (weevil)
Caveat:	Requires suitable overwintering habitat
Cost:	Approximately $1 per weevil, plus planning, and consulting fees
Efficacy, Time Frame:	Depends on ecological conditions; large numbers of weevils needed
Legal Issues	Whole-lake treatments proposed, with possibility of ecosystem-wide effects

[1] US Forest Service, Pacific Island Ecosystems at Risk (PIER). 2010. *Myriophyllum spicatum* L., Haloragaceae. Retrieved December 22, 2010 from: http://www.hear.org/pier/species/myriophyllum_spicatum.htm

[2] United States Department of Agriculture, Natural Resource Conservation Service. 2010. The PLANTS Database. National Plant Data Center, Baton Rouge, LA, USA. Retrieved March 26, 2010 from: http://plants.usda.gov/java/profile?symbol=MYSP2

[3] Wisconsin Department of Natural Resources. 2010. Eurasian Water-Milfoil in Wisconsin. Retrieved November 24, 2010 from: http://dnr.wi.gov/lakes/invasives/Species.aspx?species=EWM&countyCode=

[4] University of Wisconsin – Madison. 2005. Family - Haloragaceae. Wisconsin Botanical Information System Wisflora. Retrieved December 22, 2010 from: http://wisplants.uwsp.edu/scripts/detail.asp?SpCode=MYRSPI

[5] Jacono, C.C. and M.M. Richerson. 2003. United States Geologic Survey Nonindegenious Aquatic Species . Retrieved December 22, 2010 from: http://nas.er.usgs.gov/taxgroup/plants/docs/my_spica.html

[6] Grillas, P. 1990. Distribution of submerged macrophytes in the Camargue in relation to environmental factors. Journal of Vegetation Science 1(3):393-402.

[7] Madsen, J.D. 1998. Predicting invasion success of Eurasian watermilfoil. Journal of Aquatic Plant Management 36:28-32.

[8] Nichols, S.A. and B.H. Shaw. 1986. Ecological life histories of the three aquatic nuisance plants, *Myriophyllum spicatum*, *Potamogeton crispus* and *Elodea canadensis*. Hydrobiologia 131(1):3-21.

[9] Carpenter, S.R. 1980. The decline of *Myriophyllum spicatum* in a eutrophic Wisconsin (USA) lake. Canadian Journal of Botany 58(5):527-535

[10] Les, D.H. and L.J. Mehrhoff. 1999. Introduction of nonindigenous aquatic vascular plants in southern New England: a historical perspective. Biological Invasions 1:281-300.

[11] Aiken, S.G., P.R. Newroth and I. Wile. 1979. The Biology of Canadian Weeds. 34. *Myriophyllum spicatum* L. Canadian Journal of Plant Science 59(1):201-215.

[12] O'Hare, M.T., K.A. Hutchinson and R.T. Clarke. 2007. The drag and reconfiguration experienced by five macrophytes from a lowland river. Aquatic Botany 86(3):253-259.

[13] Smith, C.S. and J.W. Barko. 1990. Ecology of Eurasian watermilfoil. Journal of Aquatic Plant Management 28:55-64.

[14] Nichols, S.A. and L.A. Buchan. 1997. Use of native macrophytes as indicators of suitable Eurasian watermilfoil habitat in Wisconsin lakes. Journal of Aquatic Plant Management 35:21-24

[15] Madsen, J.D. and C.W. Boylen. 1989. Eurasian watermilfoil seed ecology from an oligotrophic and eutrophic lake. Journal of Aquatic Plant Management 27:119-121.

[16] Creed, R.P., Jr. 1998. A biogeographic perspective on Eurasian watermilfoil declines: additional evidence for the role of herbivorous weevils in promoting declines? Journal of Aquatic Plant Management 36:16-22.

[17] Shearer, J.F. 2002. The potential role of an endophytic fungus in the decline of stressed Eurasian watermilfoil. Journal of Aquatic Plant Management 40:76-78.

[18] Gunner, H.B. 1983. Microbiological control of Eurasian watermilfoil. Final Report: U.S. Army Aquatic Plant Control Research Program: Vicksburg, MS. 6pp.

[19] Madsen, J.D. and D.H. Smith. 1997. Vegetative spread of Eurasian watermilfoil colonies. Journal of Aquatic Plant Management 35:63-68.

[20] Boylen, C.W., L.W. Eichler and J.D. Madsen. 1999. Loss of native aquatic plant species in a community dominated by Eurasian watermilfoil. Hydrobiologia 415:207-211.

[21] Knapton, R.W. and S.A. Petrie. 1999. Changes in distribution and abundance of submerged macrophytes in the inner bay at Long Point, Lake Erie: implications for foraging waterfowl. Journal of Great Lakes Research 25(4):783-798

[22] Cheruvelil, K.S., P.A. Soranno, J.D. Madsen and M.J. Roberson. 2002. Plant architecture and epiphytic macroinvertebrate communities: the role of an exotic dissected macrophyte. Journal of the North American Benthological Society 21(2):261-277.

[23] Keast, A. 1984. The introduced aquatic macrophyte, *Myriophyllum spicatum*, as habitat for fish and their invertebrate prey. Canadian Journal of Zoology 62(7):1289-1303.

[24] Glomski, L.M., K.V. Wood, R.L. Nicholson and C.A. Lembi. The search for exudates from Eurasian watermilfoil and hydrilla. Journal of Aquatic Plant Management 40:17-22

[25] Crooks, J.A. 2002. Characterizing ecosystem-level consequences of biological invasions: the role of ecosystem engineers. Oikos 97(2):153-166.

[26] Larson, D. 2003: Predicting the threats to ecosystem function and economy of alien vascular plants in freshwater environments. Department of Environmental Assessments, Swedish University of Agricultural Sciences Report 2003: p7