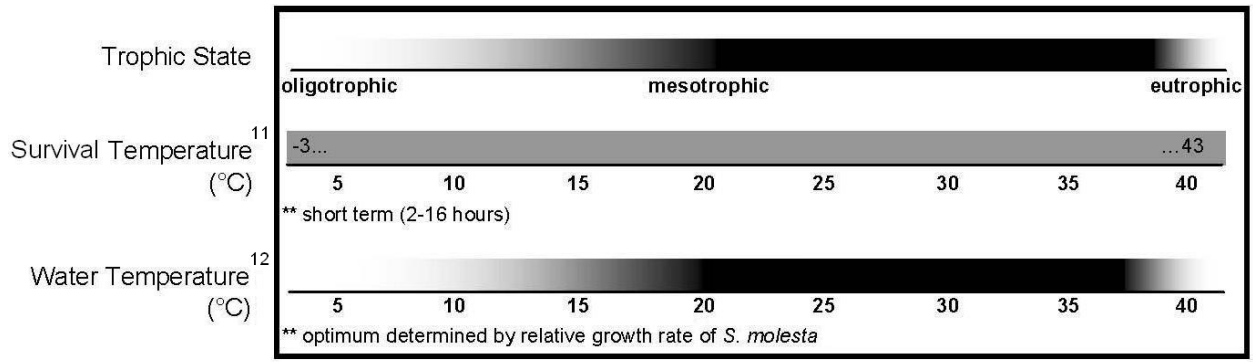
Aquatic Plant		Salvinia
I. Current Status and Distribution		***Salvinia molesta, S. minima, S. herzogii, S. natans***
a. Range	**Global/Continental**	**Wisconsin**
Native Range *S. molesta*: South America (Southern Brazil)[1] *S. minima*: Central and South America[2] *S. herzogii*: South America[3] *S. natans*: Eurasia[4]	 *Figure 1: U.S and Canada Distribution Map*[5] *Also reported from Virginia & Colorado*[6] (*S. molesta, S. minima, S. herzogii, and S. natans*)	Not recorded in Wisconsin
Abundance/Range Widespread: Locally Abundant: Sparse:	 Tropics, subtropics Warm temperatures, high nutrients[7] Frost-limited	 Not applicable Not applicable Not applicable
Range Expansion Date Introduced: Rate of Spread:	 Late 19th century[8]; 1930s[2]; late 1970s to early 1980s[9] Extremely rapid; doubling time of 2.9 days (*S. herzogii*)[10]	 Not applicable Not applicable
Density Risk of Monoculture: Facilitated By:	 High; capable of 30,000 plants/m^2; can result in mats 3 feet thick[9] High temperatures, nutrients	 Unknown Unknown
b. Habitat	Lakes, reservoirs, wetlands, low energy systems	
Tolerance	Chart of tolerances: Increasingly dark color indicates increasingly optimal range	



Preferences	Low energy freshwater systems; high nutrient input (nitrogen) and high temperatures[10,13]; intolerant of salinity[8]

c. Regulation	
Noxious/Regulated[5]:	Federal Noxious Weed List; AL, AZ, CA, CO, CT, FL, MA, MS, NV, NC, OR, SC, TX, VT
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*
II. Establishment Potential and Life History Traits	
a. Life History	Floating leaf aquatic fern; subtle differences exist between species but in general they are very closely related[13]; *S. molesta* can act as an annual or perennial (depending on climate)[7]
Fecundity	Very high
Reproduction	Asexual
Importance of Spores:	Sporocarps of low reproductive importance
Vegetative:	Very important: autofragmentation, ramets
Hybridization	Undocumented
Overwintering	
Winter Tolerance:	Medium: will survive mild winters when frost is slight[13,14]
Phenology:	Starts growing later than most native plants
b. Establishment	
Climate	
Weather:	Warm temperatures stimulate growth
Wisconsin-Adapted:	Uncertain; plants can act as an annual and still achieve nuisance-level growth during summer[7]; *S. natans* has a temperate zone distribution
Climate Change:	Likely to facilitate growth and distribution
Taxonomic Similarity	
Wisconsin Natives:	Low
Other US Exotics:	High; several *Salvinia* spp. are considered exotic in the United States
Competition	
Natural Predators:	*Cyrtobagous salviniae* (beetle)[10]
Natural Pathogens:	Undocumented
Competitive Strategy:	Very prolific; rapid growth rate; dense canopy shades competition[7,13]
Known Interactions:	*S. herzogii* replaced by *Eichhornia crassipes* in 103 days[11]
Reproduction	
Rate of Spread:	High; can cover 40 mi^2 in three months[13]; relative growth rate positively correlated with nitrogen[10]
Adaptive Strategies:	Prolific vegetative growth
Timeframe	Can dominate a community in one season
c. Dispersal	
Intentional:	Aquarium trade, ornamental use, wastewater treatment[7]
Unintentional:	Wind, water, animals, humans
Propagule Pressure:	Medium; fragments easily accidentally introduced but source populations not near Wisconsin


Figure 2: S. natans; Courtesy of Kurt Stueber[15]
Figure 3: S. molesta; Courtesy of Wikimedia Commons[16]

III. Damage Potential	
a. Ecosystem Impacts	
Composition	Migrating birds find it difficult to access water in areas covered by *Salvinia* spp.[7]; mats pose risk for native species at multiple trophic levels; displaces native vegetation and provides very little habitat for native fauna[13,17]
Structure	High risk of monocultures; drastic architectural changes[7]; decrease in light penetration (affects structure of plant and microbial community)[18]; increase in siltation and reduction in water flow
Function	Depletes dissolved oxygen[13]; increases CO_2; increases siltation and reduces water flow[7]
Allelopathic Effects	Undocumented
Keystone Species	Undocumented
Ecosystem Engineer	Yes; habitat altered by dense canopy; increased siltation
Sustainability	Undocumented
Biodiversity	Causes decrease in biodiversity[7]
Biotic Effects	Impacts native species at multiple trophic levels[7,13]
Abiotic Effects	Decrease in dissolved oxygen concentration and pH; increase in siltation and nutrient pulses
Benefits	Undocumented
b. Socio-Economic Effects	
Benefits Caveats	Used as mulch, compost and fodder; used in paper making, handcrafts, bio-gas generation[7] Risk of release and population expansion outweighs benefits of use
Impacts of Restriction	Increase in monitoring, education, and research costs
Negatives	Clogs waterways, (entire villages have been abandoned when navigation becomes impossible)[7,12,13]; can cause drowning of livestock[12]; angling becomes impossible[13]; increases level and spread of human diseases (elephantiasis, encephalitis, dengue fever, malaria)[7]; can ruin electrical and agricultural industries[7]
Expectations	More negative impacts in tropical, eutrophic, slow moving, shallow, water-limited areas[7]
Cost of Impacts	Decreased recreational and aesthetic value; decline in ecological integrity; increased research expenses
"Eradication" Cost	Undocumented

IV. Control and Prevention	
a. Detection	
Crypsis:	Low
Benefits of Early Response:	High; restricting size of population improves prospect of successful control
b. Control	
Management Goal 1	Nuisance relief
Tool:	*Cyrtobagous salviniae* (beetle)[10]
Caveat:	Eradication is impossible, suppression is realistic goal
Cost:	Comparatively cheap
Efficacy, Time Frame:	2 years for 90% control in Louisiana[19]
Tool:	Diquat, fluridone, glyphosate and manual removal
Caveat:	Labor intensive; results last for only a few weeks
Cost:	Very expensive
Efficacy, Time Frame:	Multiple times per year

[1] US Forest Service, Pacific Island Ecosystems at Risk (PIER). 2010. Retrieved December 8, 2010 from: http://www.hear.org/pier/species/salvinia_molesta.htm

[2] Morgan, V.H. 2008. *Salvinia minima*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Retrieved December 8, 2010 from: http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=297

[3] USDA, ARS, National Genetic Resources Program. 2002. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. Retrieved December 8, 2010 from: http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?316407

[4] US Forest Service, Pacific Island Ecosystems at Risk (PIER). 2006. Retrieved December 8, 2010 from: http://www.hear.org/pier/species/salvinia_natans.htm

[5] United States Department of Agriculture, Natural Resource Conservation Service. 2007. The PLANTS Database. National Plant Data Center, Baton Rouge, LA, USA. Retrieved December 8, 2010 from: http://plants.usda.gov/java/profile?symbol=SALVI2

[6] EDDMapS. 2012. Early Detection & Distribution Mapping System. The University of Georgia - Center for Invasive Species and Ecosystem Health. Retrieved January 11, 2012 from: http://www.eddmaps.org/distribution/usstate.cfm?sub=2785

[7] Global Invasive Species Database. 2010. Global Invasive Species Database. Retrieved December 8, 2010 from: http://www.issg.org/database/species/search.asp?sts=sss&st=sss&fr=1&sn=salvinia&rn=&hci=-1&ei=-1&lang=EN

[8] Weatherby, C.A. 1921. Other Records of *Salvinia natans* in the United States. American Fern Journal 11(2):50-53.

[9] Wersal, R.M. and J.D. Madsen. 2006. Invasive Species Fact Sheet: Giant Salvinia *(Salvinia molesta* D.S. Mitchell). Description, Distribution, and Management. MSU GeoResources Institute. Retrieved December 8, 2010 from: http://www.gri.msstate.edu/publications/docs/2006/11/4109Fact%20Sheet%20-%20Giant%20Salvinia.pdf

[10] Room, P.M. and P.A. Thomas. 1986. Population growth of the floating weed *Salvinia molesta*: field observations and a global model based on temperature and nitrogen. Journal of Applied Ecology 23:1013-1028.

[11] Thomaz, S.M., T.A. Pagioro, L.M. Bini and K.J. Murphy. 2006. Effect of reservoir drawdown on biomass of three species of aquatic macrophytes in a large sub-tropical reservoir (Itaipu, Brazil). Hydrobiologia 570:53-59.

[12] Van der Heide, T., R.M.M. Roijackers, E.H. van Nes and E.T.H.M. Peeters. 2006. A simple equation for describing the temperature dependent growth of free-floating macrophytes. Aquatic Botany 84(2):171-175.

[13] Jacono, C.C. 2003. United States Geological Survey. Giant Salvinia - *Salvinia molesta*. Retrieved December 8, 2010 from: http://salvinia.er.usgs.gov/html/identification.html

[14] Sale, P.J.M., P.T. Orr, G.S. Shell and D.J.C. Erskine. 1985. Photosynthesis and growth rates in *Salvinia molesta* and *Eichhornia crassipes.* Journal of Applied Ecology 22(1):125-137.

[15] Stueber, K. 2004. *Salvinia natans*. Retrieved October 20, 2010 from: http://upload.wikimedia.org/wikipedia/commons/a/ad/Salvinia_natans1.jpg

[16] Wikimedia Commons. 2008. *Salvinia molesta*. Retrieved October 20, 2010 from: http://upload.wikimedia.org/wikipedia/commons/1/1e/Salvinia_molesta_%28Habitus%29_1.jpg

[17] Adams, C.S., R.R. Boar, D.S. Hubble, M. Gikungu, D.M. Harper, P. Hickley and N. Tarras-Wahlberg. 2002. The dynamics and ecology of exotic tropical species in floating plant mats: Lake Naivasha, Kenya. Hydrobiologia 488(1-3):115-122.

[18] Sinistro, R., I. Izaguirre and V. Asikian. 2006. Experimental study on the microbial plankton community in a South American wetland (Lower Paraná River Basin) and the effect of the light deficiency due to the floating macrophytes. Journal of Plankton Research 28(8):753-768.

[19] Tipping, P.W., T.D. Center, H. Elder, R. Helton and J. Findeisen. 2004. Biological control of giant salvinia (*Salvinia molesta*) in Texas and Louisiana. US Geological Survey. Retrieved September 21, 2010 from: http://salvinia.er.usgs.gov/html/s_molesta_updates.html#november2004