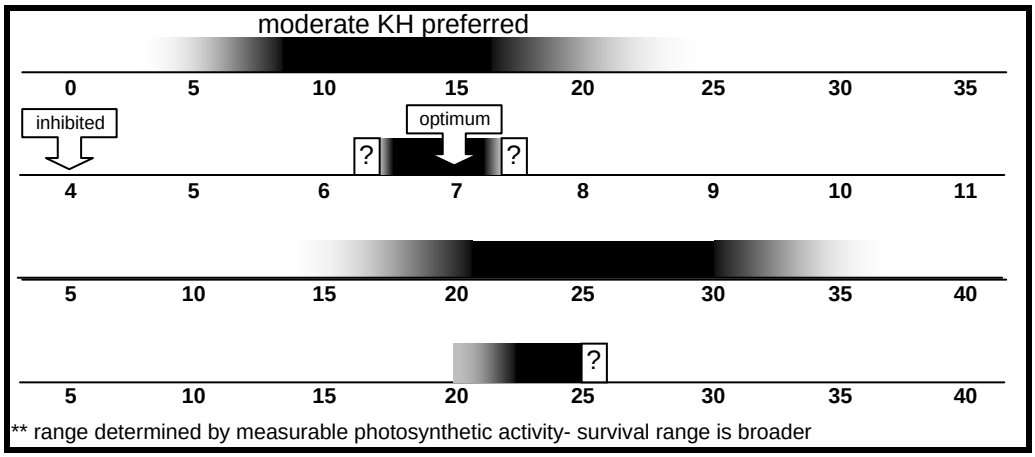
Aquatic Plant — Water Lettuce

I. Current Status and Distribution — *Pistia stratiotes*

a. RANGE	Global/Continental	Wisconsin
Native Range Unknown, now pan-tropical[32]	 Recently reported in IL and AL ref:1	Population reported to have successfully wintered for 3-4 years before a particularly strong winter caused a population crash; Mississippi River Found in Duck Creek, near Green Bay in 2002 did not overwinter[31]
Abundance/range Widespread: Locally Abundant: Sparse:	Among worlds worst weeds[4] Subtropical Florida[4] Impacted eutrophic warm systems Temperate regions	Pan-tropical species[12] Overwinters in Netherlands: Reinfests from seeds each spring[18]; survives harsh winters in Slovenia by overwintering in thermal streams[29]
Range expansion Date introduced: Rate of spread:	Continental, Regional, Local Soon after European settlement[4] Rapid[4]	Reports of several independent introductions Does not overwinter well
Density Risk of monoculture: Facilitated by:	Can reach 2,000 g/m^2 in one season[14] Unknown	Undocumented

b. HABITAT Lakes, ponds, reservoirs, canals, slow-flowing streams and rivers[4]

Tolerance **increasingly dark color indicates increasingly optimal range



Prefers: Polluted, impacted systems[21], silty/muddy substrates, clear shallow water, warm temps[28]

c. REGULATION

Noxious/regulated:[1,5] AL, CA, CT, FL, SC, TX, LA, MS, DE

Minnesota: *Not regulated* *(Although Ch84D.06 makes unlawful any nonnative introduction.)*

Michigan: *Not regulated*

Washington: *Not regulated*

II. Establishment Potential and Life History Traits

a. LIFE HISTORY	Free-floating monocotyledonous[26] perennial (but may act as annual) herb in the aroid family[4]	
Fecundity	High	
Reproduction	Sexual Asexual[4]	
Importance of seeds:	High (temperate)[4]	Hydrosoil under mats holds 4,196 seeds/m^{2}[(15)]
Vegetative:	1° means of expansion[4]	≤ 15 secondary rosettes/plant, ≤ 4 generations/stolon[14]
Hybridization	None documented	
Overwintering		
Winter tolerance:	Plant is frost intolerant[4], but seeds will tolerate ice (-5°C) for several weeks[18]	
Phenology:	Emerges late relative to natives (may change with climactic shifts)	
b. ESTABLISHMENT		
Climate		
Weather:	Warm winters may allow spread	
Wisconsin-adapted?:	No; but could persist in in cold temperate climates by reinfesting from seed in spring[4]	
50-yr climate change:	Likely to benefit species	
Taxonomic similarity		
WI natives:	Medium (family: Araceae, duckweeds and *Pistia* are monophyletic group)	
Other US exotics:	Medium (family: Araceae, duckweeds and *Pistia* are monophyletic group)	
Competition		
Natural predators:	Neotropics: 21 insects, 14 of these weevils; 9 reported in Florida[4]	
Natural pathogens:	Fungi: *Ramularia pistiae, R. aromatica, Cercospora pistiae* [23], *Sclerotinia sclerotiorum* [24] and others	
Competitive strategy:	Rapid growth rate, competitive exclusion (shading)	
Known interactions:	Outcompeted by water hyacinth;[16] coontail, EWM, *N. marina*, *T. natans* in their native ranges[29]	
Reproduction		
Rate of spread:	High	
Adaptive strategies:	Rapid clonal reproduction, floating rosettes can spread with slight current	
Timeframe	Can reach 2,000 g/m^{2} in one season[14]	
c. DISPERSAL		
Intentional:	Aquarium trade, ornamental use, wastewater treatment[11]	
Unintentional:	Wind, water, animal, human	
Propagule pressure:	Medium; fragments relatively easily accidentally introduced	

Forest & Kim Starr
USGS
www.forestryimages.org

Ken A. Langeland
University of Florida
www.forestryimages.org

III. Damage Potential

a. ECOSYSTEM IMPACTS	
Composition	Disrupts submersed animal and plant communities[5] Greatly reduces biological diversity (submersed and emersed plants)[26] Likely that [DO] impacts cause fish kills[4] Decrease in planktonic diversity[22]
Structure	Miniaturization of plankton volume[22] Floating mats changes community architecture Fish respond to change in architecture
Function	Increased siltation[6], nutrient loading[9], alkalinity[11]and thermal stratification[10] reduced DO[11]
Allelopathic effects	Undocumented
Keystone species	Unknown
Ecosystem engineer?	Yes; dense canopy decreases light penetration, siltation, temperature
Sustainability	Unknown
Biodiversity	Decreases
Biotic effects	Planktonic structure, diversity decreases[22]
Abiotic effects	Decrease in [DO], pH and permanganate index[22] Increase in siltation, transparency, nitrate, ammonium, TN, TP, total bacteria[6,22]
Benefits	Increases water clarity[22]

b. SOCIO-ECONOMIC EFFECTS	
Benefits	Wastewater treatment[19]
Caveats:	Risk of release and population expansion Favorable breeding ground for mosquitoes (not malarial species)[20]
Impacts of restriction	Increase in monitoring, education, research costs; impacts green industry and recreation
Negatives	Blocks navigational channels[5] Impedes water flow in irrigation and flood control canals[5] Breeding ground for mosquitoes (disease vectors)[4] Bioaccumulation of heavy metals[4]
Expectations	
Cost of impacts	Decreased recreational, aesthetic value, ecological integrity; increased research expenses
"Eradication" cost	Depends on level of infestation

IV. Control and Prevention

a. PREVENTION

Types of prevention:	Education, monitoring, research Watercraft inspection, distribution (ID) watch
Annual cost:	Watercraft inspection-- $147,000 for all currently targeted species Monitoring-- $116,000 covers zebra mussels, EWM, CLP, waterfleas, blue-green algae, rusty crayfish CBCW Volunteer program-- $91,000 covers most large propagule-spread species Research--contract with University of Wisconsin runs $22,000 Education-- $106,000 for information, education and outreach efforts AIS grants--$816,133 for education, early detection/rapid response and cost-shares

Detection

Crypsis:	Low[26]
Benefits of early response:	High, to prevent prolific seed set crucial to survival in temperate zones

b. CONTROL

Management goal	Eradication
Tool:	Hand pulling successful in New Zealand[25]
Caveat:	Two deliberately planted small populations were quickly removed
Caveat:	Many other regions do not report such success

Management goal	Nuisance relief
Tool:	Noctuid moth: *S. pectinocornis*
Caveat:	Populations establish, but fail to persist, restocking necessary[4]
Tool:	Weevil: *Neohydronomus affinis* Hustache[3]
Efficacy, time frame:	Produces 90% declines, cyclical (long term suppression elusive)
Tool:	Endothall
Caveat:	Non-target plant species are negatively impacted

Documented cost: Estimate total expenditures exceed $1 million annually in Florida[4]

References:

1. USDA, NRCS. 2007. The PLANTS Database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. accessed 5.29.07: http://plants.usda.gov/java/nameSearch?keywordquery=pistia+stratiotes&mode=sciname
2. Anonymous. 2001. Weevils wipe out water lettuce weeds. Florida Grower. 94(1):46.
3. Mbati, G and P. Neuenschwander. 2005. Biological control of three floating water weeds, *Eichhornia crassipes, Pistia stratiotes,* and *Salvinia molesta* in the Republic of Congo. BioControl 50:635-645.
4. Dray, FA and TD Center. 2002. Chapter 5: Waterlettuce. *In* Van Driesche, R., et al., 2002, Biological Control of Invasive Plants in the Eastern United States, USDA Forest Service Publication FHTET-2002-04, 413 p.
5. Sculthorpe 1967; Attionu 1976; Bruner 1982; Sharma 1984 *in ibid.*
6. Sculthorpe 1967 *in ibid.*
7. Beumer 1980 *in ibid.*
8. Roback 1974 *in ibid.*
9. Schmitz *et al.* 1993 *in ibid.*
10. Sculthorpe 1967; Attionu 1976 *in ibid.*
11. Yount 1963; Attionu 1976; Sridhar and Sharma 1985 *in ibid.*
12. Sculthorpe 1967 and Holm *et al.* 1977 *in ibid.*
14. Dray and Center 1992 *in ibid.*
15. Dray and Center 1989 *in ibid.*
16. Tag el Seed 1978; Agami and Reddy 1990 *in ibid.*
17. Dray and Center 1003; Grodowitz *et al.* 1992 *in ibid.*
18. Pieterse, AH, L Delange and L Verhagen. 1981. A Study of Certain Aspects of Seed Germination and Growth of *Pistia stratiotes.* Acta Botanica Neerlandica. 30(1-2): 47-58.
19. Zimmels, Y, F Kirahner and A Malkovskaja. 2006. Application of *Eichhornia crassipes* and *Pistia stratiotes* for treatment of urban sewage in Israel. Journal of Environmental Management. 81(4):420-428.
20. Kengne, IM, F Brissaud, A. Akoa, RA Eteme, J Nya, A. Ndikefor, T Fonkou. 2003. Mosquito development in a macrophyte-based wastewater treatment plant in Cameroon (Central Africa). Ecological Engineering. 21(1):53.
21. Ghavzan, JN, VR Gunale, DM Mahajan, DR Shirke. 2006. Effects of environmental factors on ecology and distribution of aquatic macrophytes. Asian Journal of Plant Sciences. 5(5): 871-880.
22. Leiming, Cai. 2006. Impact of floating vegetation in Shuikou impoundment, Minjiang River, Fujian Province. Hupo-Kexue. 18(3): 250-254.
23. Silva, H, G Gonzaga, M Camargo and Fernando A. 2005. Interacoes ecologicas entre as macrofitas aquaticas flutuantes *Eichhornia crassipes* e *Pistia stratiotes*. Ecological interrelationships between floating aquatic and *Pistia stratiotes.* Hoehnea. 32(3): 445-452.
24. Waipara, NW, GW Bourdot, GA Hurrell. 2006. *Sclerotinia sclerotiorum* shows potential for controlling water lettuce, alligator weed and wandering Jew. New Zealand Plant Protection. 59: 23-27.
25. Champion, PD and JS Clayton. 2003. The evaluatio nand management of aquatic weeds in New Zealand. Plant Invasions: Ecological Threats and Management Solutions. 429-434.
26. Unlisted. *Pistia stratiotes* L. University of Florida Sea Grant Pages, accessed 5/31/07: http://plants.ifas.ufl.edu/seagrant/pisstr2.html
27. Kasselmann 1995 *in ibid.*
28. Benson, AJ, CC Jacono, PL Fuller, ER McKercher, MM Richerson. 2004. Summary report of nonindigenous aquatic species in U.S. Fish and Wildlife service region 5. Prepared for: U.S. Fish and Wildlife Service, Arlington, VA.
29. Sajna, N, M Haler, S Skornik, M Kaligaric. 2007. Survival and expansion of *Pistia stratiotes* L. in a thermal stream in Slovenia. Aquatic Botany 87: 75-79.
30. Global Invasive Species Database, accessed 05.31.07: http://www.invasivespecies.net/database/species/ecology.asp?si=285&fr=1&sts=sss
31. Cleland, C. 2007. Personal communication.
32. Pacific Island Ecosystems at Risk (PIER) Plant Treats to Pacific Ecosystems. Accessed 11/2/07: http://www.hear.org/pier/species/pistia_stratiotes.htm