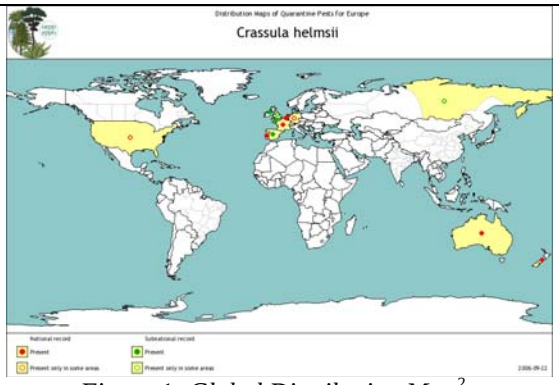
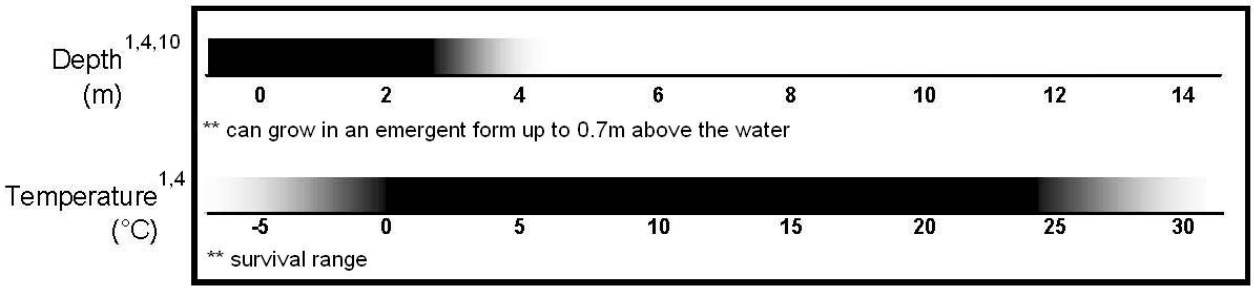
Aquatic Plant	Australian Swamp Stonecrop; New Zealand Pygmyweed
I. Current Status and Distribution	***Crassula helmsii***

a. Range	**Global/Continental**	**Wisconsin**
Native Range Australia, New Zealand[1]	 *Figure 1: Global Distribution Map*[2]	Not recorded in Wisconsin
Abundance/Range Widespread: Locally Abundant: Sparse:	 United Kingdom[1] Belgium, Denmark, France, Germany[1] Reports from Southeastern United States[4]	 Not applicable Not applicable Not applicable
Range Expansion Date Introduced: Rate of Spread:	 Essex, United Kingdom, 1950s[4] Rapid; number of invaded sites doubles every two years[5]; 1500 recorded sites, though distribution likely under-reported[3,6]	 Not applicable Not applicable
Density Risk of Monoculture: Facilitated By:	 High; occasional problem in native range[7] Nutrient enrichment, low energy systems[5]	 Unknown Unknown
b. Habitat	Inland and coastal wetlands, lakes, reservoirs, riverbanks, canals, ponds, slow moving rivers, low-energy systems[1,5]	
Tolerance	Chart of tolerances: Increasingly dark color indicates increasingly optimal range	



Preferences	Nutrient-enriched environments, slow-moving or static water[5]
c. Regulation	
Noxious/Regulated[11]:	FL, NC, WA
Minnesota Regulations:	*Prohibited;* One may not possess, import, purchase, propagate, or transport
Michigan Regulations:	*Not regulated*
Washington Regulations:	State Wetland and Aquatic or Noxious Weed Quarantine List

II. Establishment Potential and Life History Traits	
a. Life History	Submersed, emersed, or semi-terrestrial perennial herbaceous dicot[1,4,11]
Fecundity	High[10]
Reproduction	Sexual; Asexual
Importance of Seeds:	Low; plant flowers but produces no viable seeds (in United Kingdom)[4]
Vegetative:	High; one node on 5mm of stem fragment can start a new plant[9]; apical turions[4]
Hybridization	Undocumented
Overwintering	
Winter Tolerance:	High[5]
Phenology:	Vigorous growth through most of the year without period of senescence (in United Kingdom)[5]; flowers from July to September in Europe[1]
b. Establishment	
Climate	
Weather:	20-25°C in summer, 0-15°C in winter; can tolerate extended drying[1]; survival temperatures ranging from -6°C to 30°C reported[4]
Wisconsin-Adapted:	Yes
Climate Change:	Undocumented
Taxonomic Similarity	
Wisconsin Natives:	Medium; family Crassulaceae (genus: *Penthorum*)[11]
Other US Exotics:	High; *C. tillaea* & C. *multicava* introduced in western U.S.[11]
Competition	
Natural Predators:	Few natural enemies are reported[7]
Natural Pathogens:	Undocumented
Competitive Strategy:	CAM photosynthesis, broad nutrient tolerance, vegetative spread, no senescence[5,9,12]
Known Interactions:	Out-competes *Elodea* spp., *Ludwigia palustris*, and *Galium debile* in United Kingdom[6]
Reproduction	
Rate of Spread:	High
Adaptive Strategies:	Vegetative spread; turions; very small fragments are viable[5,9]
Timeframe	Doubles number of invaded sites every two years[5]; currently spreading from United Kingdom to mainland Europe[5]
c. Dispersal	
Intentional:	Sold as oxygenator for aquaria (often called *Tillaea recurva* or *T. helmsii*)[5,9]
Unintentional:	Water currents, mud, wildlife, aquarium disposal, escape from ponds, 'contaminant' with other water plants, humans (boats, angling equipment, clothes)[1,6]
Propagule Pressure:	Potentially high; fragments easily accidentally introduced[10]


Figure 2: Courtesy of Centre for Aquatic Plant Management[9]
Figure 3: Courtesy of Dan Minchin, DAISIE[13]

III. Damage Potential	
a. Ecosystem Impacts	
Composition	Often results in almost total suppression of the native flora[6,14]; six plant species in one study showed germination suppression up to 83% under *C. helmsii*[15]; no significant loss of plant species numbers or changes in newt hatching[15]; impoverishes the ecosystem for invertebrates and fish[4]
Structure	Monocultures can form 100% cover and smother native vegetation[1,4]; fish respond to change in architecture
Function	Can choke ponds[16]; severe oxygen depletion below dense growth[9]
Allelopathic Effects	Undocumented
Keystone Species	Undocumented
Ecosystem Engineer	Yes; dense canopy causes dissolved oxygen fluctuations, kills fish and suppresses native plants[4]
Sustainability	Dense growth threatens ecosystem sustainability
Biodiversity	Creates impoverished ecosystems[4]
Biotic Effects	Fish kills due to severe dissolved oxygen fluctuations[9]
Abiotic Effects	Dissolved oxygen concentration fluctuations[9]; changes in water temperature; altered light regime
Benefits	Undocumented
b. Socio-Economic Effects	
Benefits Caveats	Sold as submerged oxygenating plant for aquaria and ponds[1] Risk of release and population expansion outweigh benefits of use
Impacts of Restriction	Increase in monitoring, education, and research costs
Negatives	Can block ponds and drainage ditches, causing flooding[1,4]; loss of aesthetic and recreational value[1]; interferes with recreation and angling[13]; can be mistaken for dry land with associated dangers for animals and humans[1,4,13]
Expectations	More negative impacts can be expected in eutrophic systems[5]
Cost of Impacts	Decreased recreational and aesthetic value; decline in ecological integrity; increased research expenses
"Eradication" Cost	Extremely expensive; eradication may be impossible
IV. Control and Prevention	
a. Detection	
Crypsis: Benefits of Early Response:	High; confused with *Callitriche* spp.[1,5] Control is more effective at an early stage of invasion and may reduce

	turion set[1,5]
b. Control	
Management Goal 1	Eradication
Tool:	Must take multi-tiered approach with large scale populations[14]
Caveat:	May be impossible, no reported success[5]
Cost:	Very expensive
Efficacy, Time Frame:	Many times per year until control is achieved
Management Goal 2	Nuisance relief
Tool:	Mechanical control
Caveat:	Must remove entire surface layer of humic sand and vegetation[6]
Cost:	Expensive and labor intensive
Efficacy, Time Frame:	Produces more fragments that can increase rate of spread
Tool:	Shading with black plastic or carpet[1,13]
Caveat:	Only useful for very small (1-20m^2) areas[1]
Cost:	Affordable
Efficacy, Time Frame:	*C. helmsii* is tolerant to shade; needs to be shaded for at least 8 weeks, preferably 6 months[1]
Tool:	Freezing with liquid nitrogen[1]
Caveat:	Only useful for small areas
Cost:	Very expensive
Efficacy, Time Frame:	Partial success reported
Tool:	Chemical (glyphosate)
Caveat:	*C. helmsii* shows high uptake resistance to chemical control[6,8]
Cost:	Expensive
Efficacy, Time Frame:	Gives 75% reduction in height[17]; elevated or multiple applications necessary at high biomass (up to 45 kg fresh wt/m^2)[8]
Tool:	Chemical (diquat)
Caveat:	Plants respond to chemical by budding, which may enhance spread[18]
Cost:	Expensive
Efficacy, Time Frame:	Most effective in the autumn and winter with water temperatures >12°C[13]; more than one application may be needed[13]; should use treatment in conjunction with containment by wire mesh[6,17]
Tool:	Biological control (grass carp)
Caveat:	*C. helmsii* is not its preferred food[10]; stocking is often illegal due to occasional fertility
Cost:	Undocumented
Efficacy, Time Frame:	Fish will not survive severe dissolved oxygen fluctuations
Documented Cost	Estimated $2 - $4 million (US) for 500 sites over 2-3 years in United Kingdom[6]
Other Options	There may be other chemical options, however, only two are permitted for aquatic use in the United Kingdom[6]

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[3] Environment Agency. 2003. Protecting our native wildlife. Guidance for the control of invasive weeds in or near fresh water. Bristol, UK. Retrieved December 21, 2010 from: http://publications.environment-agency.gov.uk/pdf/GEHO0307BLZO-e-e.pdf
[4] European and Mediterranean Plant Protection Organization. 2004. EPPO Reporting Service. Retrieved December 21, 2010 from: http://www.invasive.org/library/eppo/Rse-0403.pdf
[5] Centre for Ecology and Hydrology. 2002. *Crassula helmsii*. Focus on control – an update. Dorset, UK. Retrieved May 1, 2007 from: http://dorset.ceh.ac.uk/River_Ecology/Botany_Research/Botany_Research_Pictures/Crassula_Helmsii.pdf
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[10] Dawson, F.H. and E.A. Warman. 1987. *Crassula helmsii* (T. Kirk) Cockayne: is it an aggressive alien aquatic plant in Britain? Biological Conservation 42(4):247-272.
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[16] Author unlisted. 1993. Foreign weed raises alarm across Broads. New Scientist 138(1874):6.
[17] Child, L.E. and D. Spencer-Jones. 1993. Plant invasions: general aspects and special problems. Workshop held at Kostelec nad Cernymilesy, Czech Republic, September 16-19. 195-202.
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