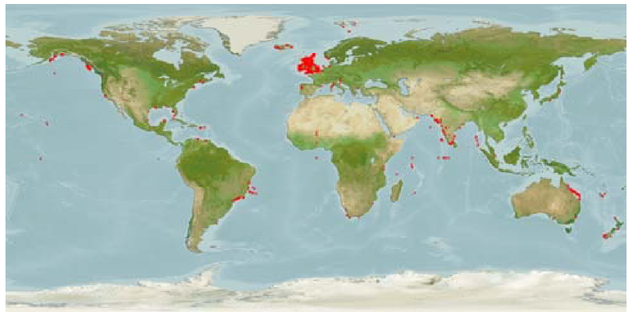
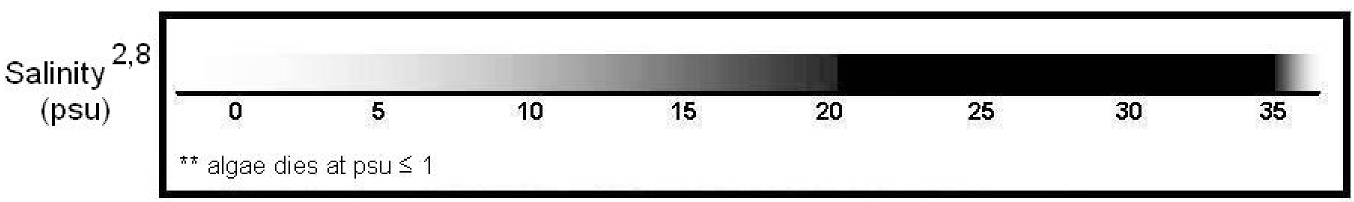
I. Current Status and Distribution — *Ulva* (*Enteromorpha*) spp.

a. Range	Global/Continental	Wisconsin
Native Range Cosmopolitan marine species[1,2]	 *Figure 1: Global Distribution Map*[3]	Not recorded in Wisconsin
Abundance/Range		
Widespread:	Worldwide coasts and estuaries	Not applicable
Locally Abundant:	Muskegon Lake, Michigan[1]; river upstream of hydropower station in Poland[4]	Not applicable
Sparse:	Undocumented	Not applicable
Range Expansion		
Date Introduced:	2003; three lakes in the Great Lakes region[1]	Not applicable
Rate of Spread:	Undocumented	Not applicable
Density		
Risk of Monoculture:	Blooms and green tides widely reported[5]; forms dense mats with masses on shore	Unknown
Facilitated By:	Addition of nitrogen (urea, nitrate, ammonium) and phosphorus; increased salinity due to industrial activity[1,6,7]	Unknown

b. Habitat	Lakes, rivers, estuaries, marine coastal waters[1,8]
Tolerance	Chart of tolerances: Increasingly dark color indicates increasingly optimal range



Preferences	In the Great Lakes Region, *E. flexuosa* subsp. *flexuosa* and subsp. *paradoxa* are found in sites that have a high level of industrial activity and hazardous waste sites[1]; eutrophic systems[8]; nutrient enrichment[6]; high salinity[1]

c. Regulation	
Noxious/Regulated:	*Not regulated*
Minnesota Regulations:	*Not regulated*
Michigan Regulations:	*Not regulated*
Washington Regulations:	*Not regulated*

II. Establishment Potential and Life History Traits	
a. Life History	Foliose tubular chlorophyte[7,9]
Fecundity	Undocumented
Reproduction	Sexual; Asexual[10]
Importance of Spores:	Zoospores less tolerant of low salinity, PO_4-P limitation and NH_4-N toxicity[8]; bloom/tide-forming version does not produce spores[5]
Vegetative:	Populations can persist through fragmentation alone[5]; lack of reliance on spores translates to broader salinity tolerance[5]
Hybridization	Undocumented
Overwintering	
Winter Tolerance:	High; survives in Lake Michigan, Manitoba; small fragments persist through winter in Finland[5,11]
Phenology:	Prolific production just after ice out in Finland[5]
b. Establishment	
Climate	
Weather:	Tolerant of very cold temperatures in Finland; also thrives in warm-water discharge area near a nuclear power plant on the Bothnian Sea[11]
Wisconsin-Adapted:	Yes
Climate Change:	Undocumented
Taxonomic Similarity	
Wisconsin Natives:	Unknown
Other US Exotics:	Cosmopolitan genus: present in oceans and estuaries of the world; also some freshwater habitats[9]
Competition	
Natural Predators:	Various benthic and other grazers
Natural Pathogens:	Undocumented
Competitive Strategy:	Eutrophication facilitates blooms which decreases space and nutrients available to other species; species is pulse tolerant[5]; can take up HCO_3 under conditions of high pH and low inorganic carbon[12]
Known Interactions:	Outcompetes phytoplankton under conditions of moderate to high nutrient concentration[1]
Reproduction	
Rate of Spread:	Undocumented
Adaptive Strategies:	Undocumented
Timeframe	Undocumented
c. Dispersal	
Intentional:	Unlikely
Unintentional:	On ships, in ballast; potentially on boats, waders, rigging; aquarium disposal
Propagule Pressure:	Undocumented

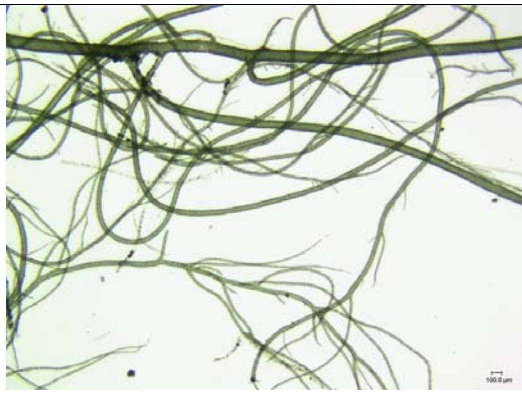


Figure 2: E. flexuosa subsp. *paradoxa; Courtesy of Lougheed and Stevenson*[1]
Figure 3: E. intestinalis; Courtesy of University of Manitoba[13]

III. Damage Potential	
a. Ecosystem Impacts	
Composition	Low epiphytic diatom densities on *Enteromorpha*[1]; blooms may be responsible for historic loss of eelgrass in southern California[5]; diversity decreases in eutrophic (bloom) conditions[14]; detrimental effects on macrofauna[15]
Structure	Declines in biomass of seagrass and macrobenthic organisms[16]; reduces sediment erosion, enhances sediment deposition[17]
Function	Green tides shade macrophytes and disrupt feeding by wading birds[5]; produces ethene (acts as macrophytic hormone)[18]; uncertain effects on littoral zone food webs[1]
Allelopathic Effects	Undocumented
Keystone Species	Undocumented
Ecosystem Engineer	Decrease in inorganic carbon is severe in high pH conditions
Sustainability	Undocumented
Biodiversity	Bloom conditions cause decrease in biodiversity[14]
Biotic Effects	Detrimental effects on macrofauna, diatoms, macrophytes[1,15,16]
Abiotic Effects	Creates conditions of high pH and low inorganic carbon[15]
Benefits	May increase rates of sedimentary nitrogen cycling[5]; affects sediment dynamics[17]
b. Socio-Economic Effects	
Benefits	Undocumented
Caveats	Not applicable
Impacts of Restriction	Increase in monitoring, education, and research costs
Negatives	Common ship-fouling alga[9]; blooms and mats are unsightly and interfere with recreation[1]
Expectations	More nuisance conditions in enriched, eutrophic disturbed systems
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:	Extremely high; high morphological plasticity[5]
Benefits of Early Response:	Undocumented

b. Control	
Management Goal 1	Nuisance relief
Tool:	Copper
Caveat:	Copper tolerance reported in *E. compressa*[19]
Cost:	Undocumented
Efficacy, Time Frame:	Undocumented
Tool:	Terbutryn
Caveat:	Kills most submerged vegetation
Cost:	Undocumented
Efficacy, Time Frame:	Regrowth often does not occur for 24 weeks

[1] Lougheed, V.L. and R.J. Stevenson. 2004. Exotic marine macroalgae (*Enteromorpha flexuosa*) reaches bloom proportions in a coastal lake of Lake Michigan. Journal of Great Lakes Research 30(4):538-544.

[2] Aliens Project, University of Oviedo. Retrieved October 26, 2010 from: http://www.unioviedo.es/bos/Aliens/E-aliens.htm

[3] Ocean Biogeographic Information System. Retrieved December 29, 2010 from: http://www.iobis.org

[4] Endler, Z., A. Goździejewska, B. Jaworska and M. Grzybowski. 2006. Impact of small hydropower station on plankton organisms in river water. Acta Scientiarum Polonorum Formatio Circumiectus 5(2):121-134.

[5] Blomster, J., S. Bäck, D.P. Fewer, M. Kiirikki, A. Lehvo, C.A. Maggs and M.J. Stanhope. 2002. Novel morphology in *Enteromorpha* (Ulvophyceae) forming green tides. American Journal of Botany 89(11):1756-1763.

[6] Fong, P., J.J. Fong and C.R. Fong. 2004. Growth, nutrient storage, and release of dissolved organic nitrogen by *Enteromorpha intestinalis* in response to pulses of nitrogen and phosphorus. Aquatic Botany 78(1):83-95.

[7] Lotze, H.K. and W. Schramm. 2000. Ecophysiological traits explain species dominance patterns in macroalgal blooms. Journal of Phycology 36(2):287-295.

[8] Sousa, A.I., I. Martins, A.I. Lillebø, M.R. Flindt and M.A. Pardal. 2007. Influence of salinity, nutrients and light on the germination and growth of *Enteromorpha* sp. spores. Journal of Experimental Marine Biology and Ecology 341(1):142-150.

[9] Tanner, C. 2000. Updated by Wilkes, R. 2005. *Ulva* Linnaeus, 1753:1163. Algaebase. Retrieved October 22, 2010 from: http://www.algaebase.org/search/genus/detail/?genus_id=33

[10] Alström-Rapaport, C., E. Leskinen and P. Pamilo. 2010. Seasonal variation in the mode of reproduction of *Ulva intestinalis* in a brackish water environment. Aquatic Botany 93(4):244-249.

[11] Snoeijs, P. 1992. Ecology and taxonomy of *Enteromorpha* species in the vicinity of the Forsmark nuclear power plant (Bothnian Sea) Acta Phytogeographica Suecica 78:11-23.

[12] Björk, M., L. Axelsson and S. Beer. 2004. Why is *Ulva intestinalis* the only macroalga inhabiting isolated rock pools along the Swedish Atlantic coast? Marine Ecology Progress Series 284:109-116.

[13] Prairie Wetland Ecology Team, University of Manitoba. Retrieved October 8, 2007 from: http://www.umanitoba.ca/faculties/science/delta_marsh/pwet/pictures.html

[14] Worm, B. and H.K. Lotze. 2006. Effects of eutrophication, grazing, and algal blooms on rocky shores. Limnology and Oceanography 51(1, Part 2):569-579.

[15] Cardoso, P.G., M.A. Pardal, D. Raffaelli, A. Baeta and J.C. Marques. 2004. Macroinvertebrate response to different species of macroalgal mats and the role of disturbance history. Journal of Experimental Marine Biology and Ecology 308(2):207-220.

[16] Cummins, S.P., D.E. Roberts and K.D. Zimmerman. 2003. Effects of the green macroalga *Enteromorpha intestinalis* on macrobenthic and seagrass assemblages in a shallow coastal estuary. Marine Ecology Progress Series 266:77-87.

[17] Romano, C., J. Widdows, M.D. Brinsley and F.J. Staff. 2003. Impact of *Enteromorpha intestinalis* mats on near-bed currents and sediment dynamics: flume studies. Marine Ecology Progress Series 256:63-74.

[18] Plettner, I., M. Steinke and G. Malin. 2005. Ethene (ethylene) production in the marine macroalga *Ulva* (*Enteromorpha*) *intestinalis* L. (Chlorophyta, Ulvophyceae): effect of light-stress and co-production with dimethyl sulphide. Plant, Cell and Environment 28(9):1136-1145.

[19] Lobban, C.S. and P.J. Harrison. 1994. Seaweed Ecology and Physiology. P 263. Cambridge: Cambridge University Press.