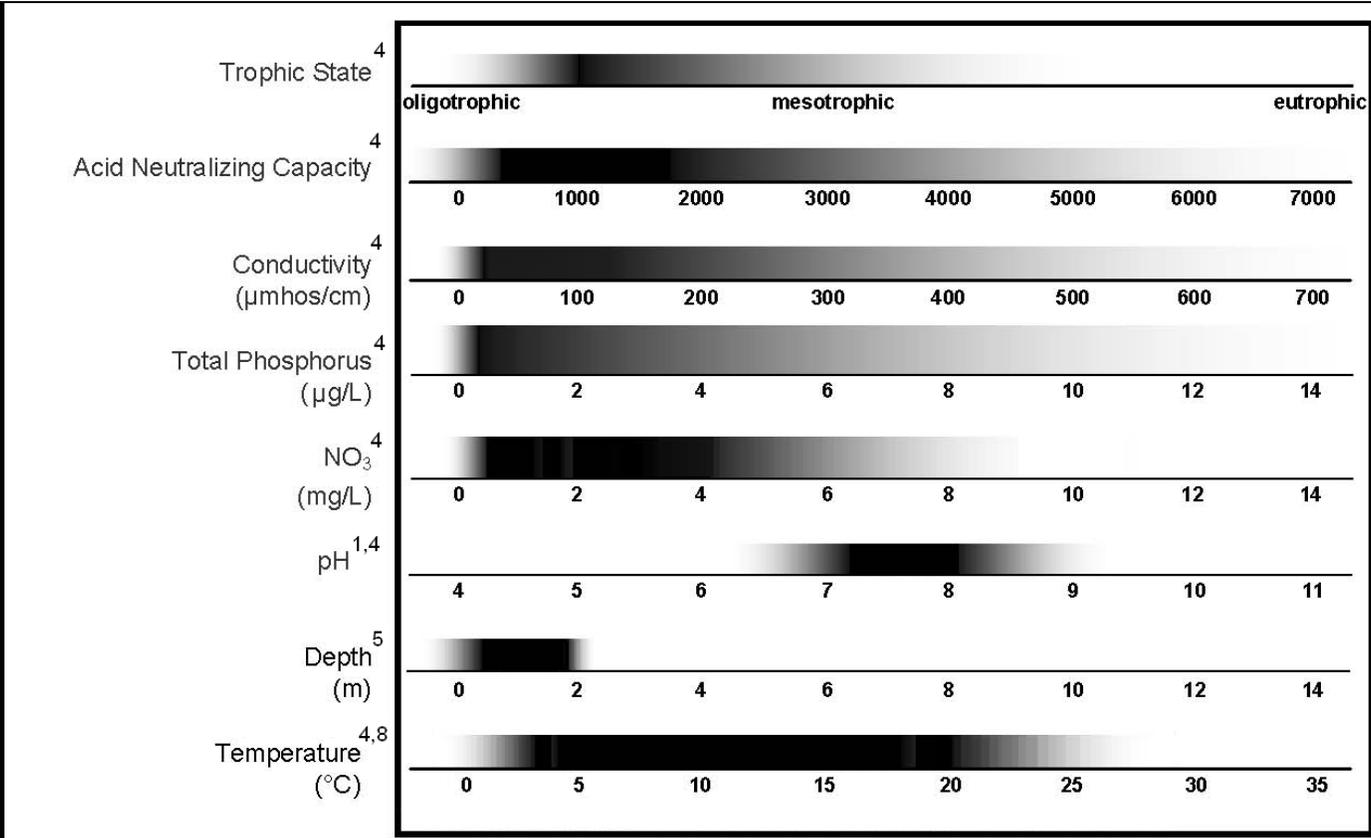


I. Current Status and Distribution		<i>Didymosphenia geminata</i>	
a. Range	Global/Continental		Wisconsin
<p>Native Range Northern Europe, Northern North America¹</p>	 <p>Confirmed presence of <i>D. geminata</i> in the United States and Canada. A total of 401 samples are included. Records are based on data from USGS National Water Quality Assessment (NAWQA), EPA Environmental Monitoring and Assessment (EMAP), and samples from other studies. (Map by Karl Hiemstra, Sarah Spaulding, and Tera Keller)</p> <p>Legend • <i>Didymosphenia geminata</i> Observed Canada United States Mexico</p> <p>Figure 1: U.S Distribution Map²</p>		 <p>Figure 2: WI Distribution Map²</p>
<p>Abundance/Range Widespread: Locally Abundant: Sparse:</p>	<p>Cold, oligotrophic waters^{3,4} Undocumented Undocumented</p>		<p>Undocumented Lake Superior Undocumented</p>
<p>Range Expansion Date Introduced: Rate of Spread:</p>	<p>Undocumented Spread from 1 to 12 streams in 1.5 years⁴; Excessive blooms at several sites⁴</p>		<p>Undocumented Expanding range includes higher nutrient systems⁴</p>
<p>Density Risk of Monoculture: Facilitated By:</p>	<p>High; can completely cover substrate in a layer 20 cm thick⁴ Good sunlight exposure¹; substrate of hard intrusive or volcanic rock⁵</p>		<p>Undocumented Undocumented</p>
<p>b. Habitat</p>	<p>Nuisance blooms known only in streams and rivers, often formerly of pristine condition⁴; rarely found in lakes^{1,5}</p>		
<p>Tolerance</p>	<p>Chart of tolerances: Increasingly dark color indicates increasingly optimal range</p>		



Preferences Traditionally restricted to clear, oligotrophic waters, now grows in more nutrient-rich streams and rivers; prefers low- and stable-flow shallow systems^{4,5}; stable substrate and high light conditions¹

c. Regulation

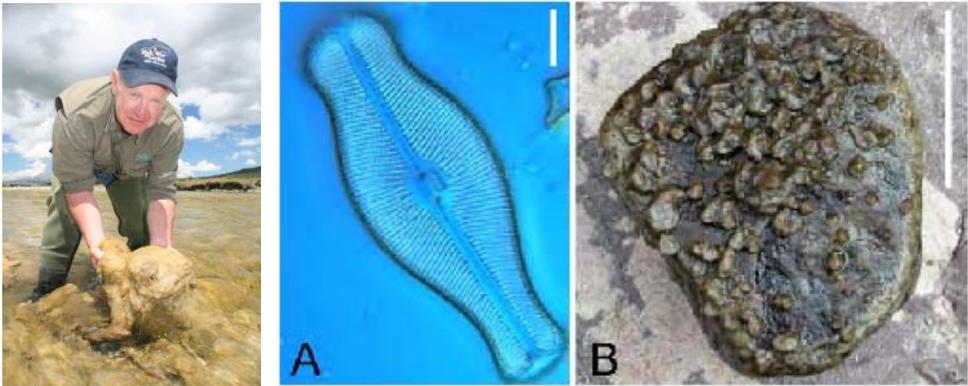
Noxious/Regulated:	<i>Not regulated</i>
Minnesota Regulations:	<i>Not regulated</i>
Michigan Regulations:	<i>Not regulated</i>
Washington Regulations:	<i>Secondary Species of Concern</i>

II. Establishment Potential and Life History Traits

a. Life History	Unicellular benthic freshwater diatom ^{4,8}
Fecundity	High; generation times reported to be less than 30 hours ⁶
Reproduction	Mainly asexual; possibly sexual to restore cell size (undocumented) ⁵
Importance of Spores:	Not applicable
Vegetative:	Cell division ¹
Hybridization	Undocumented; three 'morphotypes' have been described ⁵
Overwintering	
Winter Tolerance:	High
Phenology:	Undocumented

b. Establishment

Climate	
Weather:	Influenced annually by weather and rainfall patterns ¹
Wisconsin-Adapted:	Likely
Climate Change:	Warmer winters may favor growth and range expansion ⁵

Taxonomic Similarity Wisconsin Natives: Other US Exotics:	Unknown Unknown
Competition Natural Predators: Natural Pathogens: Competitive Strategy: Known Interactions:	Undocumented <i>D. geminata</i> stalks are resistant to degradation by bacteria and fungi ⁴ Short generational time; rapid stalk production ⁴ Dense mats exclude the growth of other diatoms ^{1,5} ; smothers streambeds which adversely affects fish, plant, and invertebrate species ³
Reproduction Rate of Spread: Adaptive Strategies:	Potentially very high (given high water flow after successful establishment) ⁵ Prolific stalk production leads to very high proportional biovolume ⁴ ; increasing nuisance reports may be due to a genetic variant ⁵ ; cells can remain viable for up to 40 days under optimal conditions ⁴
Timeframe	Benthic growths can extend beyond 1 km and persist for several months ⁴
c. Dispersal	
Intentional: Unintentional: Propagule Pressure:	Unlikely Recreational equipment, boats, waders, footwear, wind, water, animals ⁵ High; one single cell is capable of generating a new population ^{3,5}
	
<p>Figure 3: Courtesy of MAF Biosecurity New Zealand⁷ Figure 4: S.A. Spaulding and E. Elwell, USGS⁴</p>	
III. Damage Potential	
a. Ecosystem Impacts	
Composition	"Desirable" invertebrate species are lower in sites affected with <i>D. geminata</i> ⁶ , resulting in impacts to predatory fish and several endangered and threatened bird species ⁸ ; anecdotal reports of salmonid parr reduction due to abrasion of gills ⁸ ; can eliminate macrophytes and moss ^{5,8}
Structure	Massive blooms cover rocks, plants, and other materials ¹ ; reduces number of suitable habitats for fish, plant, invertebrate, and algal species ^{1,4}
Function	Potentially causes significant diurnal dissolved oxygen fluctuations ⁸ ; may impact ecosystem metabolism and nutrient cycling ⁴
Allelopathic Effects	Undocumented
Keystone Species	Undocumented
Ecosystem Engineer	Yes; dense cover displaces macrophytes ⁸
Sustainability	Undocumented
Biodiversity	Affects invertebrate diversity ^{4,5}

Biotic Effects	Impacts native species at multiple trophic levels
Abiotic Effects	Dissolved oxygen fluctuations
Benefits	May increase invertebrate diversity ⁴
b. Socio-Economic Effects	
Benefits	Undocumented
Caveats	Not applicable
Impacts of Restriction	Increase in monitoring, education, and research costs
Negatives	Unightly appearance when blooming ⁸ ; negative effects on tourism and recreation ¹ ; irritates swimmers due to its siliceous nature ^{5,8} ; blocks water filters, hydro-power canals ¹ and pipelines ⁸ ; extreme risk perceived to social, environmental and economic values ⁸
Expectations	More negative impacts can be expected in high silica, cold oligotrophic, sunny systems ^{1,6}
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:	Medium (<i>Cymbella</i> spp., <i>Gomphoneis</i> spp., and <i>Gomphonema</i> spp.) ¹
Benefits of Early Response:	Undocumented; eradication is likely not possible ³
b. Control	
Management Goal 1	Nuisance relief
Tool:	Biocide (chelated copper) coupled with spread reduction ⁴
Caveat:	Chelated copper not tested on <i>D. geminata</i> outside New Zealand
Cost:	Massive public education effort necessary ⁴
Efficacy, Time Frame:	Many years required for behavioral shift

¹ Global Invasive Species Database. 2010. *Didymosphenia geminata*. Retrieved December 21, 2010 from: <http://www.invasivespecies.net/database/species/ecology.asp?si=775&fr=1&sts=sss>

² Hermann, K., S. Spaulding and T. Keller. Confirmed presence of *D. geminata* in the United States and Canada. Retrieved December 21, 2010 from: http://www.epa.gov/region8/water/didymosphenia/na_dis.map.pdf

³ United States Environmental Protection Agency (EPA). Didymo: a nuisance and invasive freshwater alga. Retrieved December 21, 2010 from: <http://www.epa.gov/region8/water/didymosphenia/International%20fact%20sheet.pdf>

⁴ Spaulding, S.A. and L. Elwell. 2007. Increase in nuisance blooms and geographic expansion of the freshwater diatom *Didymosphenia geminate*. USGS Open-File Report 2007-1425, 38 p. Retrieved December 21, 2010 from: <http://www.fort.usgs.gov/products/publications/22046/22046.pdf>

⁵ Kilroy, C. 2004. A new alien diatom, *Didymosphenia geminata* (Lyngbye) Schmidt: its biology, distribution, effects and potential risks for New Zealand fresh waters. National Institute of Water and Atmospheric Research Ltd. Prepared for Environment Southland. Client Report: CHC2004-128, NIWA Project: ENS05501. Christchurch, New Zealand. Retrieved December 21, 2010 from: <http://www.biosecurity.govt.nz/files/pests/didymo/didymo-preliminary-org-ia-nov-04.pdf>

-
- ⁶ Kilroy C., B. Biggs, N. Blair, P. Lambert, B. Jarvie, K. Dey, K. Robinson and D. Smale. 2005. Ecological studies on *Didymosphenia geminata*. National Institute of Water and Atmospheric Research Ltd. New Zealand. Client Report: CHC2005-123, NIWA Project: MAF05505. Christchurch, New Zealand.
- ⁷ MAF Biosecurity New Zealand. Didymo photos. Retrieved December 21, 2010 from: <http://www.biosecurity.govt.nz/pests/didymo>
- ⁸ Campbell, M.L. 2005. Organism impact assessment (OIA) for potential impacts of *Didymosphenia geminata*. All Oceans Ecology. Victoria, Australia. Retrieved December 21, 2010 from: <http://www.biosecurity.govt.nz/files/pests/didymo/didymo-org-ia-oct-05.pdf>