Evaluation of Chemical Biocides and Algaecides for Controlling Sprouting of *Nitellopsis obtusa* (Starry Stonewort) Bulbils

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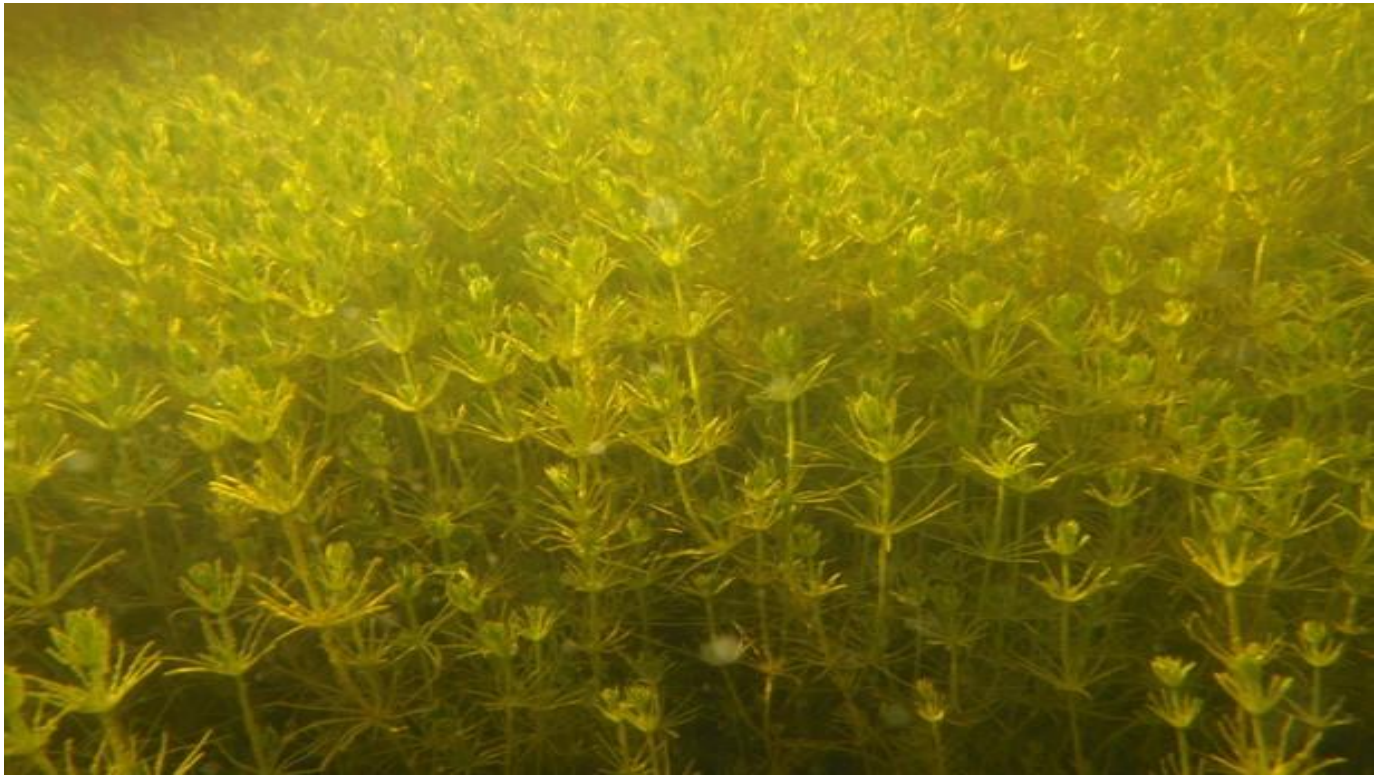
Nitellopsis obtusa

- **Starry Stonewort (*Nitellopsis obtusa* (Desv.) J.Grove) is a non-native macro-alga.**

- **Colonizes deep water, develops thick mats, grows later, and persists longer in the growing season than native vegetation (Nichols et al. 1988)**

Nitellopsis obtusa



Nitellopsis obtusa

- **Native to Eurasia, from the west coast of Europe to Japan (Mills et al. 1993, Soulie-Marsche et al. 2002).**
- **In native habitat, typically found at depths of 3–8 m, preferring deeper habitats with low light transmittance but relatively high calcium and phosphorus content, where other stoneworts generally occur less frequently (Berger and Schagerl 2004, Nicholls et al. 1988, Schloesser et al. 1986).**

- **First U.S. observation in 1978 along the St. Lawrence River (Geis et al. 1981; Mills et al. 1993).**

Nitellopsis obtusa

- **Likely introduced to the Great Lakes in ballast water.**

  (Mills et al. 1993, Schloesser et al. 1986).
- **Produces distinct star-shaped bulbils that can sprout and grow a new plant.**
- **Can also spread by fragments.**

  (Pullman and Crawford 2010).

What are bulbils?

- **Bulbil - a small bulblike structure, especially in the axil of a leaf or at the base of a stem, that can form a new plant.**

N. obtusa Ecology

- **Peak Biomass = 259 g m^{-2} (in September)**

  Nicholls et al. 1988, Schloesser et al. 1986.

- **Established *N. obtusa* forms dense mats that completely cover the lake bottom.**
- **Mats can act as benthic barrier and lead to accumulation of phytotoxins that could further alter redox conditions.**

  Pullman and Crawford 2010.

Adverse Effects of Starry Stonewort

- Loss of habitat.
- Decrease diversity of aquatic species.
- Limit access to water.
- Risks for swimmers.
- Decrease recreation opportunities.
- Decrease property values.
- Loss of tax revenue.

Laboratory Studies of the Vulnerability of *Nitellopsis obtusa* to Algaecide and Herbicide Exposures

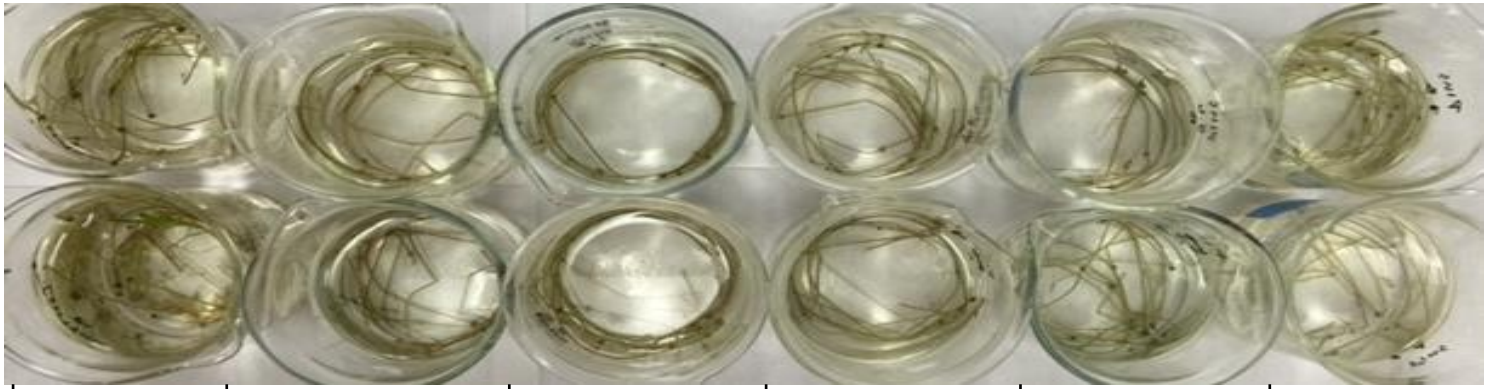
- **Exposures in 250 mL beakers.**
- **Exposures prepared with 200 mL of site water**
- **Exposed approximately 1 g (wet weight) of *Nitellopsis obtusa* per replicate, 2 replicates per exposure**
- **Treatment sites have rapid dispersion and dilution of copper due to water movement**
  - **exposures renewed with 100mL site after a contact time of 2hrs**
- **Calculations for the mass of algaecide applied per g alga were based on assumption that the treatment area was 7ft deep.**
- **Observations of algal responses were continued for 7 days.**
- **Concentrations of chlorophyll *a* were measured after 7 days.**

Formulation	Initial Exposure (mg Cu/g alga)
Clearigate®	1.4, 2.8, 4.2, 5.6, 7
Cutrine-Plus® (liquid)	1.4, 2.8, 4.2, 5.6, 7
Cutrine-Plus Granular®	0.5, 1.0, 1.5
Harpoon Granular®	0.5, 1.0, 1.5

Water Characteristics	
pH (S.U.)	7.66
Alkalinity	300 mg $CaCO_3$ / L
Hardness	340 mg $CaCO_3$ / L
Dissolved Oxygen	10.41 mg O_2/L
Conductivity	470 µS/cm
Temperature	21 °C

Results:

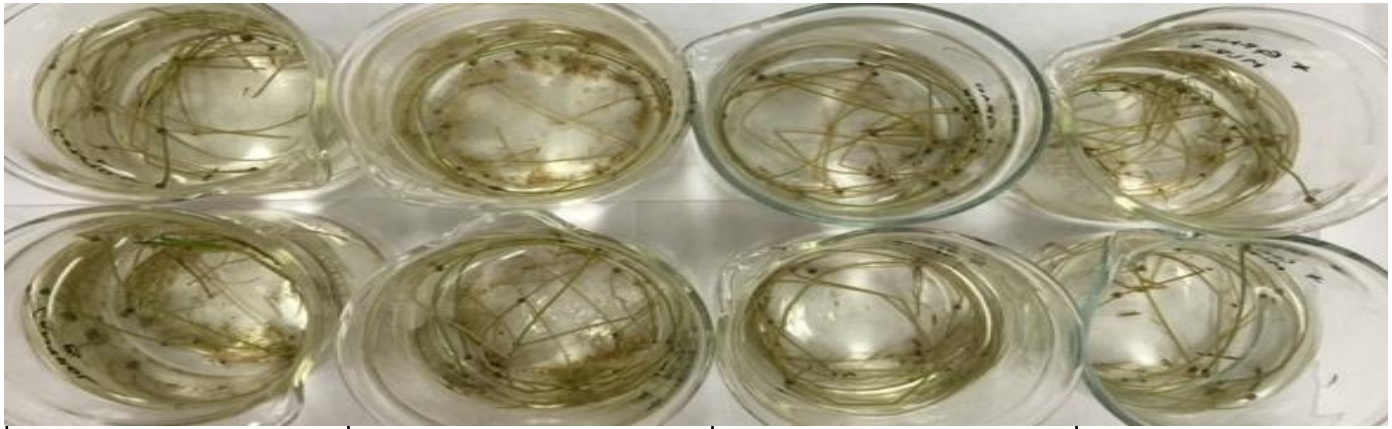
Responses of *Nitellopsis obtusa* to exposures of Cutrine-Plus® (liquid)



Cutrine-Plus® (mg Cu/g alga)	Untreated Control	1.4	2.8	4.2	5.6	7
Avg. Day 7 Chlorophyll-a (µg chl-a/ g alga)	126	88.5	108.6	90.9	87.4	63.6

Results:

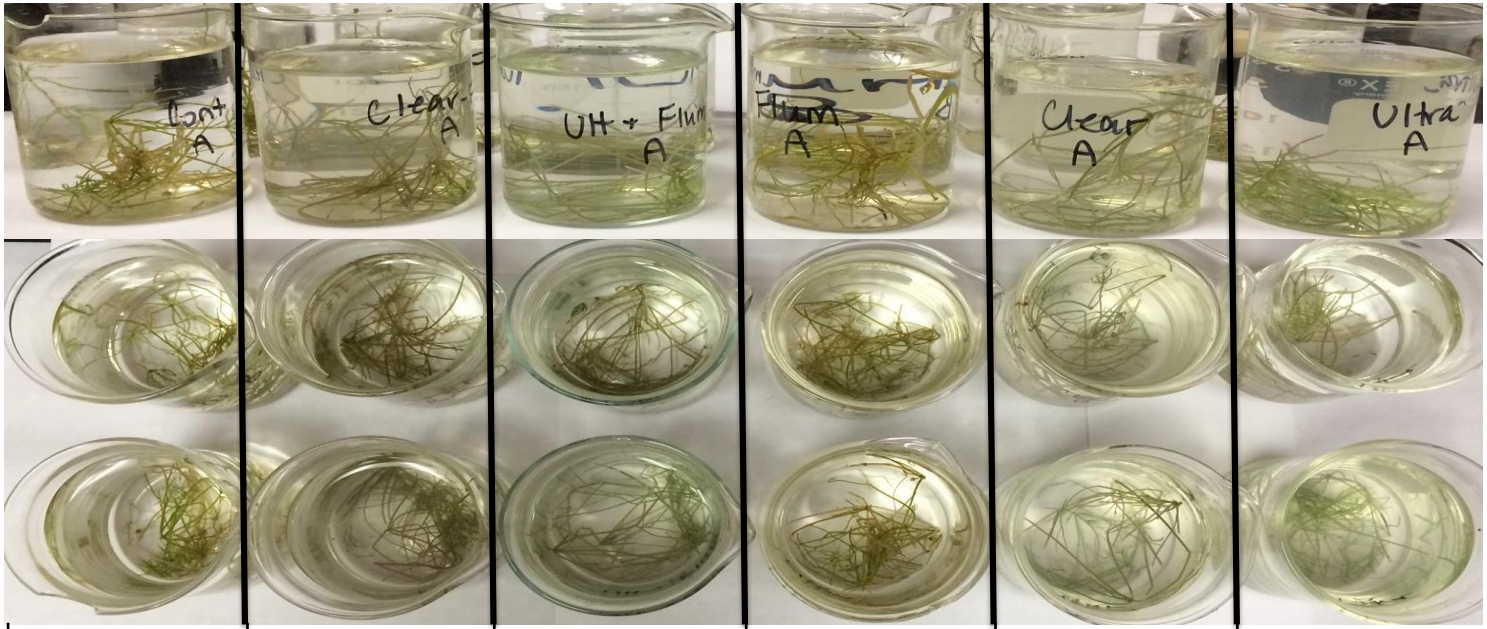
Responses of *Nitellopsis obtusa* to exposures of Cutrine-Plus® Granular



Cutrine-Plus® Granular (mg Cu/g alga)	Untreated Control	0.5	1.0	1.5
Avg. Day 7 Chlorophyll-a (µg chl-a/ g alga)	126	163	121	123

Results:

Responses of *Nitellopsis obtusa* to algaecide and herbicide exposures



Exposure	Untreated Control	Clearigate® and Clipper®	Cutrine-Ultra® and Clipper®	Clipper®	Clearigate®	Cutrine-Ultra®
Avg. Day 7 Chlorophyll-*a* (µg chl-*a*/ g algae)	2.98 x10^4	2.45 x10^4	1.44 x10^4	1.53 x10^4	1.18 x10^4	2.03 x10^4

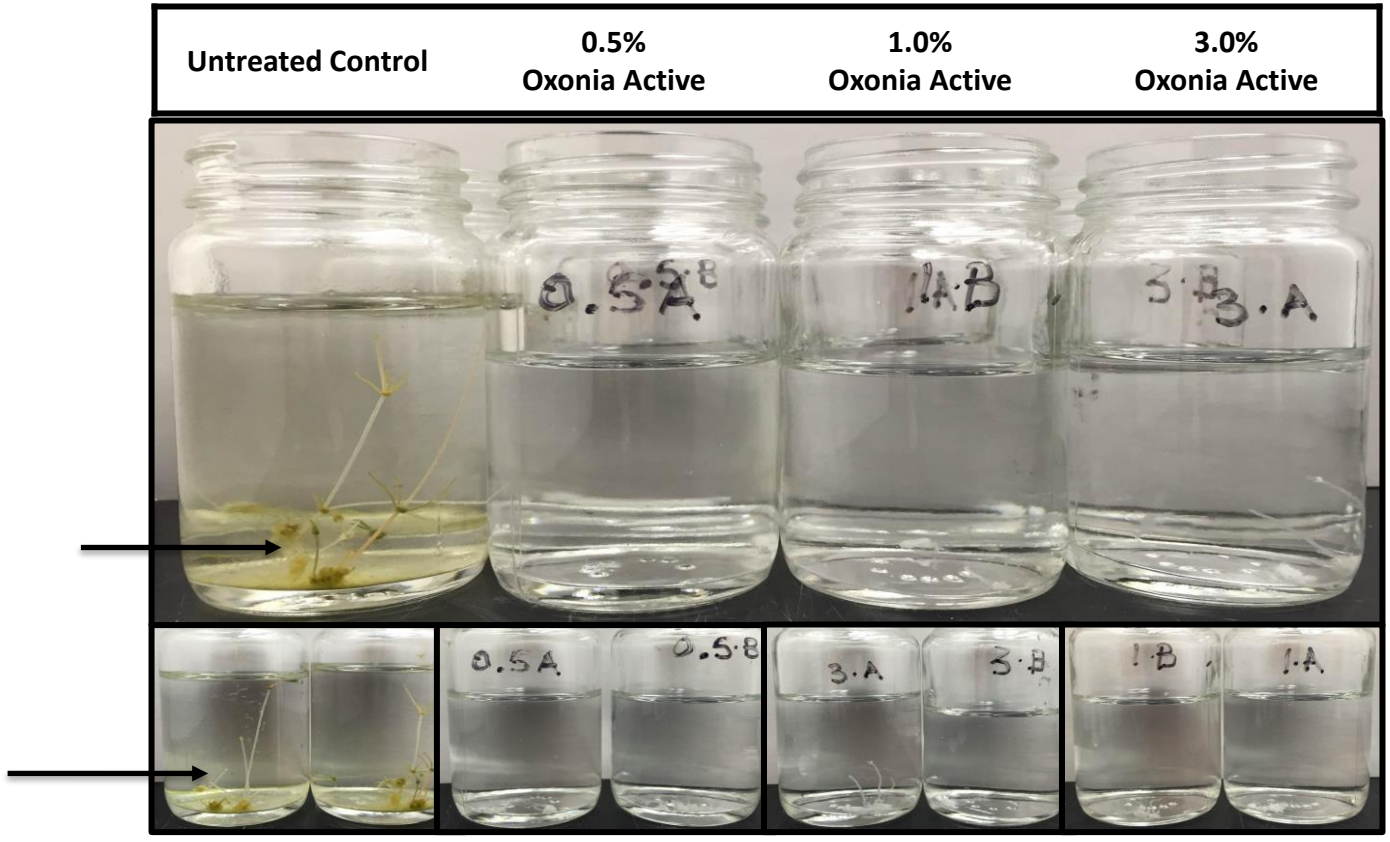
Vulnerability of *Nitellopsis obtusa* Bulbils to Biocide Exposures

- Exposures prepared with site-collected water
- 2 replicates per exposure, 4 bulbils per replicate
- Exposure solutions of Oxonia Active (as Oxonia Active)
  - 0.5%
  - 1.0%
  - 3.0%
  - Untreated control
- Bulbil propagation evaluated in terms of growth of defined algal thallus from bulbils.
- Visual observations of bulbil propagation continued for 6 WAT.

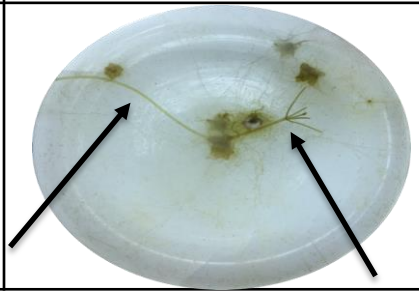
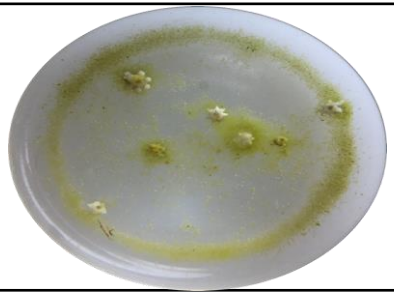
Initial water characteristics

pH (S.U.)	Alkalinity (mg $CaCO_3$/L)	Hardness (mg $CaCO_3$/L)	Dissolved Oxygen (mg O_2/L)	Conductivity (µS/cm)	Temperature (°C)
7.66	300	340	10.41	470	21

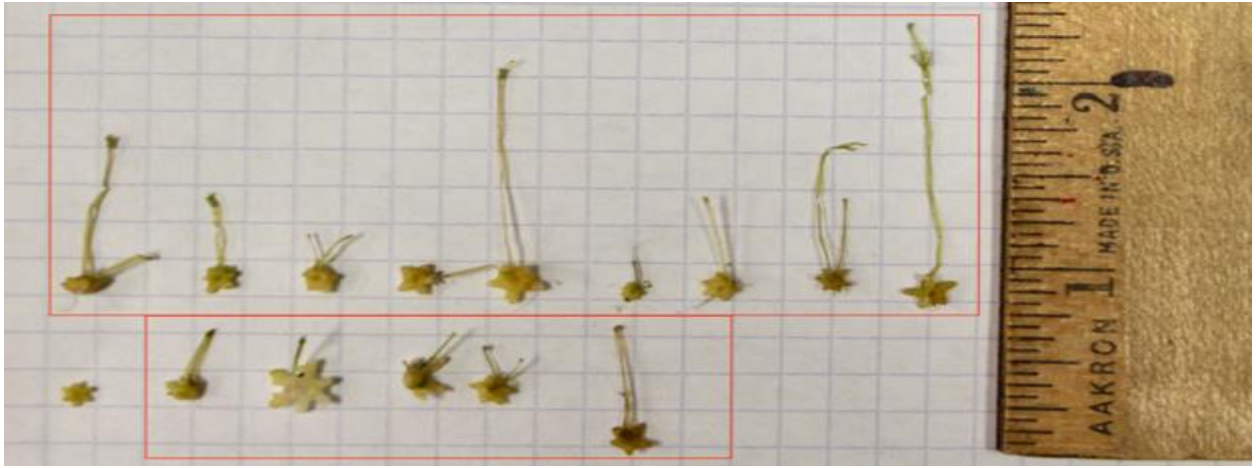
Results:
Vulnerability of *Nitellopsis obtusa* Bulbils to Biocide Exposures



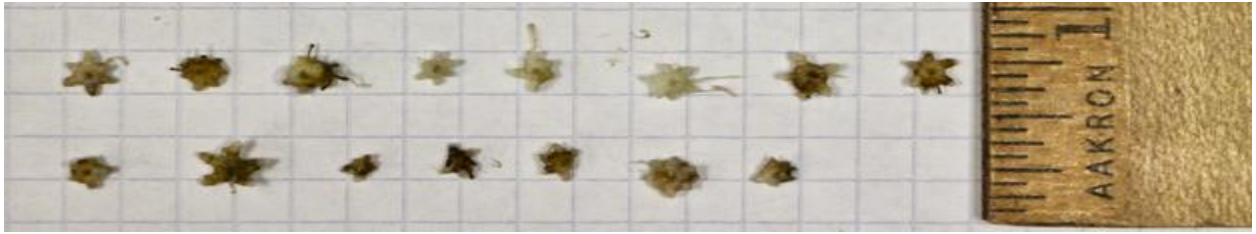
Vulnerability of *Nitellopsis obtusa* Bulbils to Algaecide Exposures

Weeks after treatment (WAT)	Treatment		
	Control	Cutrine®-Plus	Phycomycin® SCP
Initial			
6 WAT			

Vulnerability of *Nitellopsis obtusa* Bulbils to Algaecide Exposures



Untreated *N. obtusa* bulbils



N. obtusa bulbils following exposure to 1.0 mg Cu/L as Clearigate®

Vulnerability of *Nitellopsis obtusa* to laboratory exposures of algaecides and herbicides

-Exposures of 5.6 mg Cu/g algae as Cutrine®-Plus (liquid) and 4.2 mg Cu/g algae as Clearigate® yielded visible results (*i.e.* algae color change from green to light-green) and decreases in chlorophyll *a* concentrations

-Exposures of 1 mg Cu/g algae Clearigate® yielded visible results (*i.e.* algae color change from green to light-green) and decreases in chlorophyll *a* concentrations

Vulnerability of *Nitellopsis obtusa* bulbils to laboratory exposures of biocides and algaecides

-Solutions of Oxonia Active greater than 0.5% (as Oxonia Active) prevented propagation of bulbils for a duration of 6 weeks post-treatment

-Exposures of 1.0 mg Cu/L as Cutrine®-Plus and 10.2 mg H_2O_2/L as Phycomycin® SCP prevented propagation of bulbils for a duration of 6 weeks post-treatment

-Relative to untreated (control) bulbils, exposures of 1.0 mg Cu/L as Cutrine®-Plus, 0.6 mg Cu/L and 1.0 mg Cu/L as Clearigate®, and and 1.0 mg Cu/L as Cutrine® Granular resulted in fewer propagated bulbils and less growth of vegetative tissue 2 weeks after treatment

Thank you!