Ecological Factors Associated with Dense Growth of Invasive *Nitellopsis obtusa*

United States Army Corps of Engineers
Starry stonewort Workshop
Oconomowoc Community Center
Oconomowoc, Wisconsin

Thursday, September 7, 2017 @ 1330

Presentation and Photos
by

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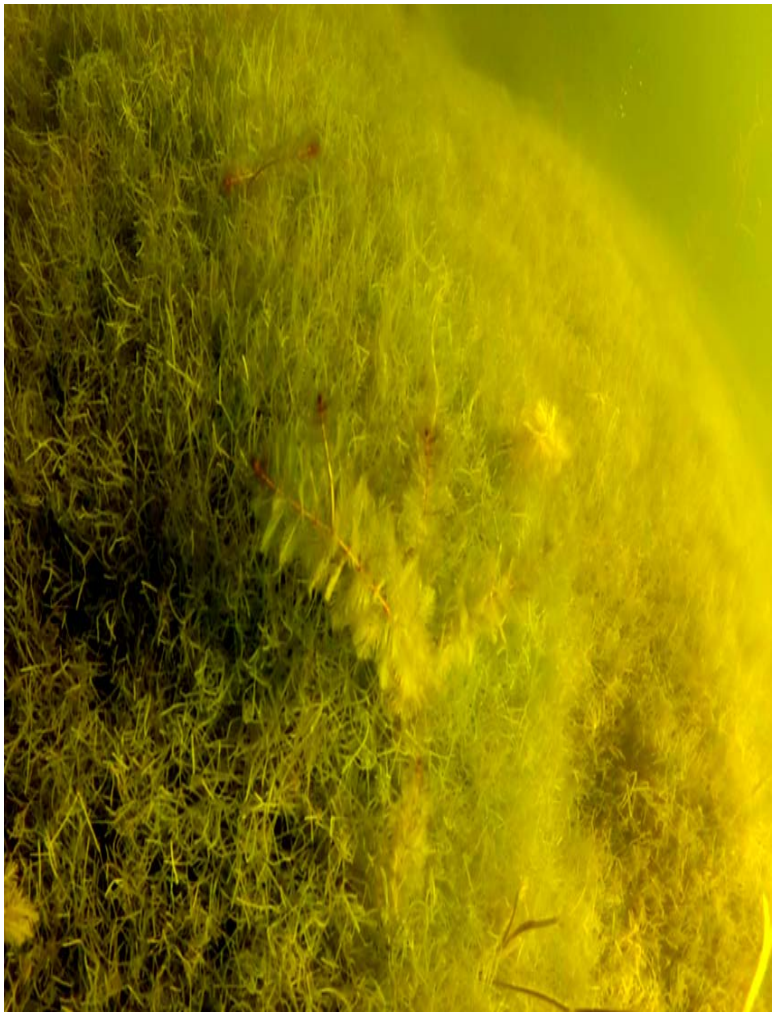
Michigan Lake & Stream Associations
Executive Director

Ecological Factors Associated with Dense Starry stonewort Growth

"The most likely ''monsters'' in fresh waters are those species whose physiological requirements closely match with the environmental characteristics of the recipient system…"

Francesca Gherardi, 2007



Inland Lake Trophic State Conditions Associated with Abundant Growth of Starry stonewort

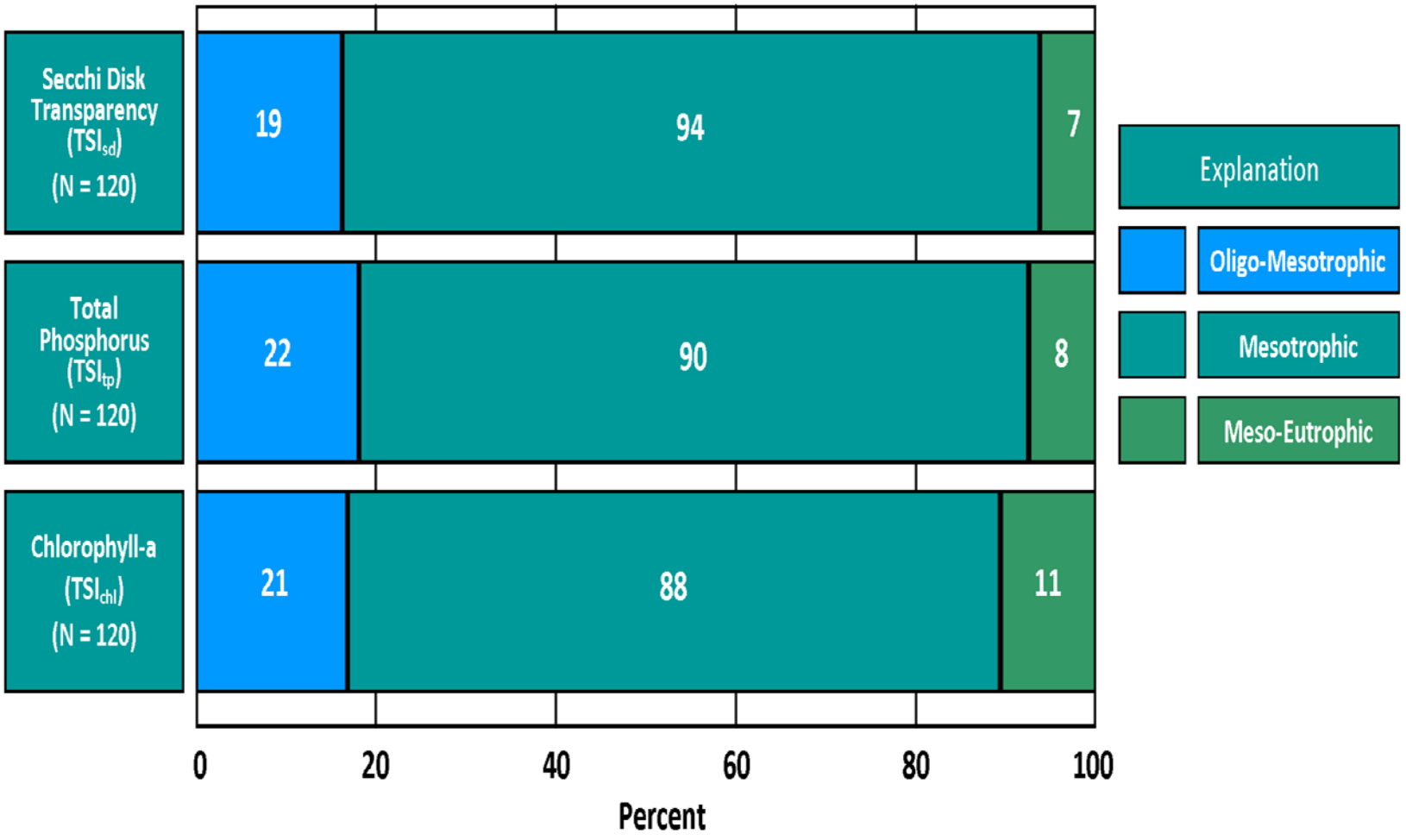
The critical role of **light** is supported by the observation that the occurrence of most species of Characeae, and in particular *N. obtusa*, become rare with increasingly eutrophic conditions, and steadily decreasing light availability (Blindlow, 1992; van den Berg, 1999; Apolinarska *et al*., 2011).

Trophic State Data for Michigan Starry stonewort invaded inland lakes

N = 120

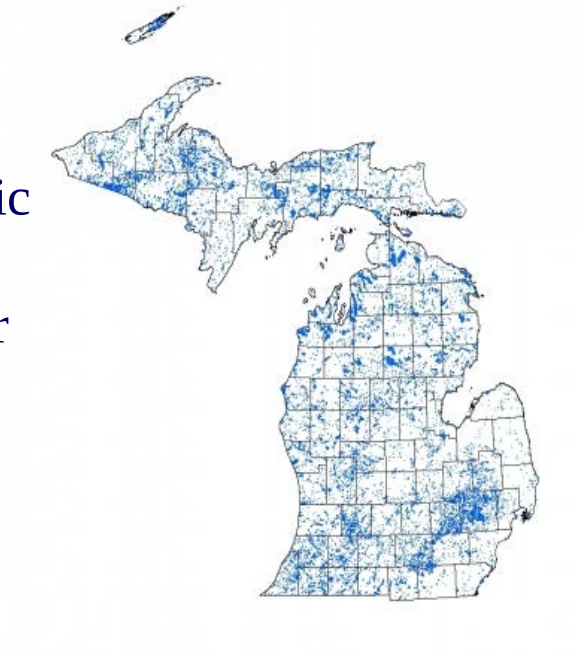
Carlson Trophic Index Parameters	Secchi Disk Transparency (Meters)	Total Phosphorus (µg/l)	Chlorophyll-a (µg/l)
Minimum	1.36	8.0	1.5
Maximum	5.49	33	13
Mean	3.08	17	4.75
Mode	3.35	15	3.6

Carlson Trophic State Classification Distribution of Invaded Lakes



Colonization Potential of Starry Stonewort in Michigan

Oligo-mesotrophic and mesotrophic conditions fostered and sustained by the stable state aquatic macrophyte dominated ecosystems required for the successful introduction of invasive *Nitellopsis obtusa* are found in approximately 75% of the 6,537 inland lakes in Michigan of ≥ 4 ha (10 acres) in size.



Graphic: MiCorps

Physical Attributes of Starry stonewort Invaded Inland Lakes

Surface Area

- N = 118
- Mean Surface Area: 111 hectares
  274 acres
- Median Surface Area: 75 hectares
  185 acres
- Outliers: Houghton: 8,115 hectares
  20,052 acres

  Gun: 1,085 hectares
  2,681 acres

Graphic: MiCorps

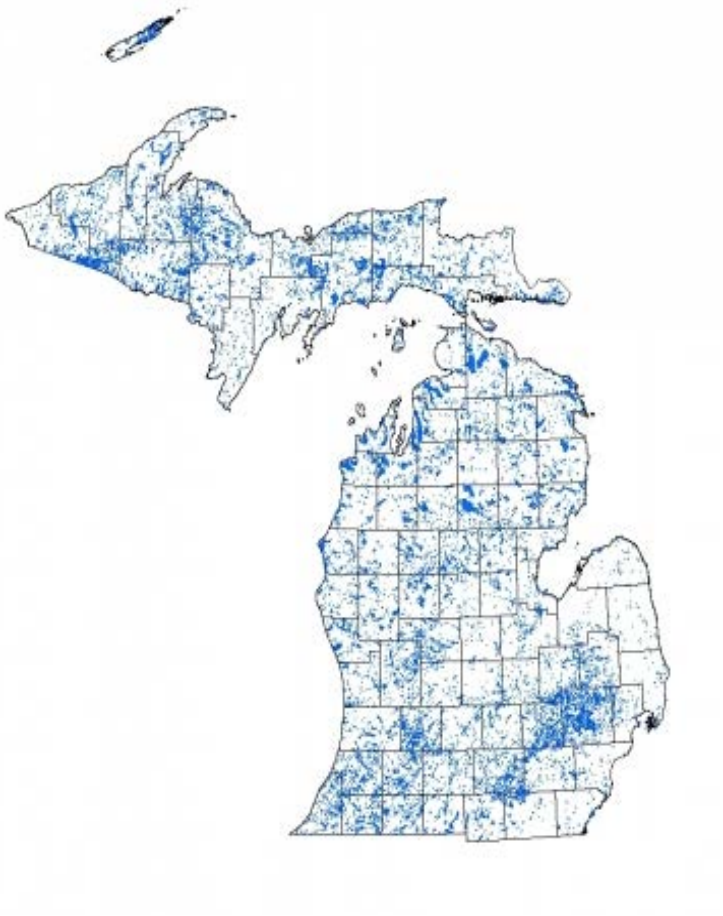
Physical Attributes of Starry stonewort Invaded Inland Lakes

Depth

- N = 120

- Mean Maximum Depth: 12.45 meters
- Median Max. Depth: 12.0 meters
- Mode: 12.8, 7.62, 16.75

- Mean Average Depth: 4.72 meters
- Median Mean Depth: 4.2 meters
- Mode: 3



Graphic: MiCorps

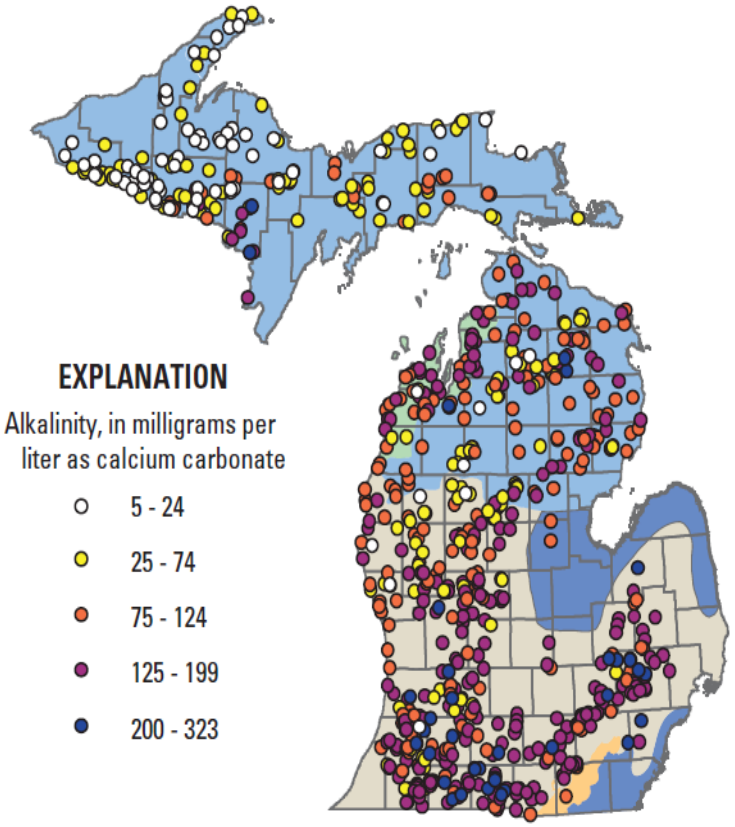
Physical Attributes of Starry stonewort Invaded Inland Lakes

Residential Shoreline Development

- N = 120
- Mean Development: 68%
- Median Development: 70%
- Mode: 90%
- Range: 10% - 100%

The Critical Role of Calcium Carbonate

The overall importance of calcium carbonate is effectively illustrated by the fact that the most abundant occurrences of Starry stonewort are strictly limited to moderately productive freshwater ecosystems possessing high alkalinity (hardwater) levels that are associated with the prevalence of calcium carbonate ($CaCO_3$)…



The Critical Role of Calcium Carbonate

The high proportion of medium to high alkalinity lakes in the southern portion of Michigan results from limestone bedrock and thick glacial deposits that dominate the Lower Peninsula. Limestone and overlying glacial deposits are rich in calcium carbonate, and groundwater and surface waters interacting with these formations provide much greater buffering capacity to lakes (Wehrly *et al*., 2015).

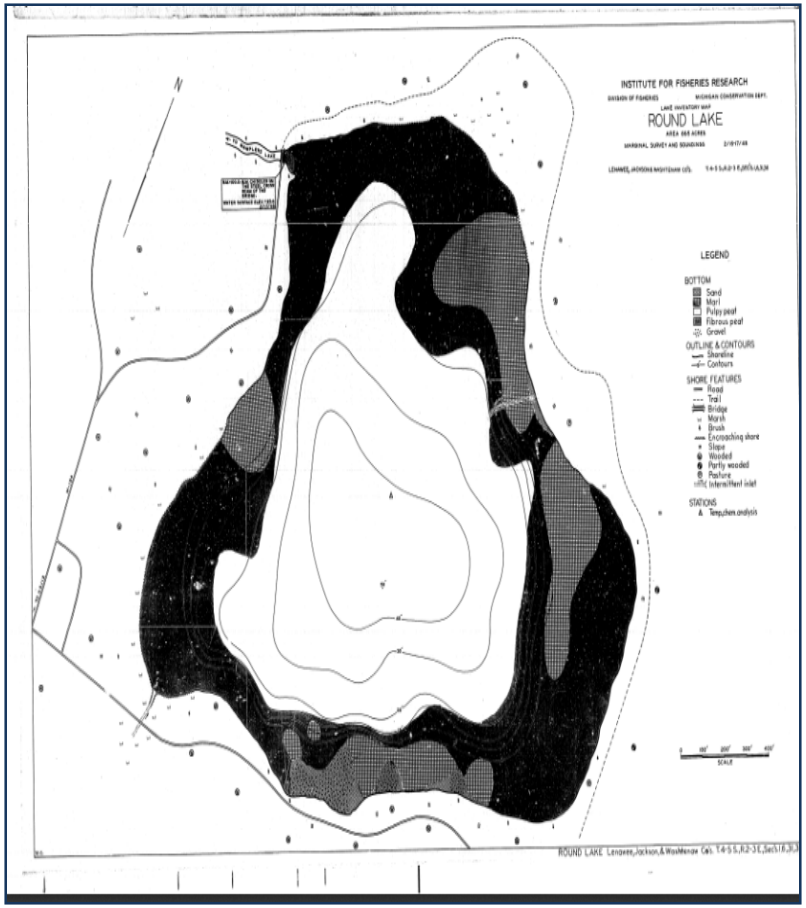
The Role of Macrophytes in Creating Optimal Conditions for the Successful Introduction and Establishment of Starry stonewort

Macrophytes, and in particular Characeae species, increase water clarity dependent light availability, and help stabilize aquatic ecosystems by:

- inhibiting the resuspension of bottom particulate
- promoting deposition of fine organic particulate matter that serves as optimal growth substrate
- providing zooplankton with a refuge from grazing by fish
- utilizing and precipitating calcite (marl) causing immobilization of phosphorus, therefore inhibiting primary production
- suppressing the growth of phytoplankton by acting as a nutrient sink
- releasing allelopathic substances that inhibits the growth of light attenuating phytoplankton
- contributing to stable ecological conditions that are conducive to their own growth and sustenance

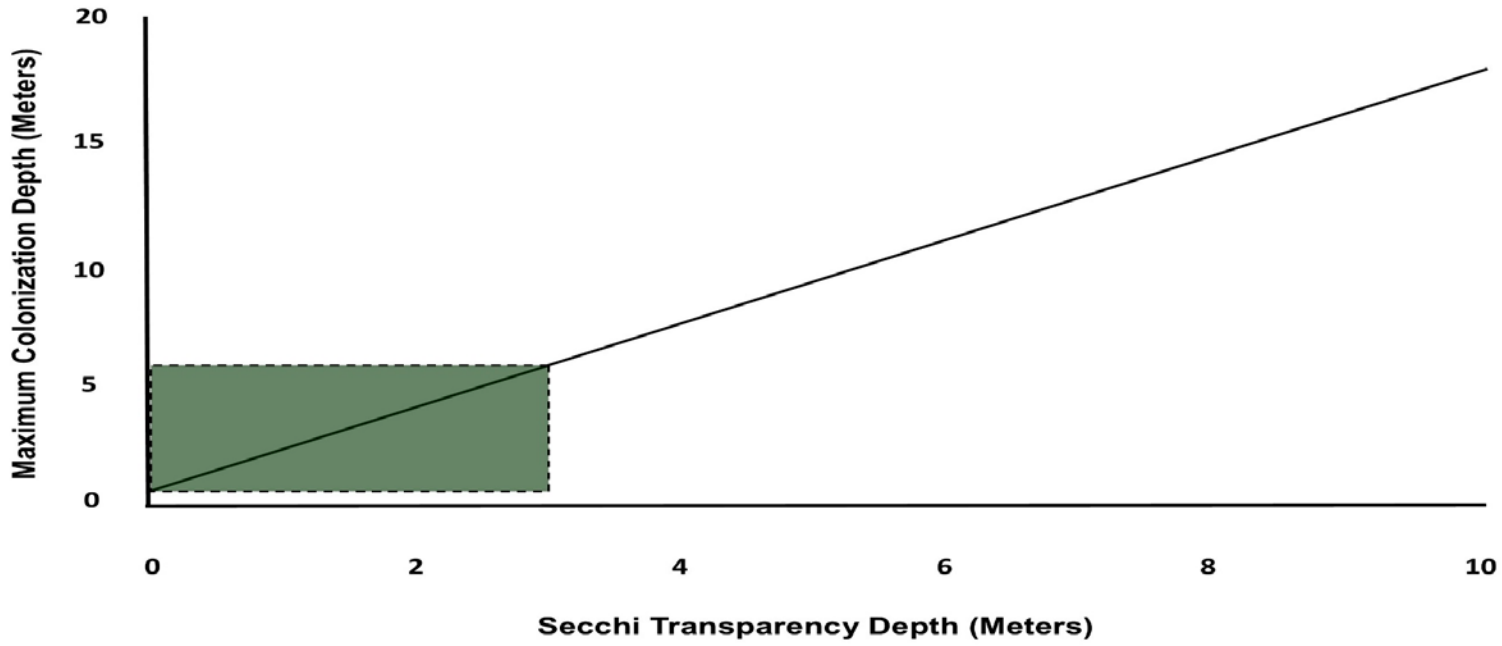
Inland Lake Bathymetry:
An Important Determinant of Starry Stonewort Colonization Patterns

The total area of cover as well as the relative abundance of Characeae species, and other submerged macrophytes, declines in inland lakes characterized by large areas of deeper, steeply sloping bottom contours that host greater proportions of their basin below the light dependent compensation depth for submerged aquatic macrophytes.



Secchi Disk Transparency v. Maximum colonization depth

- Starry stonewort is capable of colonizing depths of up to 1.5 - 2.0 times greater than Secchi disk transparency.



Adapted from Blindlow, 1992

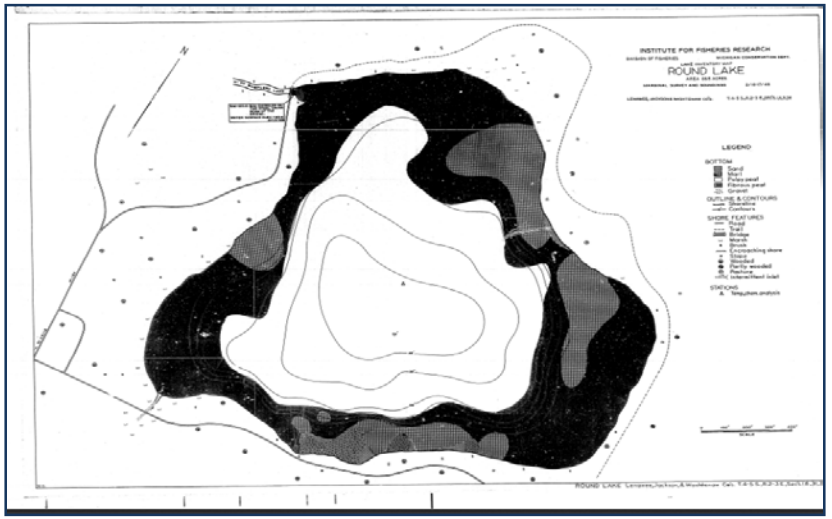
Inland Lake Bathymetry v. Secchi Disk Transparency: Important Determinants of Starry Stonewort Colonization Patterns

Round Lake|
(Jackson, Lenawee, Washtenaw)

Maximum Basin Depth: 15.8 M

Secchi Disk Transparency: 3 M

Maximum Depth Starry Stonewort: 6 M

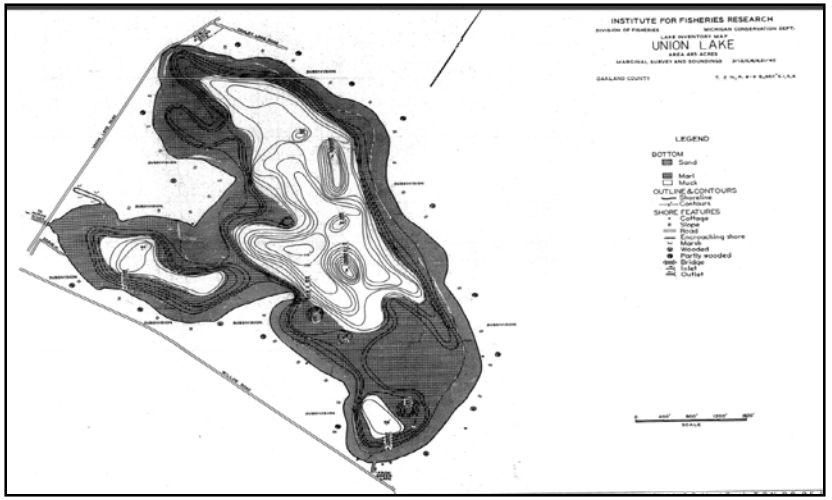


Union Lake
(Oakland County)

Maximum Basin Depth: 110 Ft.

Secchi Disk Transparency: 5.7 M

Maximum Depth Starry Stonewort: 8.8 M



Environmental Factors Associated with the Growth and Collapse of Starry stonewort

Dense meadows of Starry Stonewort are capable of complete collapse in shallow areas as surface water temperatures reach ≥ 86° F (30° C);
colonization then occurs in a band of narrow zonation defined by depth, light (water transparency) and water temperature.

Optimal Temperature Range:
56°F (13° C) – 72° F (22°C)

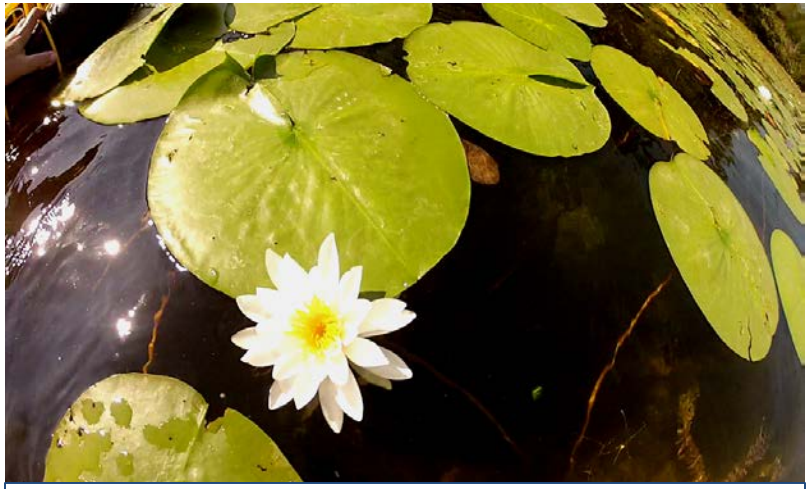
Environmental Factors Associated with the Growth of Starry stonewort

Starry Stonewort is capable of producing new growth via bulbils in 39° (4° C) water temperatures during protracted winter periods of ice and snow induced near complete darkness

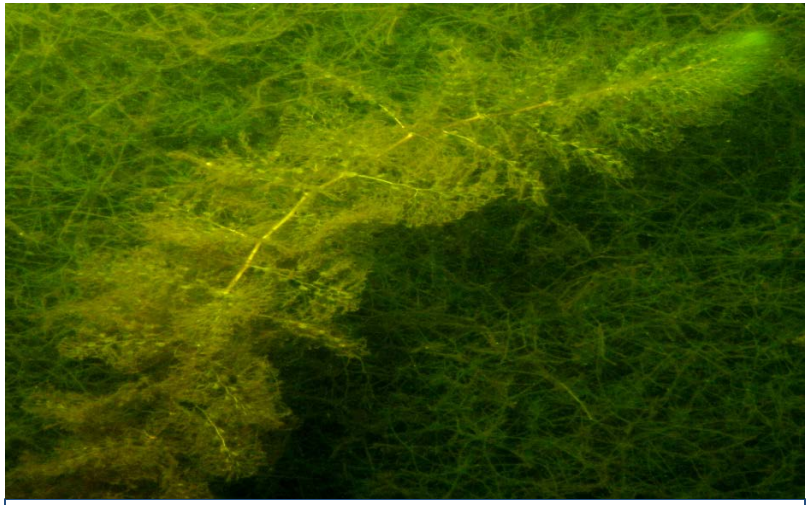
Round Lake (Walter J. Hayes State Park) on January 26, 2014

Aquatic Plants Capable of Co-Existing with Starry Stonewort Meadows

Ceratophyllum demersum (Coontail)



Nymphaea odorata (White water lily)



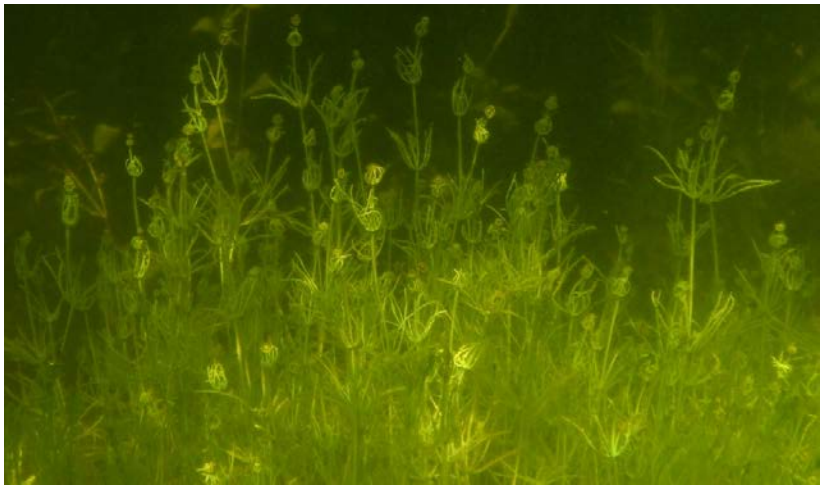
Utricularia vulgaris (Common bladderwort)

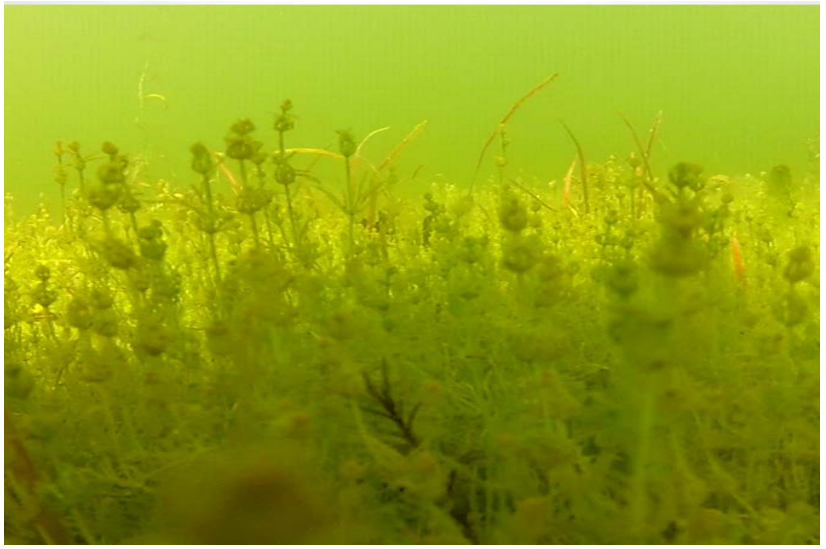
Potamogeton zosteriformis (Flat- stem pondweed)

Co-occurrence of *Chara vulgaris*

Chara vulgaris

- Co-occurs in all Michigan Starry stonewort colonized lakes
- Native to Michigan inland lakes
- Requires high calcium carbonate levels
- Length positively correlated with high calcium carbonate levels
- Depth: < .25 M – 2.5 M
- Requires good water clarity
- Intermingles with Starry Stonewort in shallow water





Co-occurrence of Eurasian Water Milfoil

Myriophyllum spicatum

- Native to Europe and Asia
- Co-occurs with Starry Stonewort in European Inland Lakes
- Co-occurred in 88% (106/120) of 2012 Starry Stonewort Reported Inland Lakes in Michigan
- Trophic State Index preference equal (CTSI = 35 – 56)
- Starry Stonewort and Eurasian Water Milfoil compete for littoral dominance

Summary

The spectacular success of invasive *Nitellopsis obtusa* within the North American Laurentian Great Lakes region may be directly attributed to the existence of thousands of submerged macrophyte dominated inland lake ecosystems whose stable clear water equilibria, abundant levels of light, and calcium bi-carbonate rich environments have enabled a rapidly colonizing invasive population consisting of all male plants to achieve extraordinary growth and exponential rates of asexual reproductive success.

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