

Starry Stonewort: Is Your Lake Capable of Hosting  
the “Connoisseur of Clean Waters”

Presentation and Photos  
by

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# Introduction

- Scientific Name: *Nitellopsis obtusa*
- common name: Starry Stonewort
- submerged aquatic macrophyte (Characeae)
- native to Europe
- bio-indicator of healthy aquatic ecosystems
- species first detected as an invasive:
  - North America's St. Lawrence Seaway in 1978
  - Laurentian Great Lakes in 1983
  - inland lakes of Michigan in 2006

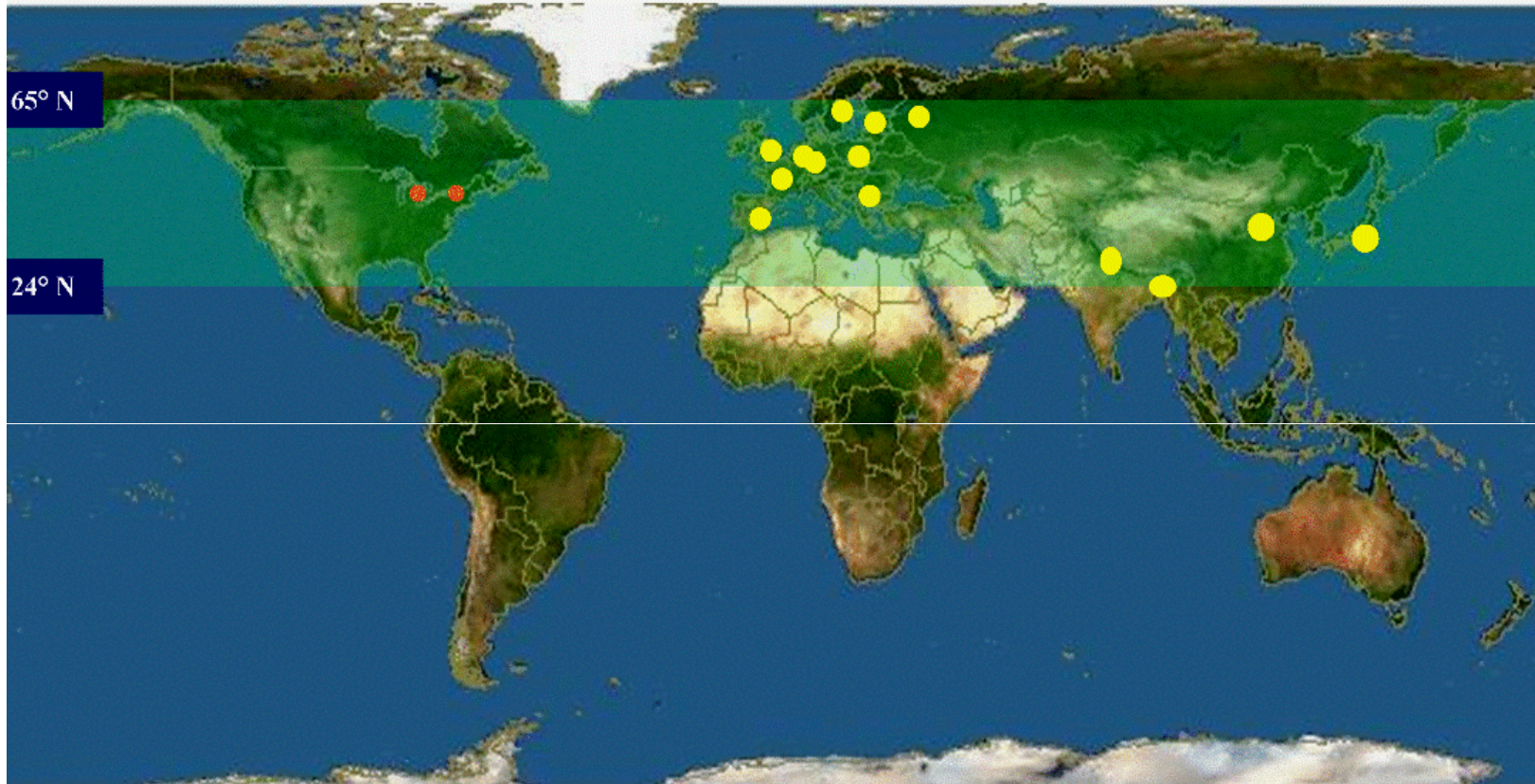
Reference: Schloesser *et al.* (1986)

*Starry Stonewort*



Illustration: R. K. Brown

# Extant Geographic Distribution



Modified Graphic: NASA

Reference: Soulie-Marsche *et al.* (2002)

# Taxonomy

**Empire:** *Eukaryota*

**Kingdom:** *Plantae*

**Phylum:** *Charophyta*

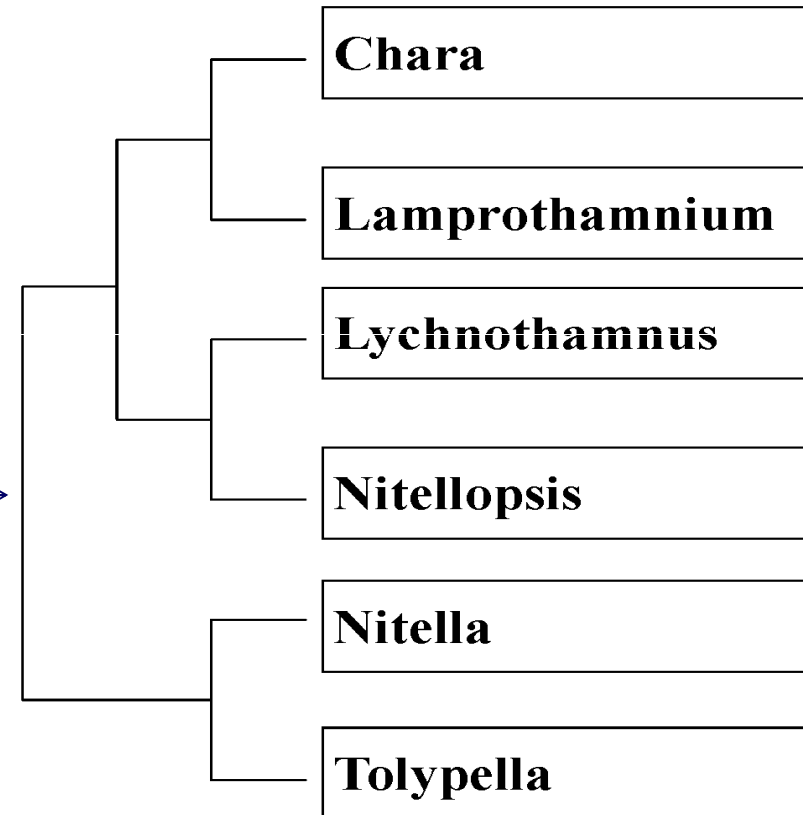
**Class:** *Charophyceae*

**Order:** *Charales*

**Family:** *Characeae* →

**Genus:** *Nitellopsis*

**Species:** *Nitellopsis obtusa*



Reference: Lewis and McCourt (2004)

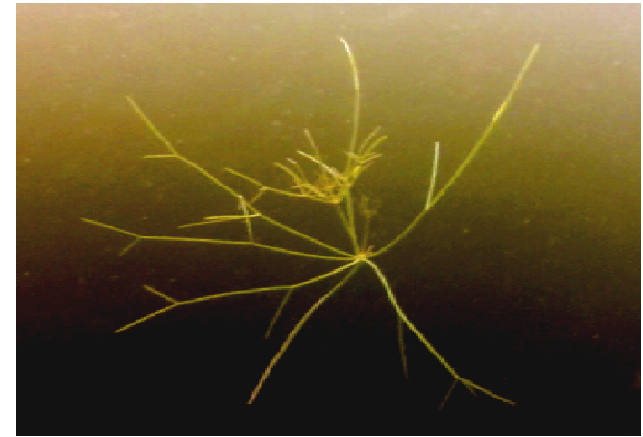
Graphic: Lewis and McCourt (2004)

# Basic Morphology

- highly evolved multi-cellular organism
- small apex coronula
- two to five inferior nodes and internodes
- whorl that consists of five or six thin upwardly radiating branchlets
- length ranges from 24 cm - 2.0 meters

Reference: Bharathan (1983)

Starry Stonewort



## Starry Stonewort: The Subject of Numerous Cytological Studies

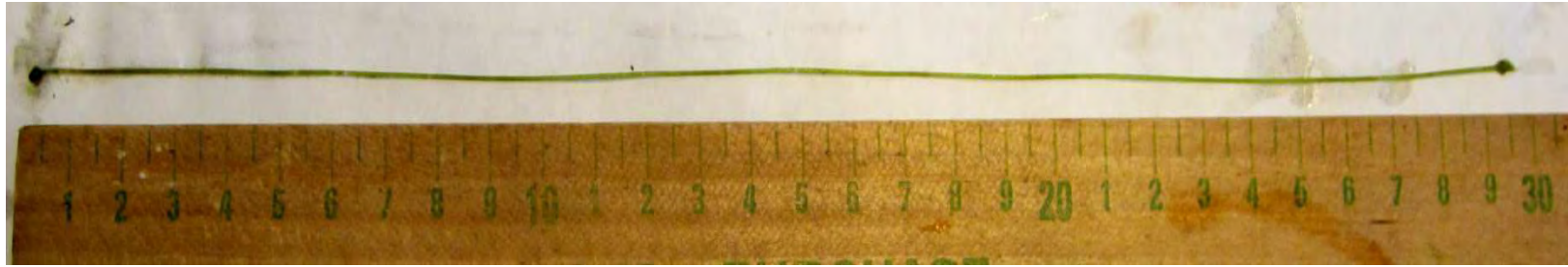


Photo: W. S. Brown

- inter-node cells 0.4 to 1 mm in diameter and up to 30 cm in length
- ideal in size for manipulation and observation
- considered to be discrete living organisms
- perpetuates cytoplasmic streaming following separation from thallus

Reference: Johnson *et al.* (2002)

## Reproductive Capabilities of Starry Stonewort

- capable of sexual and asexual reproduction
- sexual reproduction occurs through production and fertilization of oospores
- North American colonies all male plants
- asexual reproduction occurs by prolific production of vegetative bulbils
- bulbils capable of surviving for long periods



References: Soulie-Marsche *et al.* (2002); Bharathan (1983)

## Influence of Starry Stonewort on Inland Lake Trophic State Conditions

### Charophyte meadows:

- increase water clarity by minimizing re-suspension of particulate matter
- release allelopathic substances
- provide complex habitat for zooplankton
- utilizes and precipitates calcium carbonate causing immobilization of phosphorus, inhibiting primary production



Above, *Nitellopsis obtusa* precipitating calcium carbonate

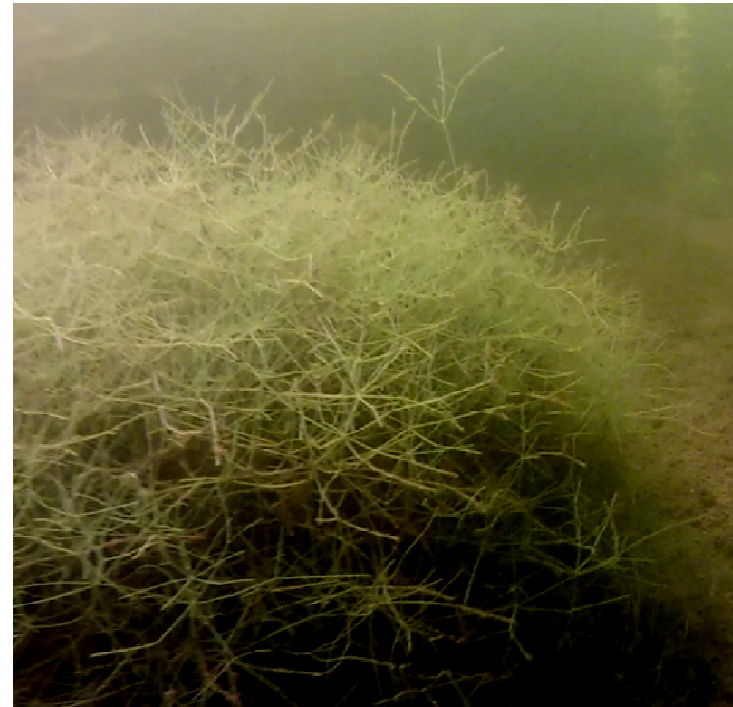
Reference: Kufel and Kufel, 2002



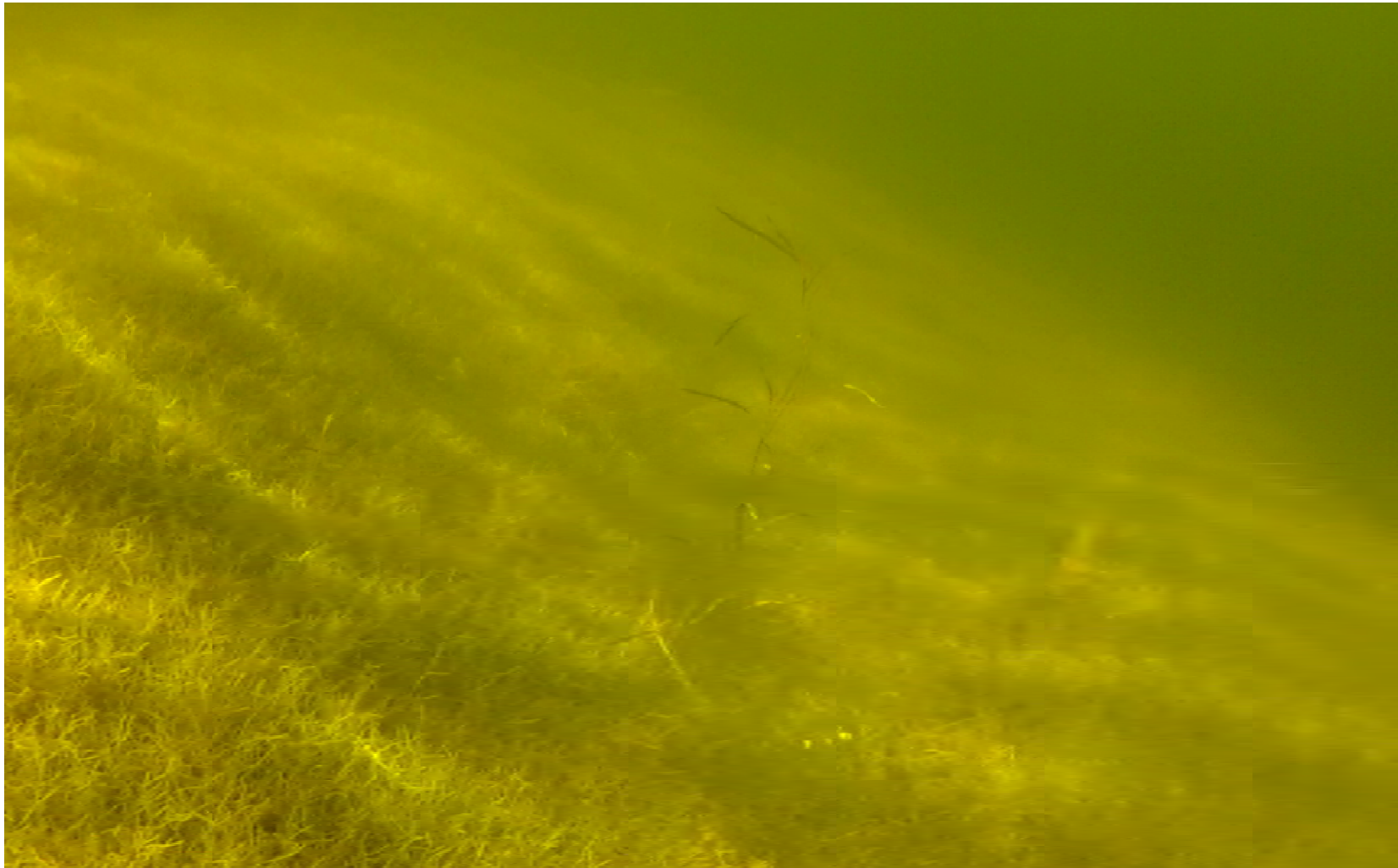
## Impact of Dense Starry Stonewort Meadows on Inland Lake Littoral Habitat

Invasive macrophyte meadows:

- form dense benthic barriers
- alter or eliminate native submerged aquatic plants
- prevent access to fish spawning substrate
- eliminate optimal growth habitat for fish fry



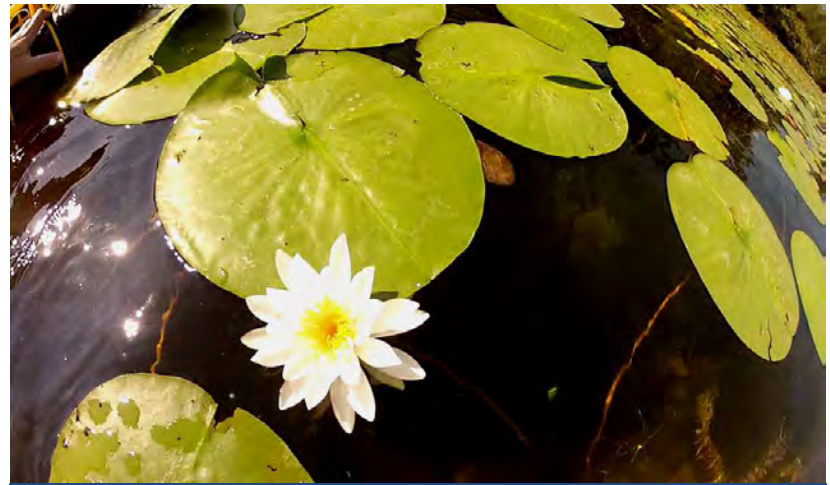
# Impact of Dense Monotypic Starry Stonewort Meadows on Inland Lake Littoral Habitat



## Aquatic Plants Capable of Co-Existing with Starry Stonewort Meadows



*Ceratophyllum demersum* (Coontail)



*Nymphaea odorata* (White water lily)



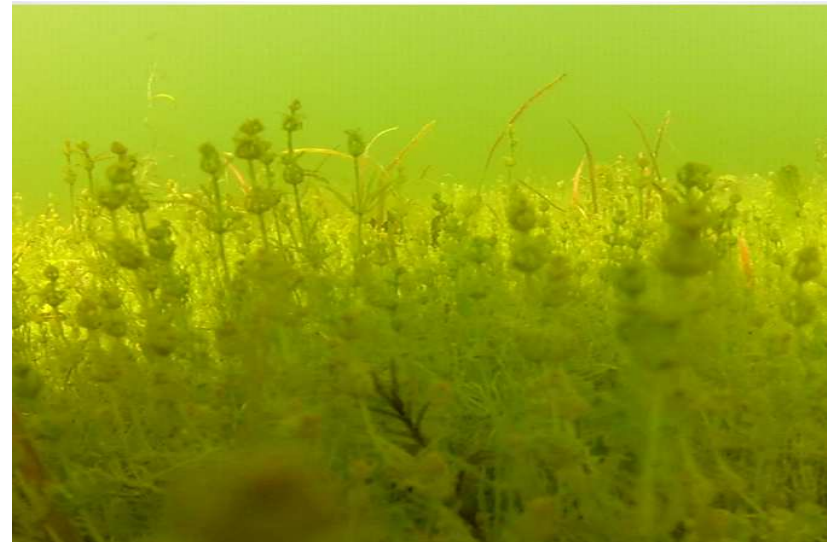
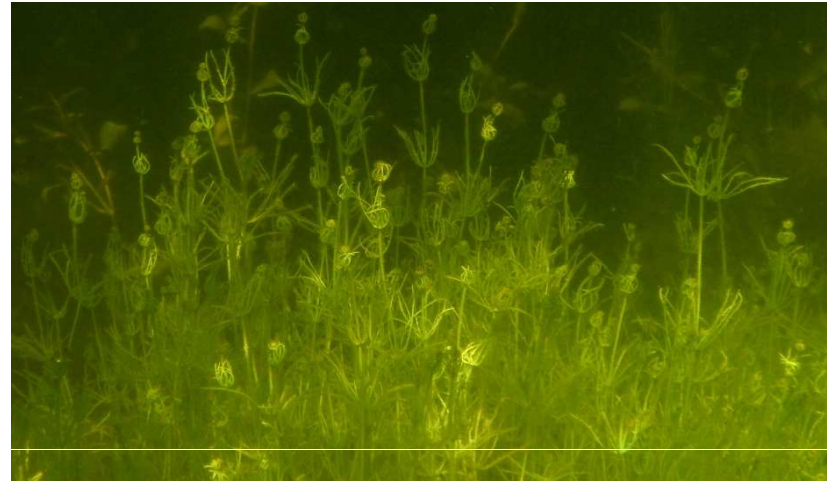
*Utricularia vulgaris* (Common bladderwort)



*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: 2 ft. – 8 ft
- 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



## Preferred Trophic State of Starry Stonewort

- earlier studies suggested limitation to “cold, clear, calcium carbonate rich waters of low trophic status” (i.e., oligotrophic conditions)
- limited knowledge of trophic state preferences of the species derived in an ancillary manner from study of more frequently observed and sometimes co-occurring charophytes such as *Chara tomentosa* and *Chara globularis*
- recent studies emphasize role of submerged macrophytes, particularly charophyte meadows, in promoting water transparency and stabilizing trophic conditions

Reference: Krause (1985)

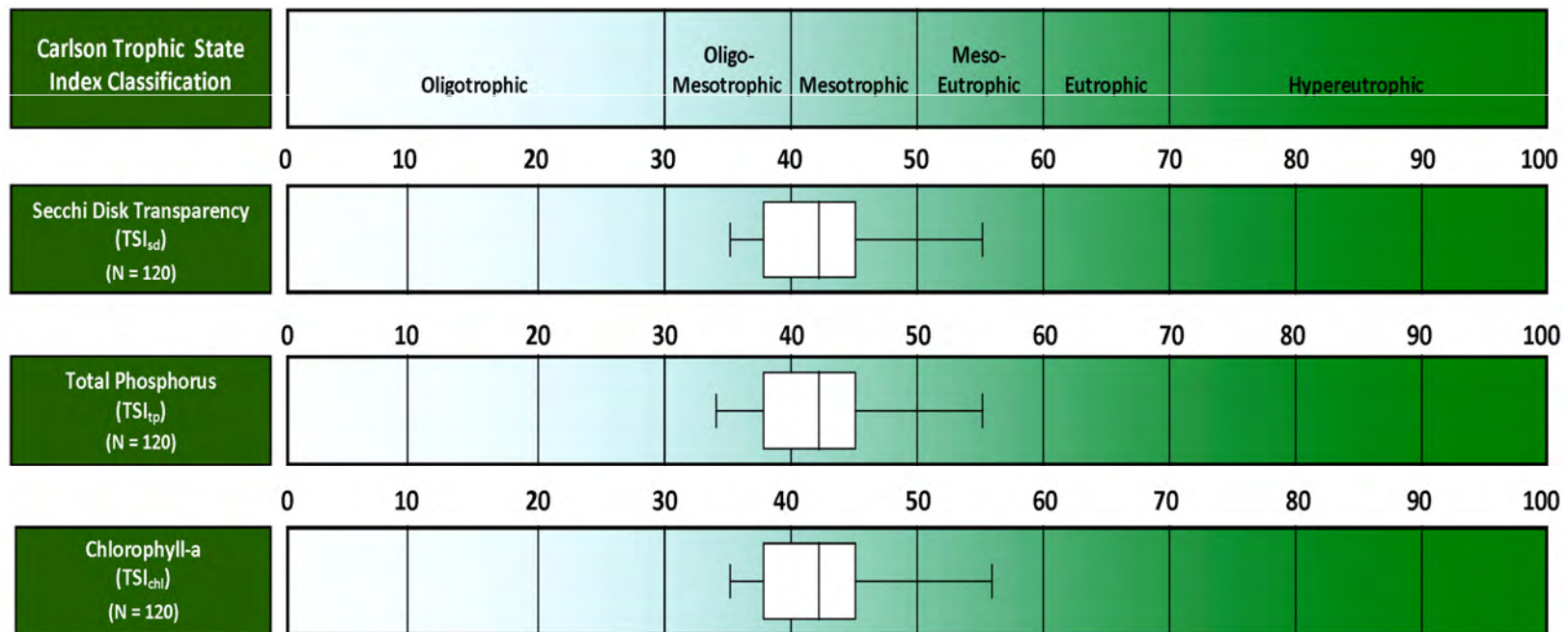
## Pre-Starry Stonewort Invasion Trophic State of Michigan Lakes

Carlson Trophic State Index parameter values for 2012 reported inland lakes:

Carlson Trophic Index Parameters	Secchi Disk Transparency (Meters)	Total Phosphorus ( $\mu\text{g/l}$ )	Chlorophyll-a ( $\mu\text{g/l}$ )
Minimum	1.36	8.0	1.5
Maximum	5.49	33	13
Mean	3.08	17	4.75
Mode	3.35	15	3.6
Median	3.35	15	3.6

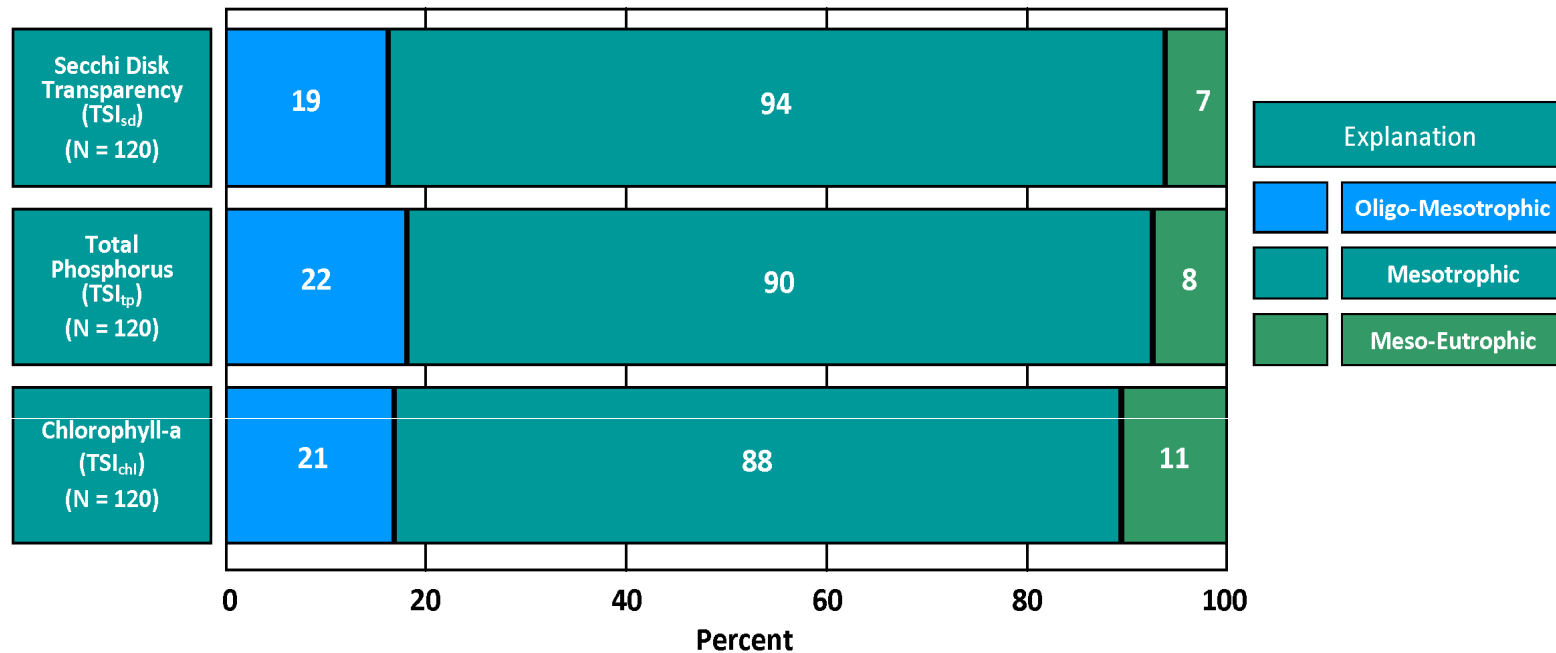
# Trophic State Requirements of Starry Stonewort

Inland lakes in Michigan that were vulnerable to colonization by invasive *Nitellopsis obtusa* were largely oligo-mesotrophic to mesotrophic, with the likelihood of successful introduction rapidly declining with trophic state conditions significantly above or below these values providing a barrier to colonization.





# Carlson Trophic State Index Values for Starry Stonewort Invaded Inland Lakes



Carlson Trophic State Index values for Secchi disk transparency, total phosphorus and chlorophyll-a classified as either oligo-mesotrophic or mesotrophic comprised 94%, 93% and 91% of the group of Michigan inland lakes invaded by Starry stonewort.

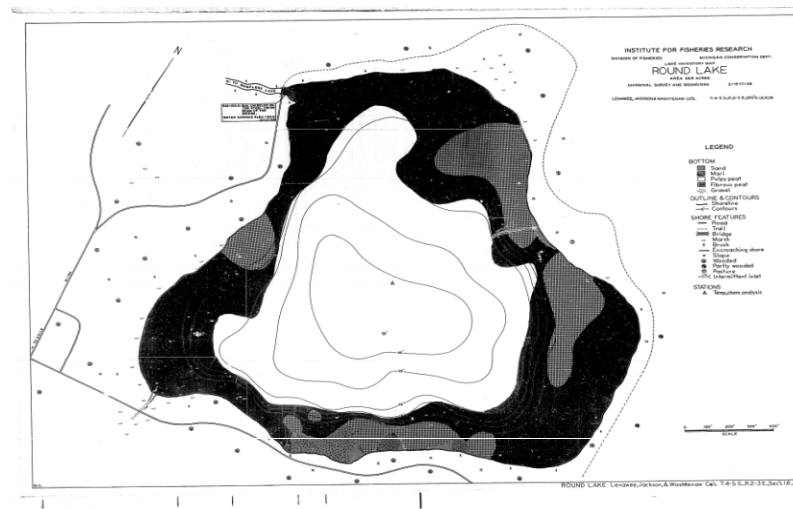
# Inland Lake Bathymetry v. Secchi Disk Transparency: Important Determinants of Starry Stonewort Colonization Patterns

Round Lake|  
(Jackson, Lenawee, Washtenaw)

Maximum Depth: 52 Ft.

Secchi Disk Transparency: 11 Ft.

Max. Depth Starry Stonewort: 16 Ft.



Union Lake  
(Oakland County)

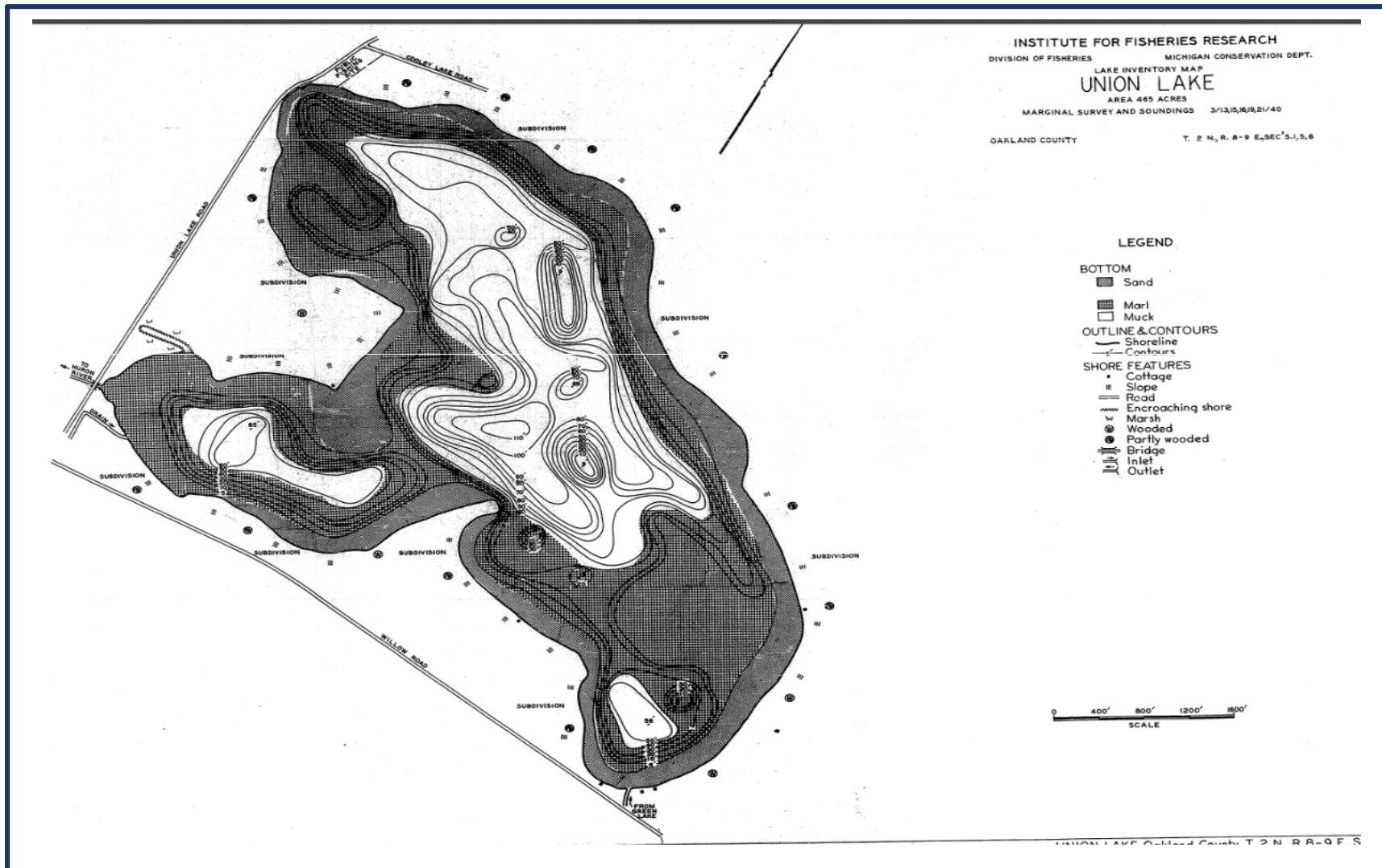
Maximum Depth: 110 Ft.

Secchi Disk Transparency: 19 Ft.

Max. Depth of Starry Stonewort: 29 Ft.



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



## Colonization Potential of Starry Stonewort in Michigan

Oligo-mesotrophic and mesotrophic conditions required for the successful introduction of invasive *Nitellopsis obtusa* are found in approximately 75% of the 6,537 inland lakes in Michigan of  $\geq 4$  ha in size.



Graphic: MiCorps

## Other Important Factors Determining Distribution and Abundance of *Nitellopsis obtusa*

- calcium carbonate levels that often exceed 100 mg/l, equal to levels found in Scandinavia and Russia
- lake shapes, shoreline ratios, bottom contours, and shallow bays capable of supporting large submerged macrophytes communities



Photo: W. S. Brown

Reference: Fuller and Taricska (2011)

## Future Study Opportunities

- impact of dense *Nitellopsis obtusa* meadows on submerged macrophyte community structure and diversity.
- influence of dense meadows on macro-invertebrate diversity.
- potential role of allelopathic chemicals in inhibiting primary production
- impact of dense meadows on fish spawning and recruitment
- influence of dense meadows on trophic state conditions
- affect of global warming on reproduction and growth patterns

Enhanced ecology-based inter-disciplinary knowledge of charophytes and their respective host aquatic ecosystems may significantly improve efforts to conserve and restore earth's increasingly vulnerable freshwater ecosystems.



Illustration by Sebastian Trapp

Reference: Coops (2002)

## References

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Thank You!

Thank you for your attention!

Questions?