

Answers to questions asked during the Q&A session following the October 17, 2019 webinar:

Starry stonewort invasion in Minnesota lakes: Spread and plant community impacts

Answers to questions provided by: Carli Wagner, graduate student, Minnesota Aquatic Invasive Species Research Center & Dan Larkin, assistant professor & extension specialist, University of Minnesota

Webinar recording available at z.umn.edu/WagnerWebinar

STUDY DESIGN

Q: Is the regression data shown early in the presentation based on one growing season or several years?

A: The regression plots showed results from objective one of my research, which involved a single, extensive sampling effort across three lakes in 2018. If of interest: the models were generalized linear mixed effects models with transect as a random effect; this accounted for the correlated data structure of quadrats within transects.

Q: Did the study control for factors such as depth, water clarity, nutrient loading, or other variables?

A: This is an observational study and we attempted to account for confounding variables as best we could. We measured depth and water chemistry parameters at each transect and were able to test whether they influenced our response variables of interest (no significant effects). Koronis, Moose, and Winnibigoshish are very different lakes, which is why we included lake ID as a predictor in our models, so we could see trends for each lake.

Q: Did you track and analyze water chemistry/quality parameters and note if there was a significant difference between the lakes in the study?

A: While sampling I collected water chemistry data at each transect, including: pH, conductivity, dissolved oxygen, and temperature. The lakes have varying water chemistries, but within lakes water chemistry was fairly consistent. We included lake ID as a predictor in models to account for overall differences between lakes.

Q: Was chemical control occurring in any of the lakes or areas that were part of the study?

A: There was ongoing management on Koronis around the time of our sampling effort. However, the infestation is large enough in Koronis to where there were large areas of unmanaged starry stonewort that were distant from any treatment areas on the lake. There had been some nearshore treatment of starry stonewort in Moose Lake but none that was ongoing during my study and I sampled further out in the lake away from the prior treatment.

Q: Is it difficult to differentiate starry stonewort from native chara along the field transects?

A: Surprisingly, no. The corticated cells that lead to calcification on Charas make them appear rough/scratchy. This is easily distinguished from starry stonewort, which has a smooth body. That, in combination with comparisons of color and size make them easy to distinguish.

STARRY STONEWORT BIOLOGY AND ECOLOGY

Q: Does starry stonewort die off at the end of the summer season?

A: We have tracked starry stonewort phenology in Koronis and Moose lake and found its growing season extends into October. October is when we have found peak biomass levels, after that the biomass drops off but is maintained at some level even under the ice. We have found starry stonewort does not pick up its growth until July.

Q: How late in the fall or winter is starry stonewort viable and able to spread to other lakes?

A: Bulbils, the vegetative reproductive structure of starry stonewort, are also at their highest density when biomass peaks in early fall. And since we see biomass persisting at some levels throughout the year, there is likely a year-round risk of spreading starry stonewort.

Q: Are there limits to the depth (or light levels) at which starry stonewort can be found?

A: Starry stonewort seems to be a generalist in its invaded range, it grows in the shallows and also into deeper

waters. I've seen reports of it growing in >20' of water depth. It's hard to give a cut off because its maximum depth of growth is lake dependent, as it would depend on depth and water clarity. 15ft in one lake might be too dark for growth but in a clear lake there is still light penetration at that depth.

Q: Does starry stonewort fix nitrogen?

A: Starry stonewort does not fix nitrogen, but it and other charophytes (algae in the family Characeae) can influence nutrient dynamics, often in ways that are beneficial for water quality/clarity.

Q: Can starry stonewort lead to an invasion meltdown that makes conditions more suitable for AIS like Eurasian watermilfoil (or others)?

A: There has not been any research on this process.

Q: Are there environmental conditions that starry stonewort performs better in?

A: Anecdotally, starry stonewort seems to do well in soft, nutrient-rich sediments and in areas protected from wave action or currents. We did environmental sampling on the transects from my first objective but did not find any significant relationships between starry stonewort abundance and environmental conditions. However, we realized we probably needed to measure biomass to test this relationship, instead of using cover. More research is needed in this area.

Q: Can nutrient richness of a water body impact how well starry stonewort can establish and/or grow?

A: There has been research done at a broader geographic scale (MN, WI, and NY) that indicates starry stonewort is more likely to invade lakes with intermediate to higher productivity (lower Secchi depth, higher chlorophyll a) and higher conductivity ([Muthukrishnan et al. 2018](#)). Starry stonewort seems to particularly thrive in Koronis, which may be because of its relatively high productivity or specific water chemistry.

Q: Are there ecological benefits (for example substrate stabilization) or other valuable ecosystem services that starry stonewort may provide?

A: If you value substrate stabilization, certainly. Starry stonewort seems to be a generalist in its invaded range and may be able to colonize bare habitat that natives aren't using, I've heard this may be occurring in some areas of Winnibigoshish.

Q: How might weather extremes (for example extreme cold) and/or climate change starry stonewort's ability to survive in Minnesota?

A: Starry stonewort is already established in northern MN lakes like Red Lake, suggesting high tolerance of cold climates. Because water buffers temperature (even under the coldest winter conditions, water under ice remains steady at 4 C), it seems unlikely that MN's relatively harsh winter climate limits habitat suitability for starry stonewort—as it might for example with many terrestrial invasive plants. The effects of climate on suitability for starry stonewort have been investigated through ecological niche models in [Escobar et al. 2016](#) and [Romero-Alvarez et al. 2017](#).

STARRY STONEWORT SPREAD

Q: How does starry stonewort spread from lake to lake?

A: Starry stonewort can regrow from intact segments of the alga and also from its bulbils. If either of these are transported on a boat or other equipment there is risk for spread.

Q: Is there any way to predict what types of lakes are more at risk to be invaded by starry stonewort?

A: Higher boater movement is certain to be a risk factor. In addition, lakes that are more productive and have higher conductivity (from calcium, magnesium and other ions) appear to be at higher risk of invasion ([Muthukrishnan et al. 2018](#)).

OTHER STARRY STONEWORT IMPACTS

Q: Can starry stonewort impact other aquatic invasive species, such as Eurasian watermilfoil?

A: During my sampling I did not sample any transects that also contained other invasive aquatic plants. This is because I was strictly interested in the native plant response to starry stonewort and did not want the confounding variable of other invasive species in my dataset. However, from the strong native response I saw in my impacts research, I'm not sure whether Eurasian watermilfoil or other invasive aquatic plants would be any more able to co-occur with starry stonewort.

Q: Does starry stonewort have any impacts on the populations of fish or invertebrates in invaded lakes?

A: There has not been work in this area, so we don't know if invertebrates/fish/etc. can even tell a difference between starry stonewort and a native charophyte. But we can confidently say that starry stonewort negatively impacts native macrophytes.

Q: Starry stonewort has been described by others as so dense you could "walk across it with snow shoes." Does this description sound feel accurate?

A: Starry stonewort grows very thick and often it looks like a carpet of on the lake bottom, we sometimes describe it as a putting green. It can look like a whole new surface, not even like individual plants. Seeing it underwater (even just snorkeling!) really gives you a sense of what the big mats look like. You can try and touch the bottom through the starry and realize the mat is 5ft or more. That said, there are other aquatic invasive plants (e.g., Eurasian watermilfoil) that more consistently and more impressively form the types of dense surface mats that look as though you could walk across.

CONTROL & MANAGEMENT OF STARRY STONEWORT

Q: What control options are available for starry stonewort?

A: Copper based algaecides, mechanical pulling, hand-pulling. Many techniques have been used. It seems we have a handle on how to control nuisance biomass, but more work/research is needed to figure out how to control starry stonewort long-term.

Q: Are there best practices for managing small populations of starry stonewort?

A: Hand-pulling has been very effective at controlling small populations of starry stonewort. For example, Grand Lake in Minnesota.

Q: Which control or containment options have proven to be successful?

A: Copper treatments are effective at reducing nuisance biomass but have not shown much carry-over effect year to year. Hand-pulling of small infestations has been very effective, which is incentive to be diligent and catch new infestations early.

Q: Are there any cost estimates available for control of starry stonewort?

A: It is dependent on the size of the infestation and control option used. Managing large infestations, like the one in Koronis, is quite expensive, as it is generally for aquatic invasive plant control due to labor and chemical costs.

STUDY RESULTS

Q: Were there any significant changes in water clarity within the lakes over the study period?

A: Koronis seemed to be more eutrophic in 2019 than it has been in previous years. We only collected water chemistry in 2018 though, so we do not know how much change actually occurred.

Q: Could the longevity of invasion in each lake affect results (for example Koronis having had starry stonewort longer than Moose)?

A: We can't know when starry stonewort initially invaded each lake, we only know when we discovered it was there. Since we were looking at small-scale, local expansion of starry stonewort on transects, longevity of invasion at the lake level should not affect our results.

Q: Why were some areas of Moose Lake more resilient to starry stonewort than others?

A: The area of Moose where we were unable to relocate transects is at the end of the lake (more sheltered) and also has extremely flocculent, organic sediments. These conditions are what we've anecdotally found to be associated with nuisance starry stonewort growth. We can't say that was the cause, but it is an idea. If the permanent Moose transects are resampled in future years it would be interesting if we are seeing that dense growth extend to other parts of the lake. If we do see that, the lost transects could just be a result of longevity of invasion as mentioned previously. Maybe it had taken up at the end of the lake sooner which is why we're seeing dense growth there.

Q: Did any transects have 100% native cover that ended up being dominated by starry stonewort by the completion of the study?

A: We did not have any uninvaded control transects in this study. The transects were set up to span from invaded to uninvaded habitat. That said, there were individual plots within transects that went from no starry stonewort/native-dominated to no natives/starry dominated over the course of the study.

Q: Were there any ecological differences between the sample lakes over time and are there any ideas as to why starry stonewort behaved different in each?

A: Moose is a low-nutrient, northern MN lake with high species diversity. Koronis is a high-nutrient, central MN lake with low species diversity. I hypothesize that those differences are why we saw starry stonewort behave differently in the lakes. But, we didn't have an experiment to test that. It is important to note that Moose also has very dense starry stonewort growth, it is just contained to an area of the lake. Hopefully we can recollect the transect data in the future to see how starry stonewort invasion plays out over an even longer period.

FUTURE WEBINARS

Q: Will there be any continued Webinars with studies about how fish, reptiles, insects and the like are affected?

A: (From Megan Weber, Extension Educator with the AIS Detectors Program). The Aquatic Invasive Species Webinar Series is a new series launched by the AIS Detectors Program at the University of Minnesota. The series covers a broad range of aquatic invasive species research, issues, and taxa. At this time, there is not sufficient research completed regarding impacts of starry stonewort to aquatic animals to be able to invite a speaker on that specific topic, but we are constantly evaluating topics and emerging research for the series and if new data becomes available it would certainly be considered as a webinar topic.