SCUGOG LAKE STEWARDS Inc.

Executive summary of research activities of the Stewards and partners to date.
As of November 15, 2021

Partner update- progress on targets and results:

In 2016 the Scugog Lake Stewards initiated a partnership with Dr. Andrea Kirkwood from Ontario Tech U. to investigate the emergence of the new invasive macrophyte starry stonewort. This project was expanded and extended throughout 2019 by successfully obtaining an Ontario Trillium Foundation grant.

The initial goal of this study was to identify possible community-to-ecosystem level impacts upon discovering starry stonewort had invaded our lake. We were successful in completing that goal, and framing Lake Scugog as a sentinel ecosystem for other lakes within south-central Ontario.

From our work, our partners were able to create several community-to-ecosystem level models to supplement what limited information is currently available for Ontario lakes and this new invasive macrophyte.

Erin Smith, PhD candidate work to date:

Erin Smith, a PhD candidate with Dr. Andrea Kirkwood's lab has been hard at work collecting evidence how our use of the land results in alterations of the nearshore zone, and ultimately leads to additional stressors to lake health, making invasive species thrive. Recently, she was able to publish a paper that demonstrated total phosphorus and chloride concentrations were explained by developed land use at the subcatchment scale. Both of these parameters are of interest, as they are often parameters that invasive species have a higher biological tolerance to, and thrive in elevated conditions where native organisms cannot.

Tyler Harrow-Lyle, PhD work to date:

Ecosystem models revealed that the serendipitous increases of both zebra mussels and algal blooms observed across Lake Scugog were not by chance, but rather were demonstrated to be the unique biological interactions between starry stonewort, zebra mussels, and Microcystis. This also provided a quantitative context to anecdotal observations that have emerged from invaded regions of the United States, that have suggested a possible relationship between these problematic organisms.

Additionally, our partnership also resulted in a lake community level model that clearly demonstrated that starry stonewort has pervasive impacts on the lower aquatic food web upon establishment. This is of particular importance as the lower aquatic food web is what provides a healthy ecosystem framework and structure.

At an ecosystem level, we were also able to demonstrate that starry stonewort affects the cycling of phosphorus and oxygen within Lake Scugog. This provided evidence that the

elevating levels of phosphorus were not driven by the land, but rather from legacy nutrients within the sediments following the reduction of oxygen.

We were also able to provide contrasting information that implies other invasive macrophytes, primarily Eurasian water milfoil, also had the same impacts, which is not physiologically possible of that particular invasive organism despite previous assertions.

The expansion and extension of our initial research efforts also led our partners to do a targeted synoptic survey of Ontario lakes that covered an area of 65,000 square km of south-central Ontario in 2019. Their premise behind this vital study was to identify lakes in Ontario that had habitat conditions conducive of starry stonewort, as well as to develop an ecological niche model that can be used to model the distribution of starry stonewort in Ontario for future work. They successfully identified starry stonewort in 19 lakes across south-central Ontario, with the species distribution modelling demonstrating 6 additional lakes were likely to have starry stonewort populations.

Shelby Ravary and Tyler Harrow-Lyle work to date:
Shelby and Tyler have been working closely with Brook Schryer at OFAH to confirm the submissions of starry stonewort to EDDmaps. They also assisted Kawartha Conservation in the training, and identification confirmation for their pilot project monitoring starry stonewort.
From this work, Tyler and Shelby are now applying the ecological niche model that Tyler had developed as part of his PhD, to identify lakes across Ontario where starry stonewort can inhabit. Currently they are testing open data from 4,000 lakes across Ontario to identify the probability of invasion. This will be an important component to any work undertaken in the future, as the range of starry stonewort is usually drastically reported outside the physiological tolerance of the species within Ontario. This is likely due to misidentifications, please refer to the challenges faced section for more information.

This is but a brief summary of some of the results that we have obtained and have used to frame Lake Scugog as a sentinel ecosystem for south-central Ontario lakes. As more work is published and available updates will be sent out.

Challenges faced:

As I hope everyone has come to appreciate, Ontario and its lakes are extremely complex. Nothing is *isolated,* everything is connected. From the land to the nearshore environment to the offshore environment. Linking these are critical in our understanding, and fight, of lake stressors now and in the future. We will be watching Erin's work with great anticipation as she addresses these critical questions.

With respects to starry stonewort. Even though there has been a recent surge of information, primarily from the United States, the majority of this information remains anecdotal. Almost all but a few studies are a qualitative summary from work conducted in the native range, or in many cases, from other charophyte species as starry stonewort is a threatened to critically endangered species.

Prior to our work, there were only two quantitative reports from Dr. Brian Ginn of Lake Simcoe Region Conservation Authority, and four lakes of New York, United States.

One of the biggest challenges to date, is combating misinformation. With the momentum starry stonewort has been gaining, there have been several misidentifications. This is not an uncommon phenomenon, as charophytes in general change their physical appearance based on the environmental conditions of the habitat they occupy. In some instances, this has even resulted in trained scientists who dedicate their career to working with charophytes to have claimed starry stonewort was extinct, only to find several years later through DNA analysis that it had changed its appearance.
This fact has only been exacerbated by the abundant charophyte, and to a lesser extent macrophyte, populations of Ontario. With climate change increasing charophyte populations throughout the world, the need for increased public education by trained professionals, as well as confirmation of populations is imperative.

Something to share:

To date the research, we and our partners have conducted have greatly contributed to our general knowledge, as well as supplement the scientific community's knowledge. However, that does little to address the questions that have been raised from our work.

Recently, we have formed a partnership with the Kawartha Lake Stewards Association to begin to find funding to expand the research we have been conducting. Over the coming months, some of our partners will be organizing a symposium, to bring together interested parties for discussions and a more in-depth presentation of results to date to identify additional areas of interest.

We would happily ask that if any party is interested, please send us a note so that we may incorporate you into our distribution list.

Recommended Resources:

1. Erin D. Smith, Deborah Balika, & Andrea E. Kirkwood. (2021). Community science-based monitoring reveals the role of land use scale in driving nearshore water quality in a large, shallow, Canadian lake. https://www.tandfonline.com/action/showCitFormats?doi=10.1080/10402381.2021.1989525
2. Erin D. Smith, Deborah Balika, & Andrea E. Kirkwood. (2020). An assessment of Lake Scugog nearshore water quality and ecological condition (2017-2019). https://scugoglakestewards.com/lake-scugog-research/
3. Tyler J. Harrow-Lyle & Andrea E. Kirkwood. (2020). An assessment of Lake Scugog offshore water quality and ecological condition (2017-2019). https://scugoglakestewards.com/lake-scugog-research/
4. Tyler J. Harrow-Lyle & Andrea E. Kirkwood. (2020). The invasive macrophyte *Nitellopsis obtusa* may facilitate the invasive mussel *Dreissena polymorpha* and *Microcystis* blooms in a large, shallow lake. http://dx.doi.org/10.1139/cjfas-2019-0337

5. Tyler J. Harrow-Lyle & Andrea E. Kirkwood. (2021). Low benthic oxygen and high internal phosphorus- loading are strongly associated with the invasive macrophyte *Nitellopsis obtusa* (starry stonewort) in a large, polymictic lake. https://doi.org/10.3389/fenvs.2021.735509
6. Tyler J. Harrow-Lyle & Andrea E. Kirkwood. (2021). An ecological niche model based on a broad calcium-gradient reveals additional habitat preferences of the invasive charophyte *Nitellopsis obtusa*. *https://doi.org/10.1016/j.aquabot.2021.103397*
7. Tyler J. Harrow-Lyle & Andrea E. Kirkwood. (*In review/ conditionally accepted*). Pervasive changes to the lower aquatic food web following *Nitellopsis obtusa* establishment in a large, shallow lake.
8. Tyler J. Harrow-Lyle & Andrea E. Kirkwood. (*In review*). The non-native charophyte *Nitellopsis obtusa* (starry stonewort) influences shifts in macrophyte diversity and community structure in lakes across a geologically heterogeneous landscape.

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