

Aquatic plants of Lake Simcoe (Ontario, Canada): Tracking the spread of invasive starry stonewort

Brian Ginn,
Limnologist, Certified Lake Manager (NALMS)

B.Ginn@lsrca.on.ca



Lake Simcoe Region
conservation authority



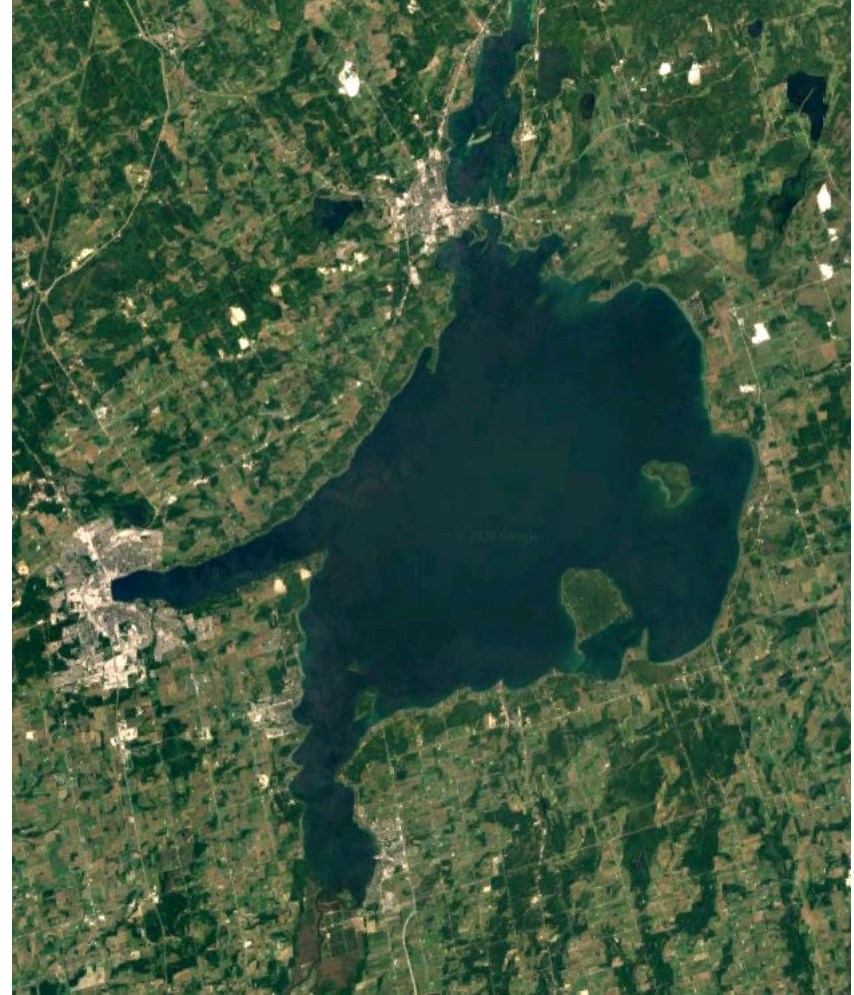
Member of Conservation Ontario

Lake Simcoe



Lake Simcoe


- Max. depth: 42 m (mean = 15 m)
- Watershed: 3,307 km² (1300 sq. mi)
- Lake: 722 km² (280 sq. mi)
- 3 areas: Cook's Bay, Kempenfelt Bay, "main basin"
- 435,500 residents (+50,000 seasonal)
- Very important resource for drinking water and recreation (tourism, boating, fishing)
- "Small version of Great Lakes" (L. Champlain, Finger Lakes, etc.)
 - Understand environmental problems on the bigger lakes!



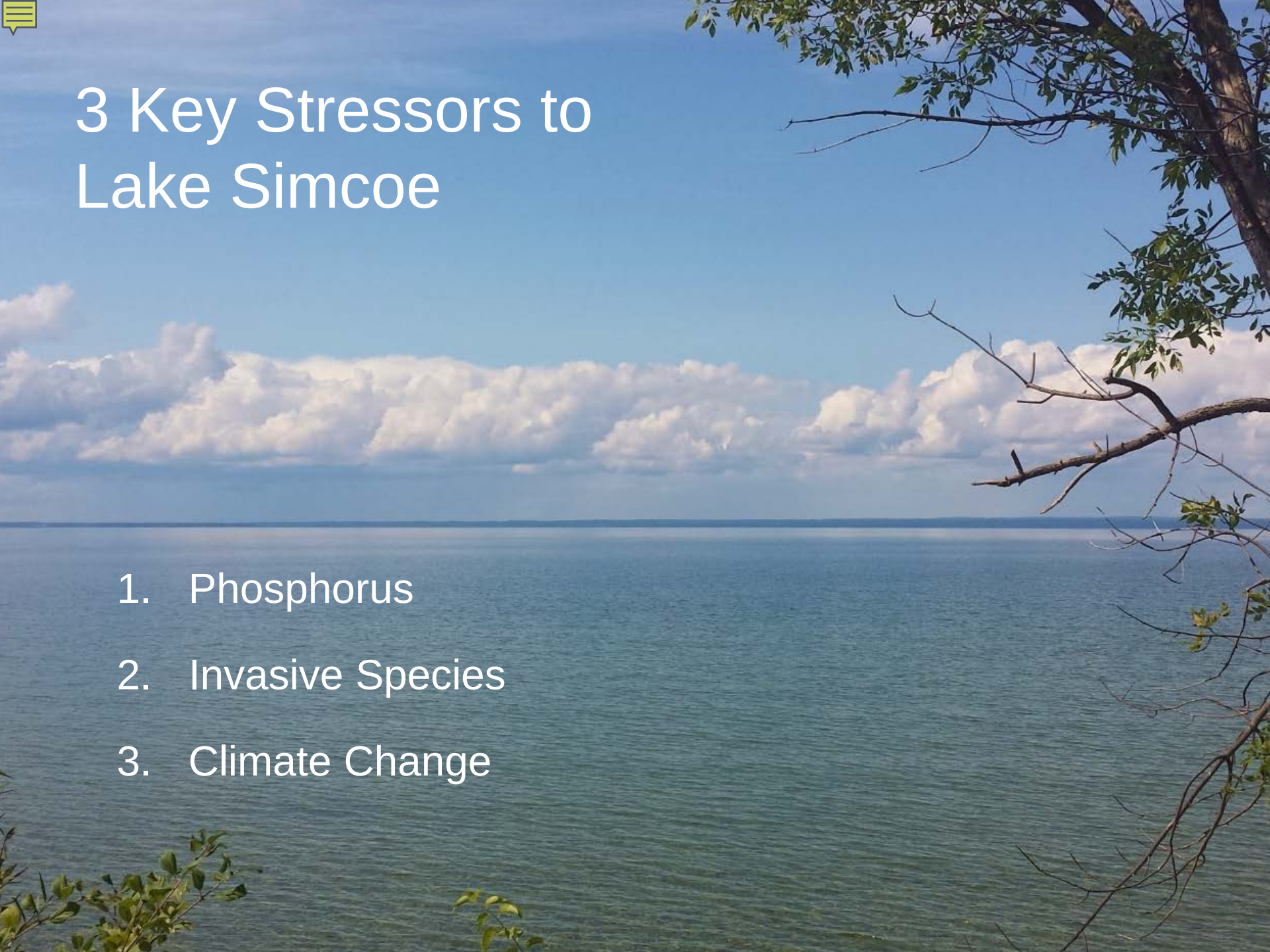


Our Role in Lake Research

- Address residents' concerns
- Fill data gaps (nearshore zone)
- Investigate new / emerging issues
- Work with MECP and MNRF



3 Key Stressors to Lake Simcoe

1. Phosphorus
 2. Invasive Species
 3. Climate Change
- 

Aquatic Plants

- **Public's #1 lake concern!**
 - 53% of inquiries
- **Legally protected in Ontario**
 - Important fish habitat / nursery
 - Buffer wave action / reduce erosion
- Naturally present in “healthy” lakes
- **But...** amount increases with:
 - Surplus nutrients
 - Increased water clarity



Aquatic Plants

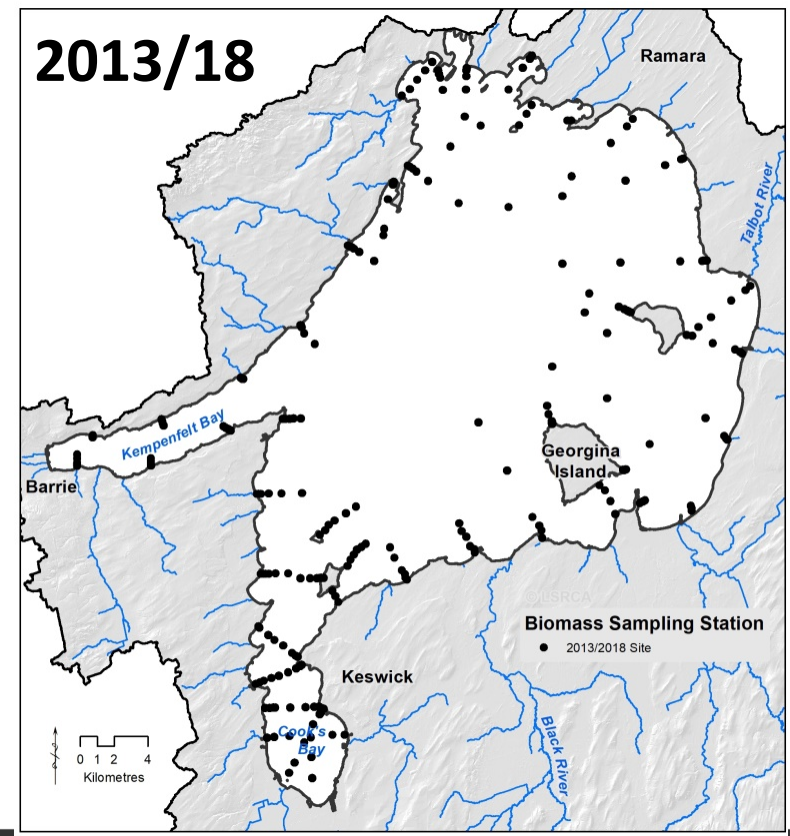
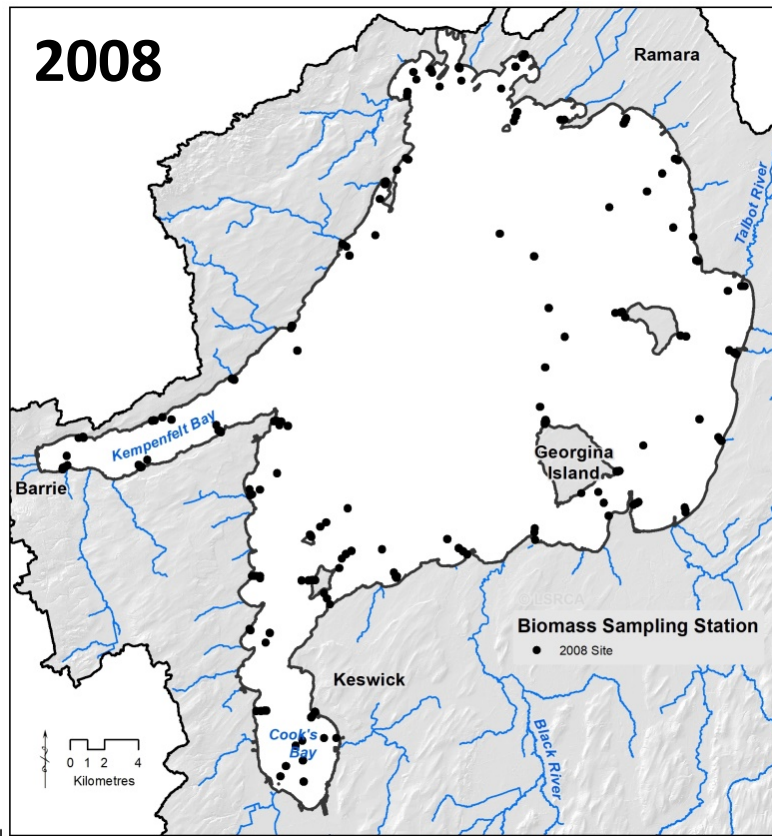
Complaints of “excessive weed growths and shoreline accumulations” since 1960s

- 1971: 29 spp., *Chara* with coontail, six areas of high biomass
 - Qualitative categories (“heavy”, “moderate”, “scattered”)
 - Species list included ‘*Nitella*’
- 1984: Cook’s Bay only, qualitative (wet wt. biomass)
 - *Chara* dominant, first report of Eurasian watermilfoil (12% of biomass)
- 1987: repeat of 1984
 - *Chara* still dominant, EWM = 40% of biomass
- 2006: Cook’s Bay only, ponar grab sampling
 - Coontail dominant , EWM = 40% of biomass



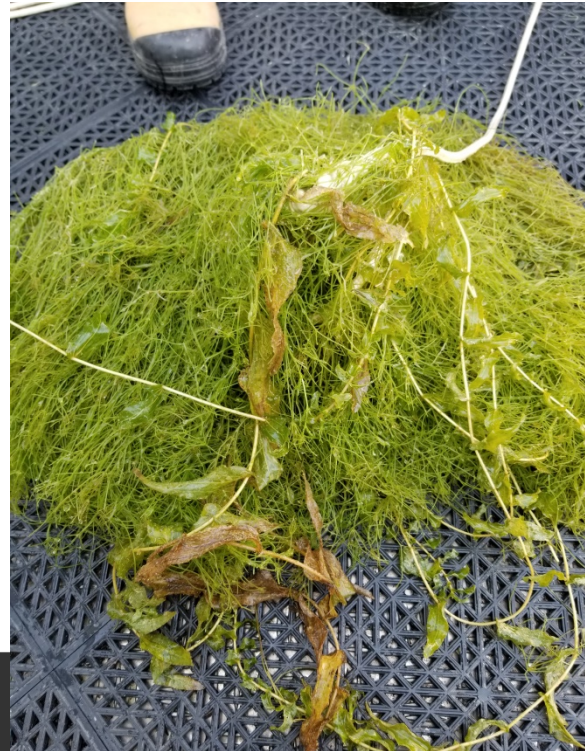
Methods: Full lake survey

- Petite Ponar grab sampling at 5-year intervals
 - 2008: 215 sites 2013 / 2018: 244 sites
- Kriging analysis: GIS-based inverse distance weighting with dry weight biomass; presence / absence data for tracking starry stonewort expansion



Methods: Annual survey (2017/19)

- Subset of 50 (from 244) sites for biomass
- Target marinas / boat launches for invasive species
- Rake toss method (PITRAM); % of plant species
- 2019: tested starry stonewort reporting app (Survey123)
 - Partnership with Starry Stonewort Collaborative, Finger Lakes Institute, NY



2019 Starry Stonewort Pilot

Map Location
pan and zoom to locate sampling location
44.242°N 79.489°W ± 3.2 m

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Waterbody
enter name of waterbody
Lake simcoe

Water Depth (m)
3.7

Water Access
 Shoreline Boat

Visible Starry Stonewort Beds
Are underwater mats or "pillows" of Starry Stonewort clearly visible?
 Yes No

Rake Toss Density
Z= no plants, T= handfull of plants, S= two hand-fulls, M= armful, D= covered rake
 Zero Trace Sparse Medium Dense

Estimated percentage of Starry Stonewort in sample
Estimate how much of the entire rake toss sample is Starry Stonewort
 0% 1% - 25%
 26% - 50% 51% - 75%
 76% - 100%

Sample Collected?
 Yes No

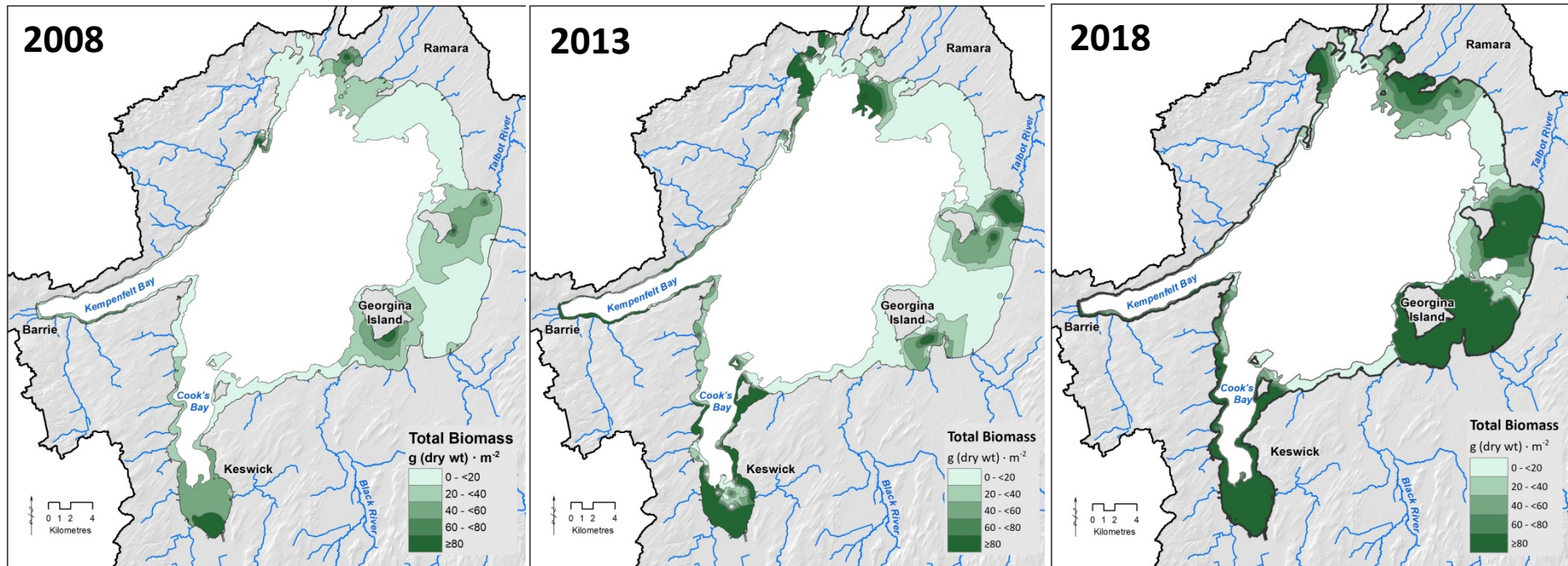
Results

23 species (3 invasive):

- *C. demersum*
- *Chara* spp.
- *E. robbinsii*
- *E. canadensis*
- *E. nuttallii*
- *Fontinalis* spp.
- *M. sibiricum*
- ***M. spicatum* (1984)**
- *M. verticillatum*
- *N. flexilis*
- ***N. obtusa* (2009)**
- *P. amplifolius*
- ***P. crispus* (1984)**
- *P. friesii*
- *P. pusillus*
- *P. richardsonii*
- *P. strictifoliosus*
- *P. zosteriformis*
- *S. pectinalis*
- *U. vulgaris*
- *V. americana*
- *Z. palustris*
- *Z. dubia* (*H. dubia*)



Aquatic plant mapping (2008, 2013, 2018)



	2008	2013	2018
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spp. recorded

15

19

19

Mean dry biomass (g/m²)

29.9

80.3

153.9

Max wet biomass (kg/m²)

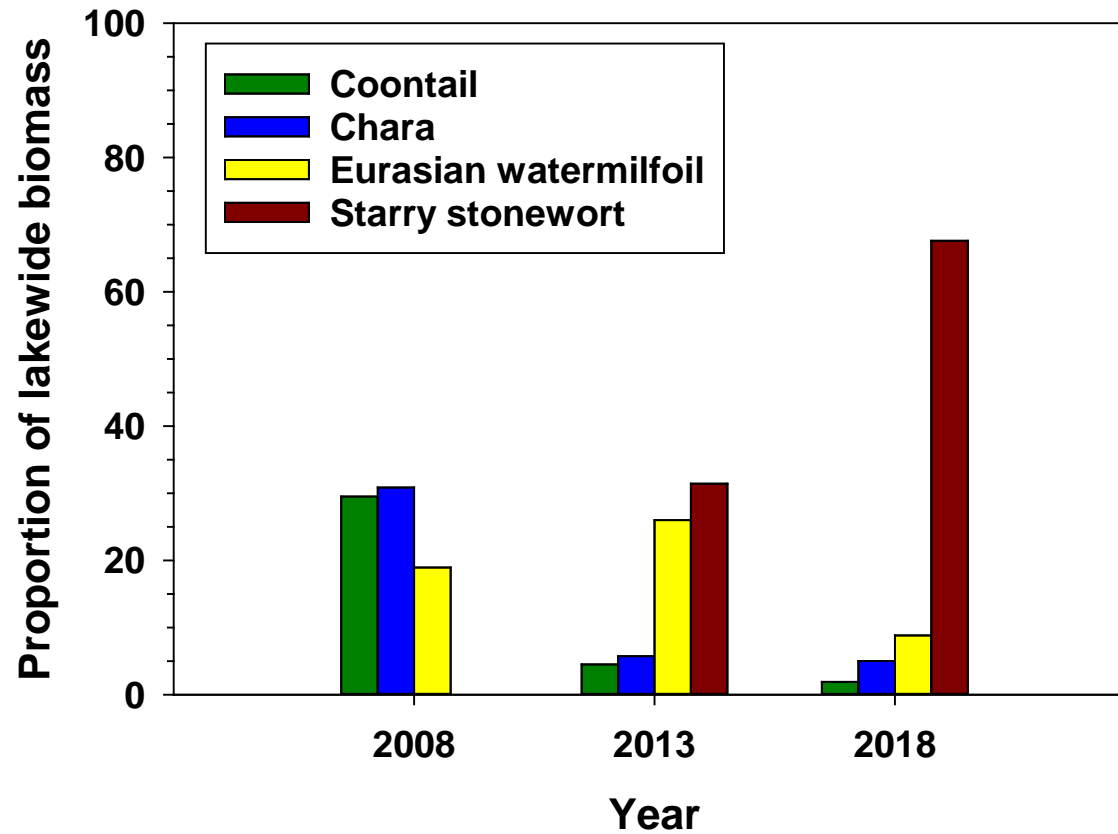
3.5

4.5

26.4

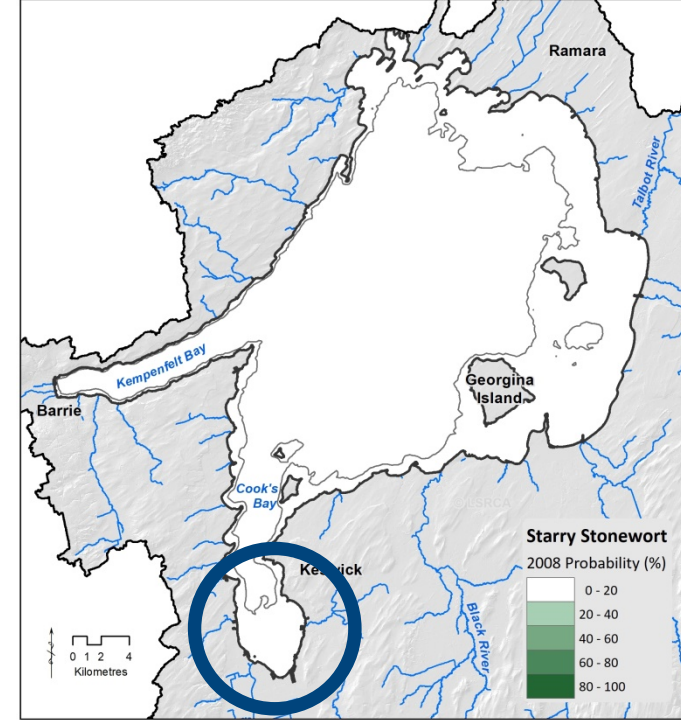
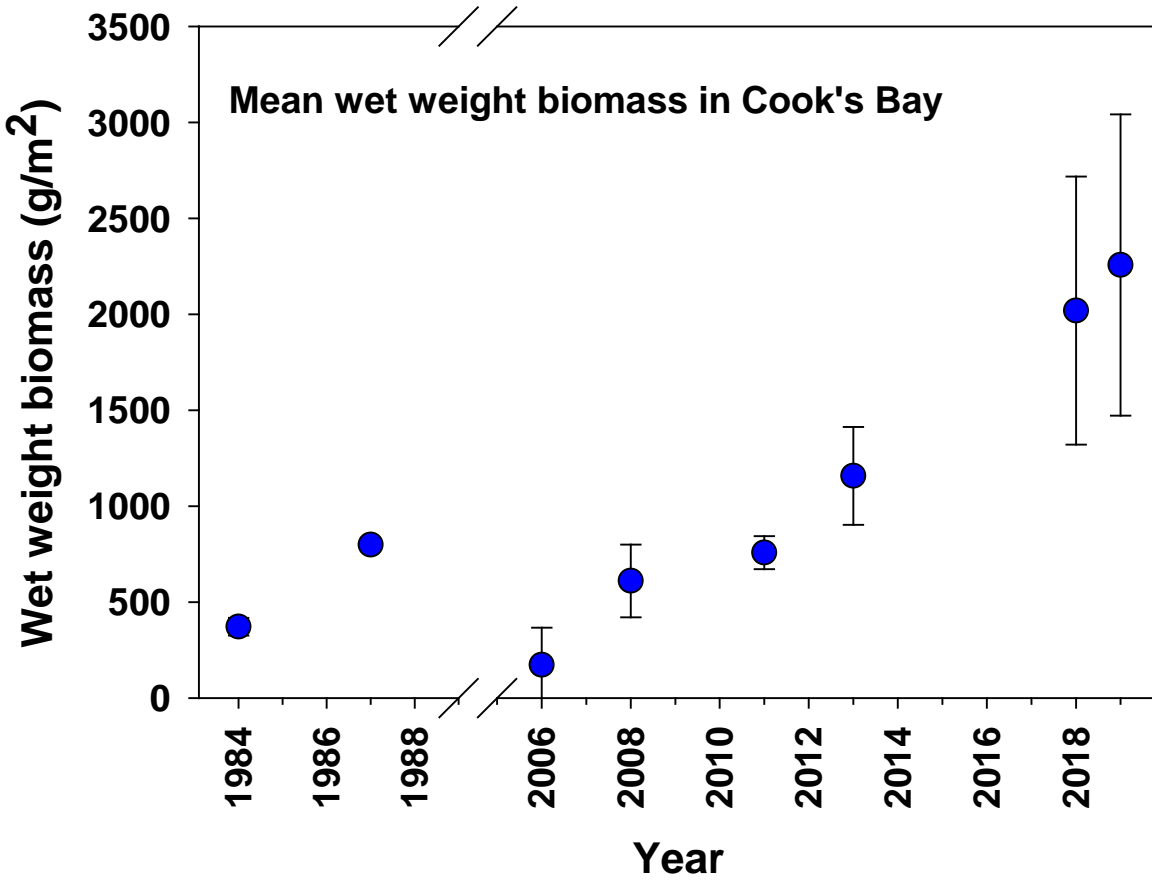
Change in species diversity

- Increase in starry stonewort to 67.6 % of total biomass in 2018
- Decrease in all other species



Cook's Bay: 1984-2019

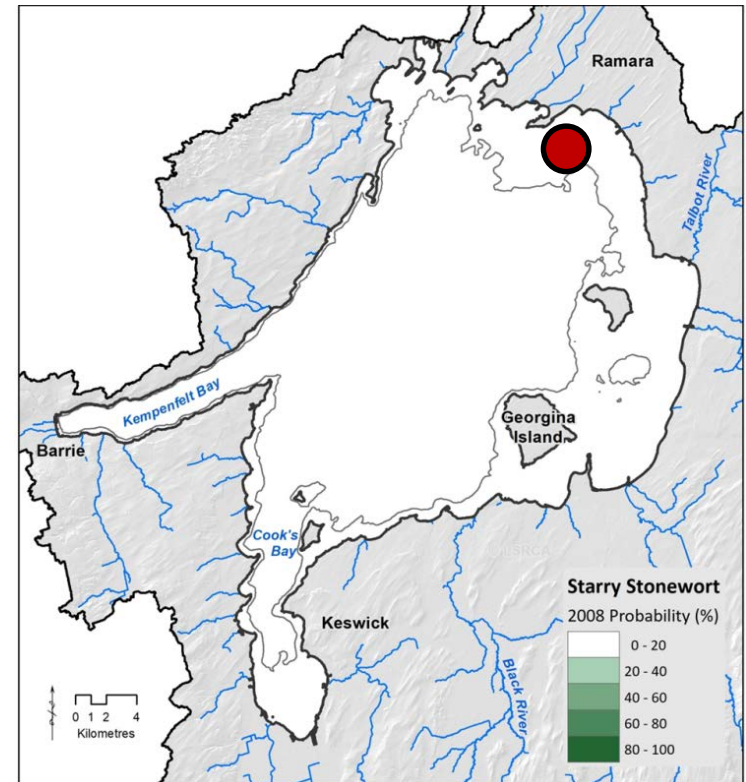
- 1984 / 87 studies used wet weight biomass
- Increase with water clarity (1990s): 6.0 → 10.5 m
- Post-2011 increases from starry stonewort



1987 was 1.4°C warmer than other sampling years

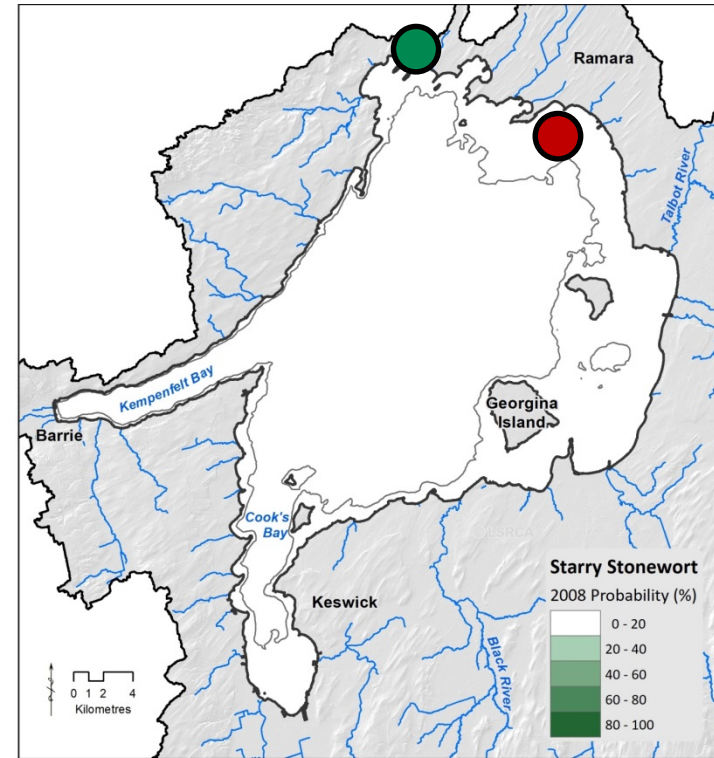
Starry Stonewort: initial reports

- Arrived from Eurasia: St. Lawrence R. south of Montreal (1973-4); New York State (1978); Detroit River – Lake St. Clair (~1983).
- Ontario: Presqu’île Bay → Kingston (2013) (Midwood et al. 2016. JGLR 42: 348-355)
- But: 2009 Lake Simcoe benthic sample:

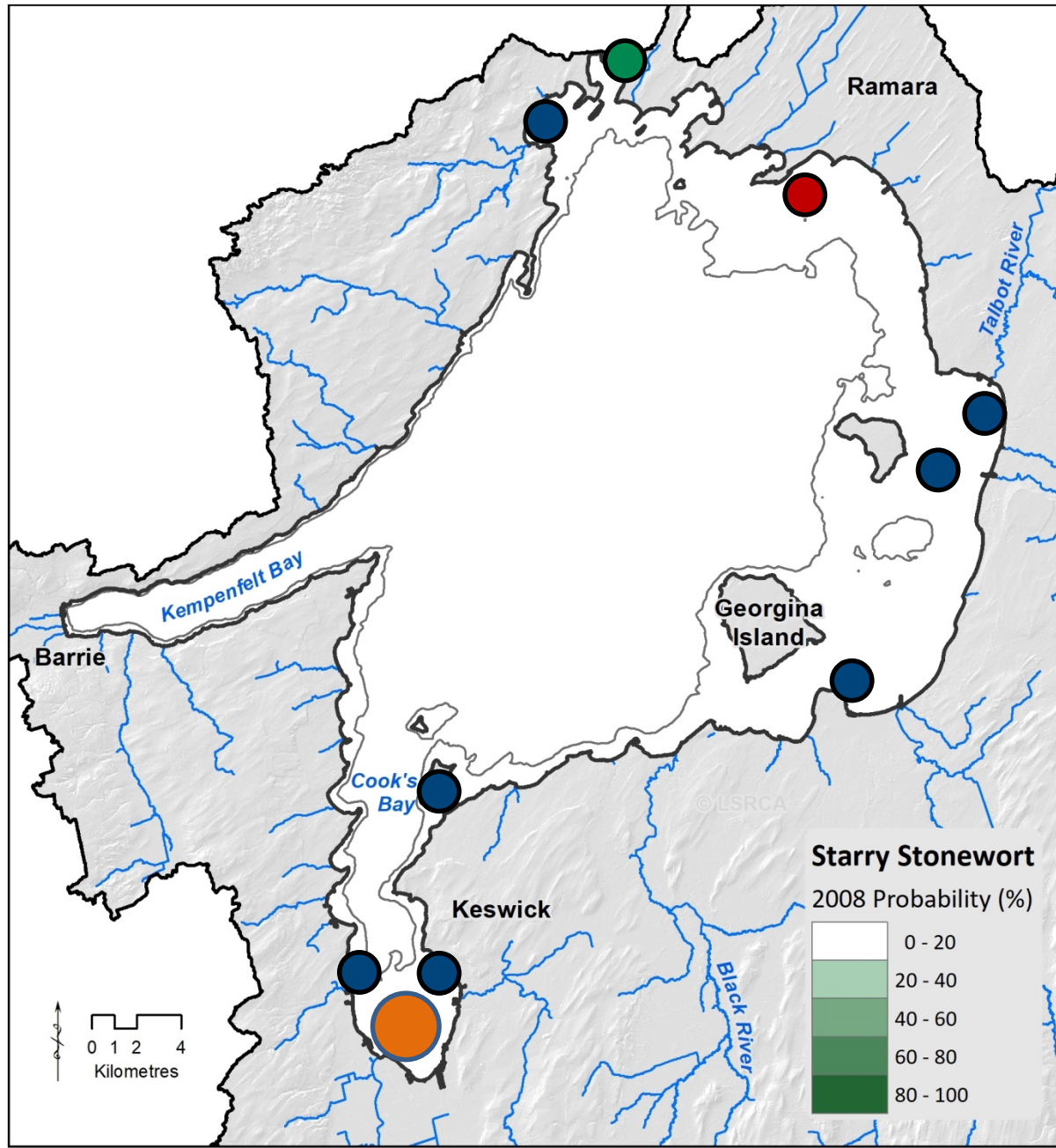


Starry Stonewort: initial reports

- 2010: Marina, “We have a plant problem!”
- Herbicide (diquat) treatment for EWM



Starry Stonewort: initial reports



2011: Cook's Bay

- Re-sample 1984 / 87 sites
- SSW @ 14.5% of sites
- SSW = 1.4% of biomass

2013: whole-lake survey

- SSW = 23% of biomass

2013 Cook's Bay:

- SSW = 6% biomass

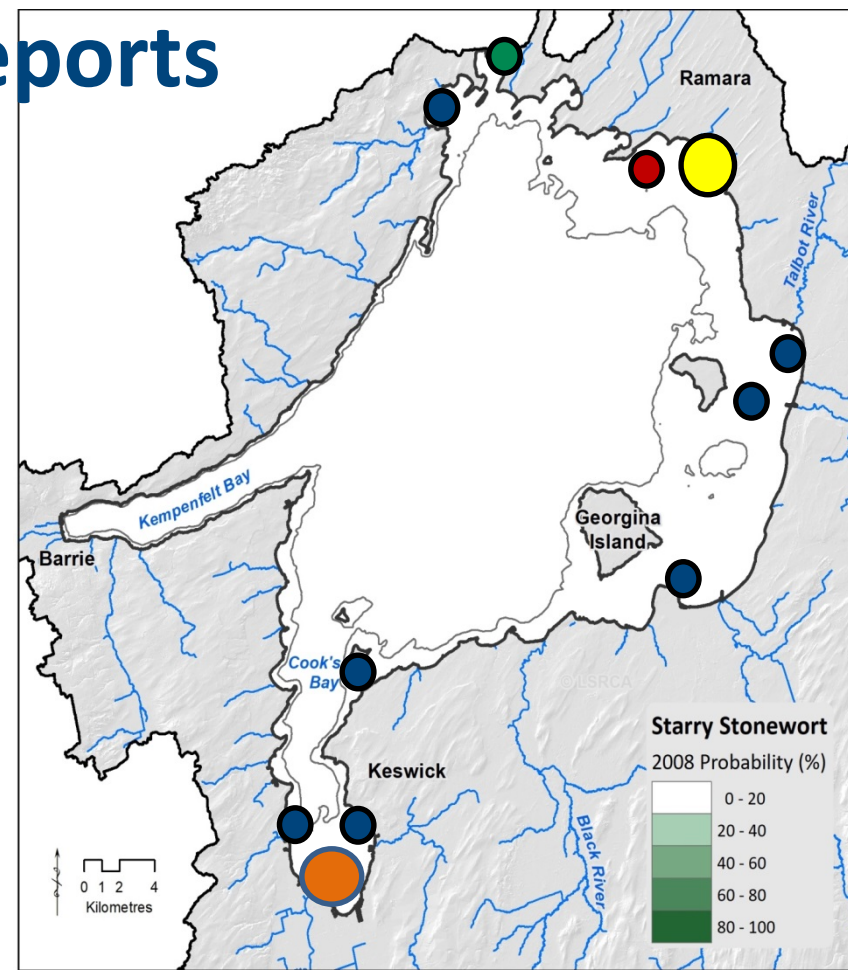
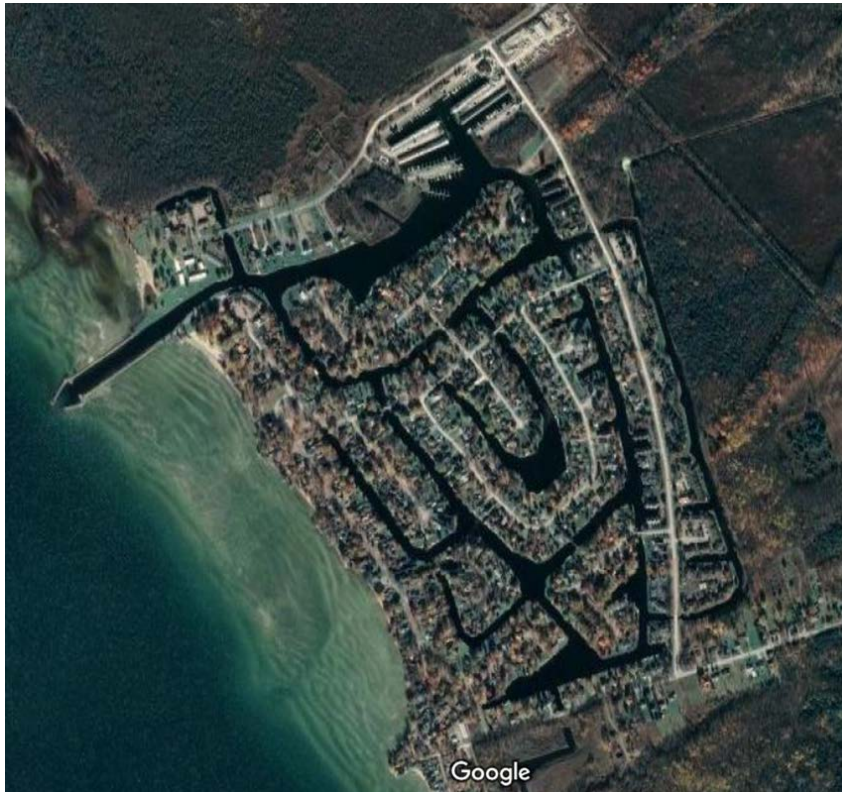
Starry Stonewort: initial reports

2013-14: Lagoon City

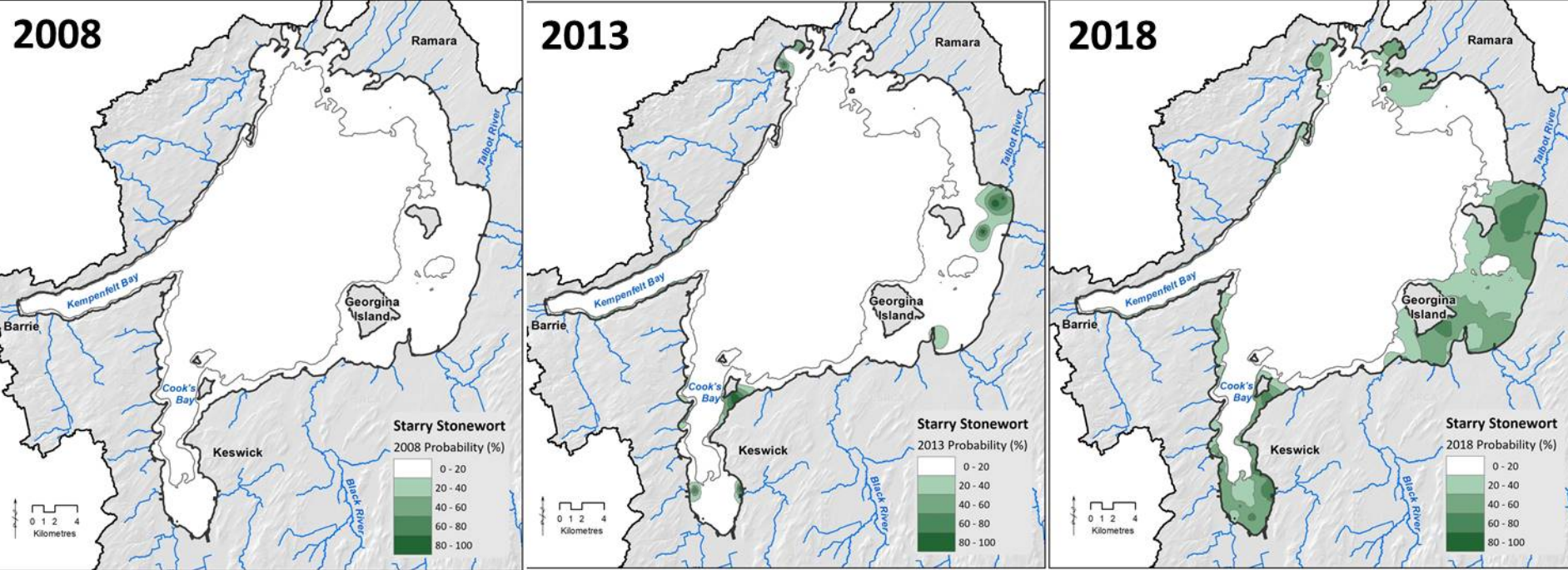
Herbicide (diquat) treatment for EWM

Year 1: blue-green algae

Year 2+: starry stonewort



Starry stonewort: trends



	2008	2013	2018
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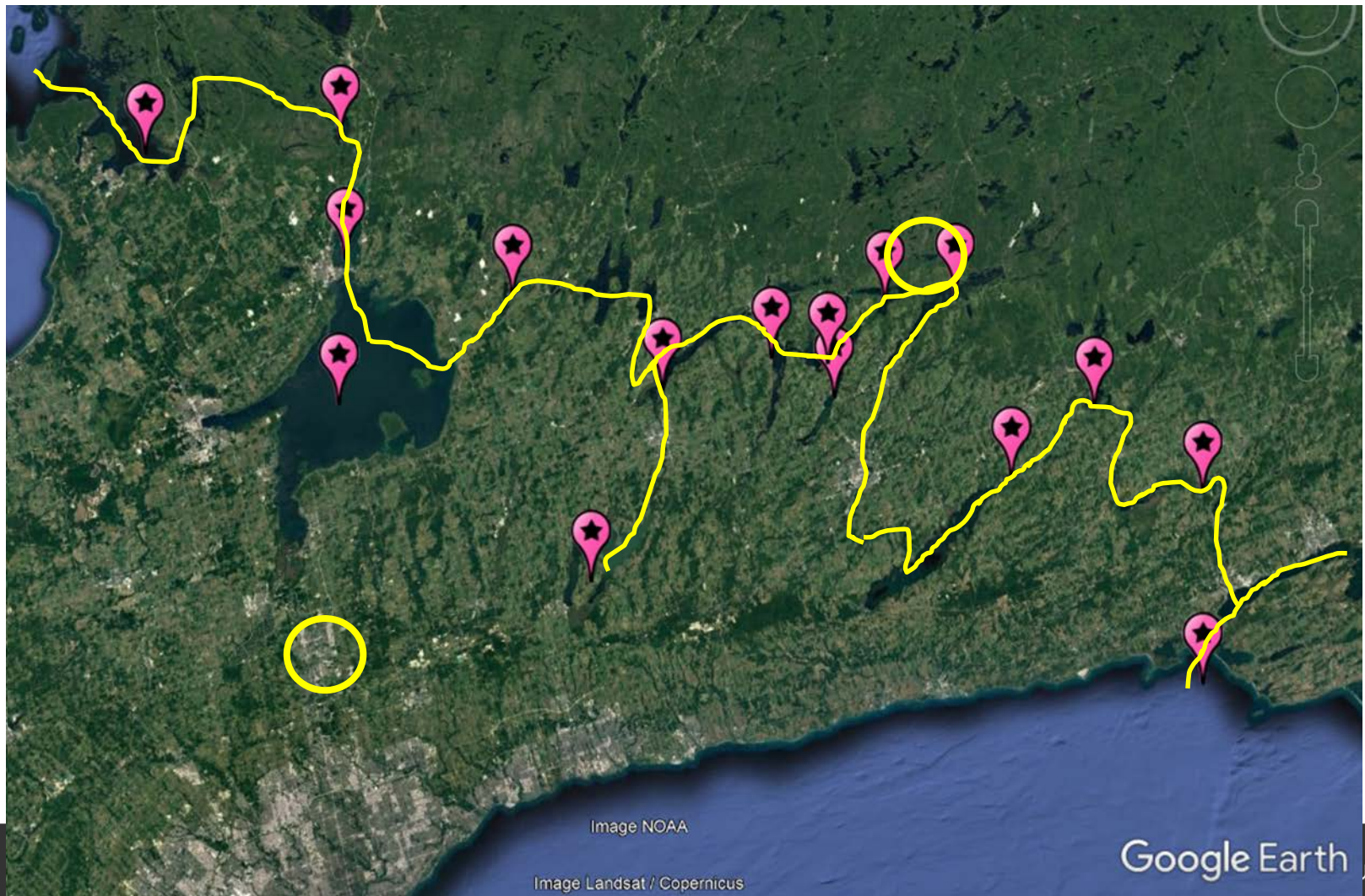
Proportion of total biomass (%) 0 31.4 67.6

Mean dry biomass (g/m²) 0 25.5 104.1

Now: the dominant shallow water species in Lake Simcoe

Starry stonewort in Ontario

- “Under the radar” invader
- Not widely reported (not listed on Ontario’s invasive species reporting website / app!)
- Spread along Trent-Severn Waterway (Lake Ontario → Georgian Bay / Lake Huron)

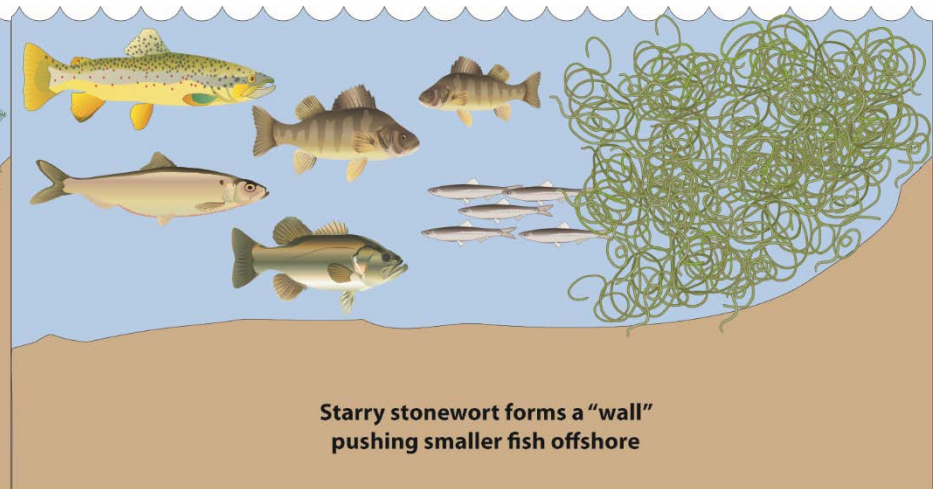
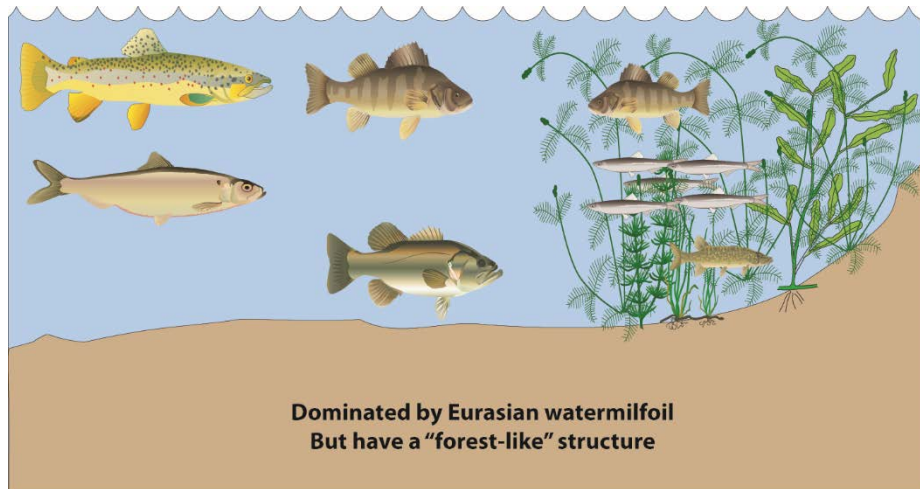


Consequences to recreation?

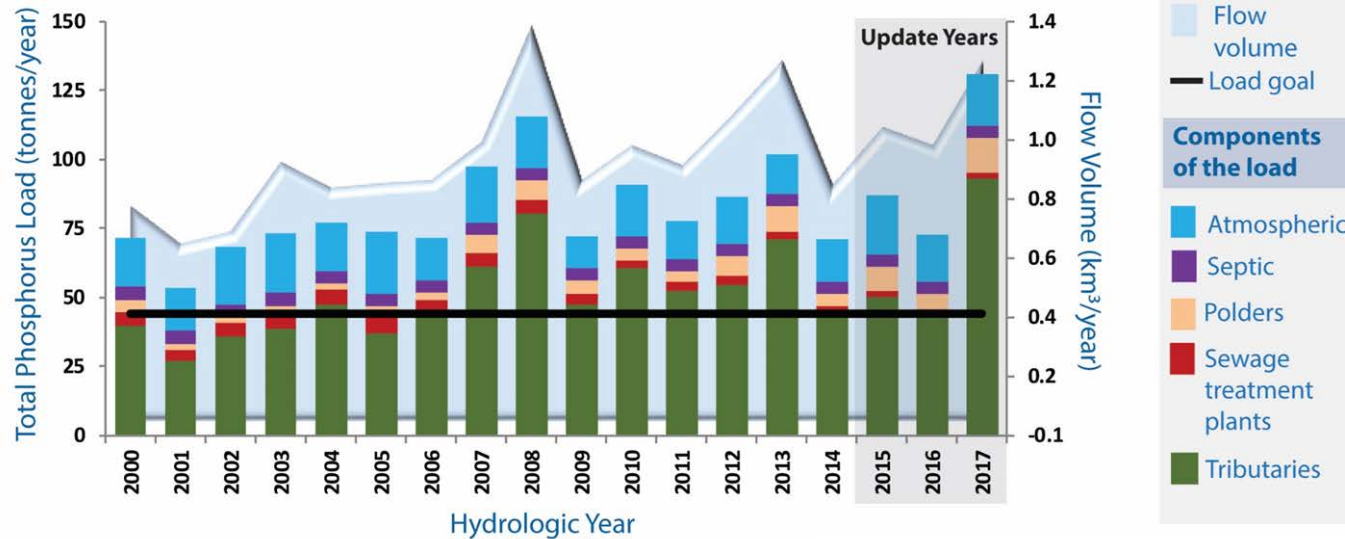
- Increased wash-ups of plant material
- Increased public complaints to municipalities, LSRCA, government agencies
- High economic impacts to marinas, beaches, shorelines, shallow water



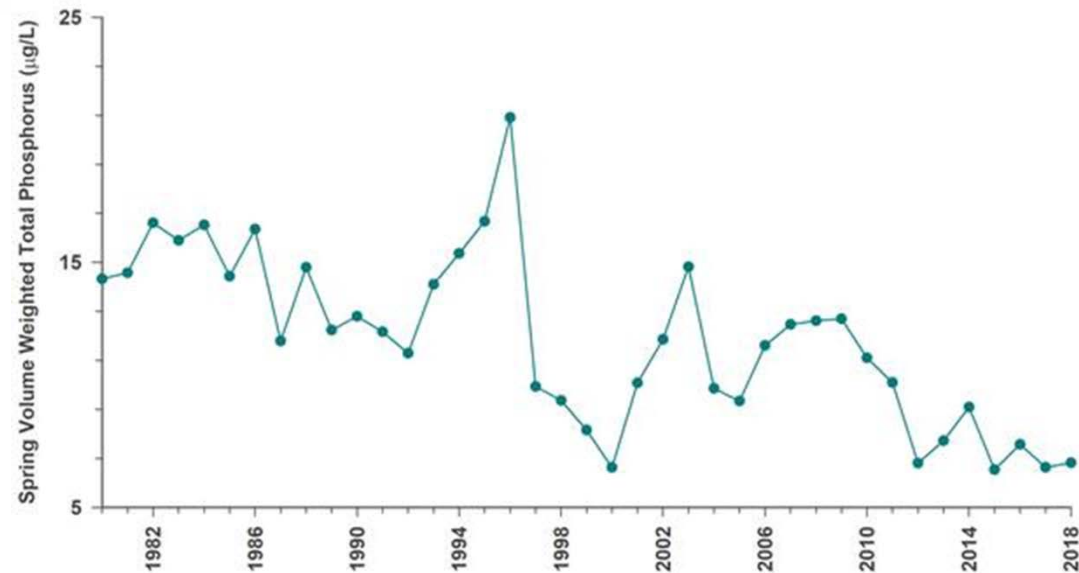
Consequences to nearshore habitats?



Consequences to P cycling?



- P loading “disconnected” from in-lake P
- Macroalgae uptake dissolved P
- Is SSW a sink?
- *Chara* uptakes 94% available SRP
(Kufel & Ozimek 1994 Hydrobiol 275/276: 277-283)



How do we manage SSW?

- Herbicides?
 - Limited effectiveness, only diquat permitted in Ontario
 - Copper? Effects to drinking water?



How do we manage SSW?

- Manual removal?
 - Partly effective, but very labour intensive, must be repeated
 - Spread via fragmentation
 - Best at early stages of infestations / localized sites
 - Bulbils?



How do we manage SSW?

- Communication, education, boat launch inspections?
 - Limited / not done in Ontario (L. Simcoe boat launches mostly “self-serve”)
 - Not effective “after the fact”
 - We are (slowly) making progress with messaging



Summary

- Increase in aquatic plant biomass (2008 → 2018)
- Increase in habitat space (increased water clarity):
 - P reductions
 - Invasive mussels
- **Also the increase in starry stonewort:**
 - Rapid increase since 2009
 - Has it peaked? Further increases?
 - Impacts to lake restoration and nutrient cycling?
- We need to develop effective control and management strategies!



Hawkestone



Beaverton



R/V Ouentironk in Cook's Bay