Monitoring and Management of Starry Stonewort (*Nitellopsis obtusa*) in Wisconsin Lakes

Starry Stonewort Collaborative Webinar

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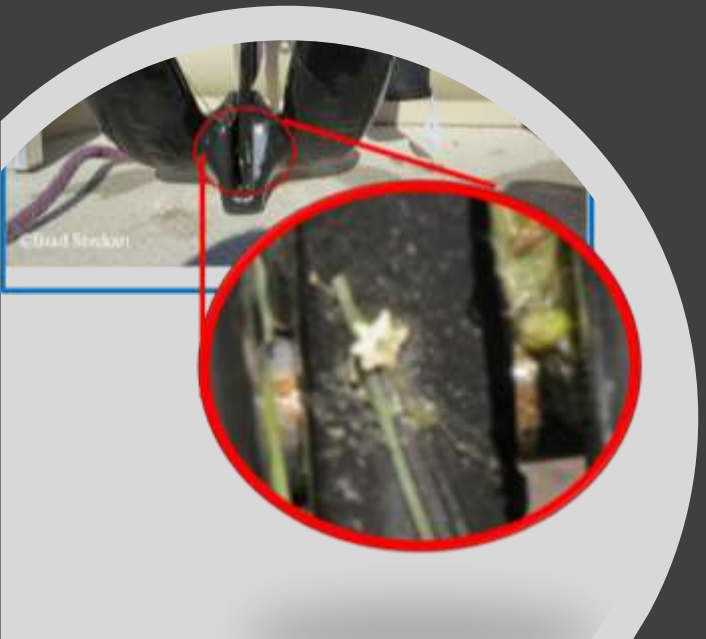
Photo: Paul Skawinski

What is starry stonewort?

- Starry stonewort (*Nitellopsis obtusa*) is a macroalgae in the Characeae family.
- Not a vascular plant like most our aquatic plant species.
- Native to Europe & Asia; rare in portions of its range (endangered species in the United Kingdom and Japan).
- First documented in St. Lawrence River in 1970s; likely transported to U.S. via international ballast water.

Ecology & Habitat

- Macroalgae species that can grow ~4-7 ft tall
- Anchored to the sediments with clear filaments called rhizoids
- Found in deep and shallow lakes, bays, rivers, oxbows, and secondary channels
- In native range found at water depths of 1.5 to >46 ft; reported from depths of 1.5 to 23 ft in invaded range
- Occurs in calcareous, neutral to alkaline, mesotrophic to eutrophic waters
- Found growing on a variety of substrates (rocky, sandy, & mucky)



Reproduction & Dispersal

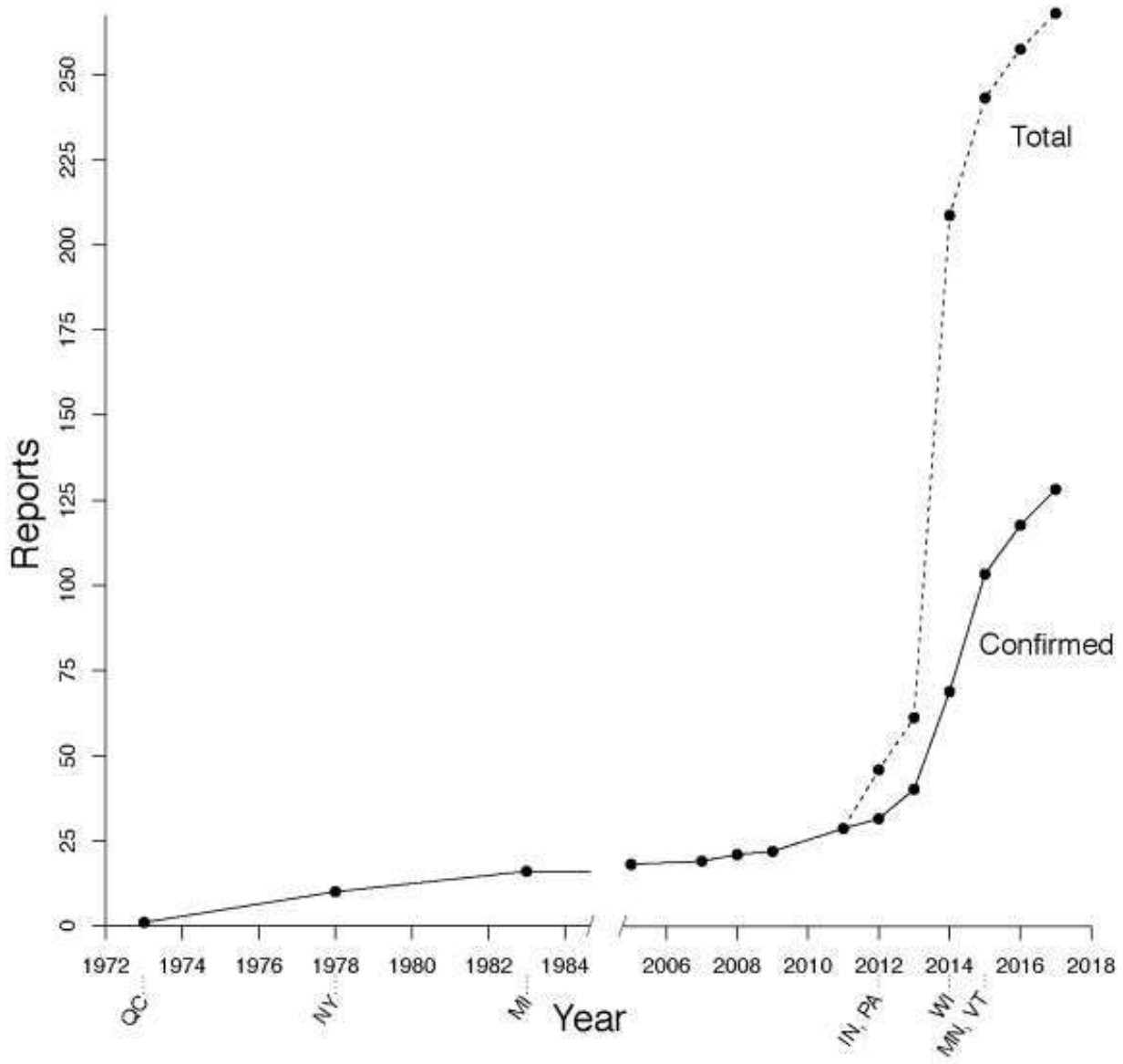
- Fragmentation of the stem
- Specialized structures called bulbils
  - white, star-shaped and less than 1/3-inch (~1 cm)
  - green bulbils also arise from main axes and branchlet nodes
- Only male starry stonewort has been found in North America
  - No sexual reproduction
- Primarily moved by boats, trailers, & anchors
- Waterfowl not believed to be source of dispersal due to lack of sexual reproduction (zygotes)

Non-Native Range Expansion

- Documented in lower Michigan inland lakes in the mid-2000s; Indiana in 2008.
- First documented in Wisconsin in 2014; Minnesota in 2015.
- Currently known from Indiana, Michigan (Lower), Minnesota, New York, Ohio, Pennsylvania, Vermont, Wisconsin, and Ontario.

Starry Stonewort Invasion Over Time

Larkin et al. 2018,
Aquatic Botany

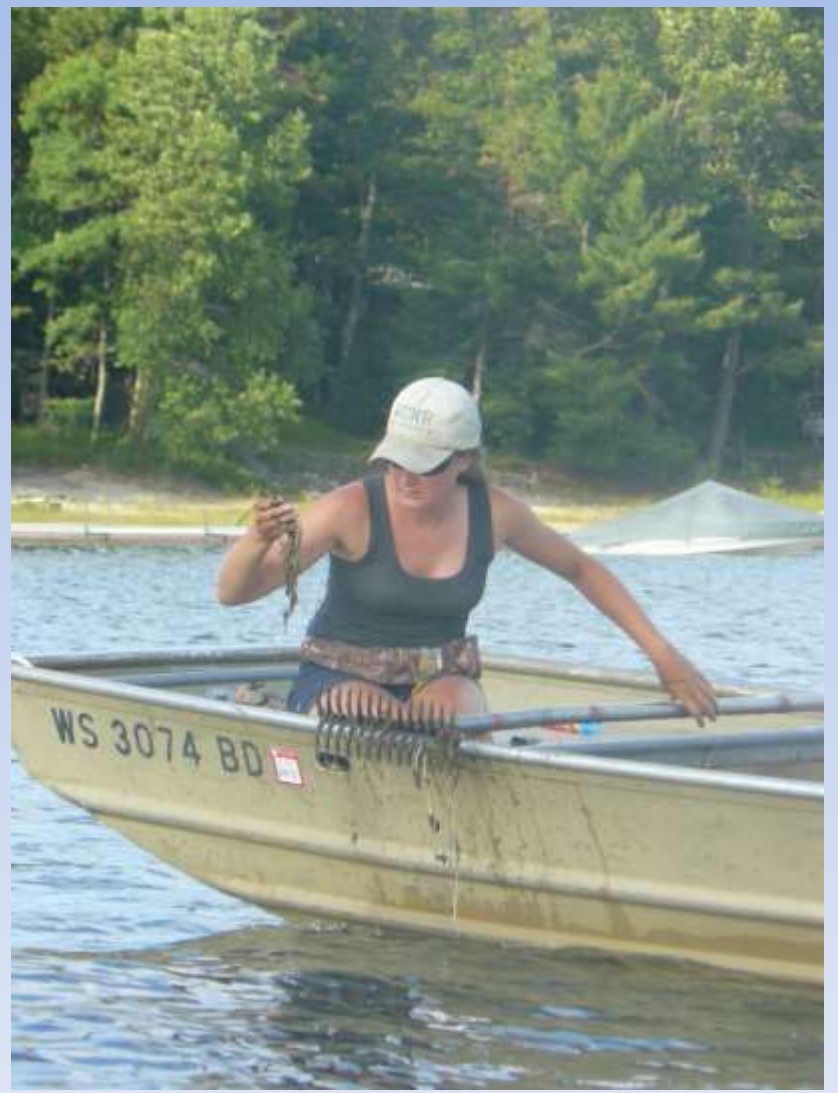


First Discovery of Starry Stonewort in Wisconsin

- Wisconsin DNR staff first discovered starry stonewort in September 2014 while conducting an aquatic plant point-intercept (PI) survey out on Little Muskego Lake, Waukesha Co.
- Verified by Wisconsin DNR and the New York Botanical Garden.

Monitoring & Response Approach

- Rapid Assessment Monitoring
  - Targeted monitoring effort in southeast WI waterbodies around Little Muskego Lake
  - Monitoring consisted of rake tosses at boat launches, shoreline meanders, snorkeling, and lakewide AIS surveys
  - Some efforts were made to prioritize surveying waterbodies based on within lake characteristics (i.e., presence of other native Characeae, water hardness)
- Statewide AIS & Point-Intercept Surveys
  - Heightened outreach, education and awareness of starry stonewort



Verified SSW Populations

2014
- Little Muskego

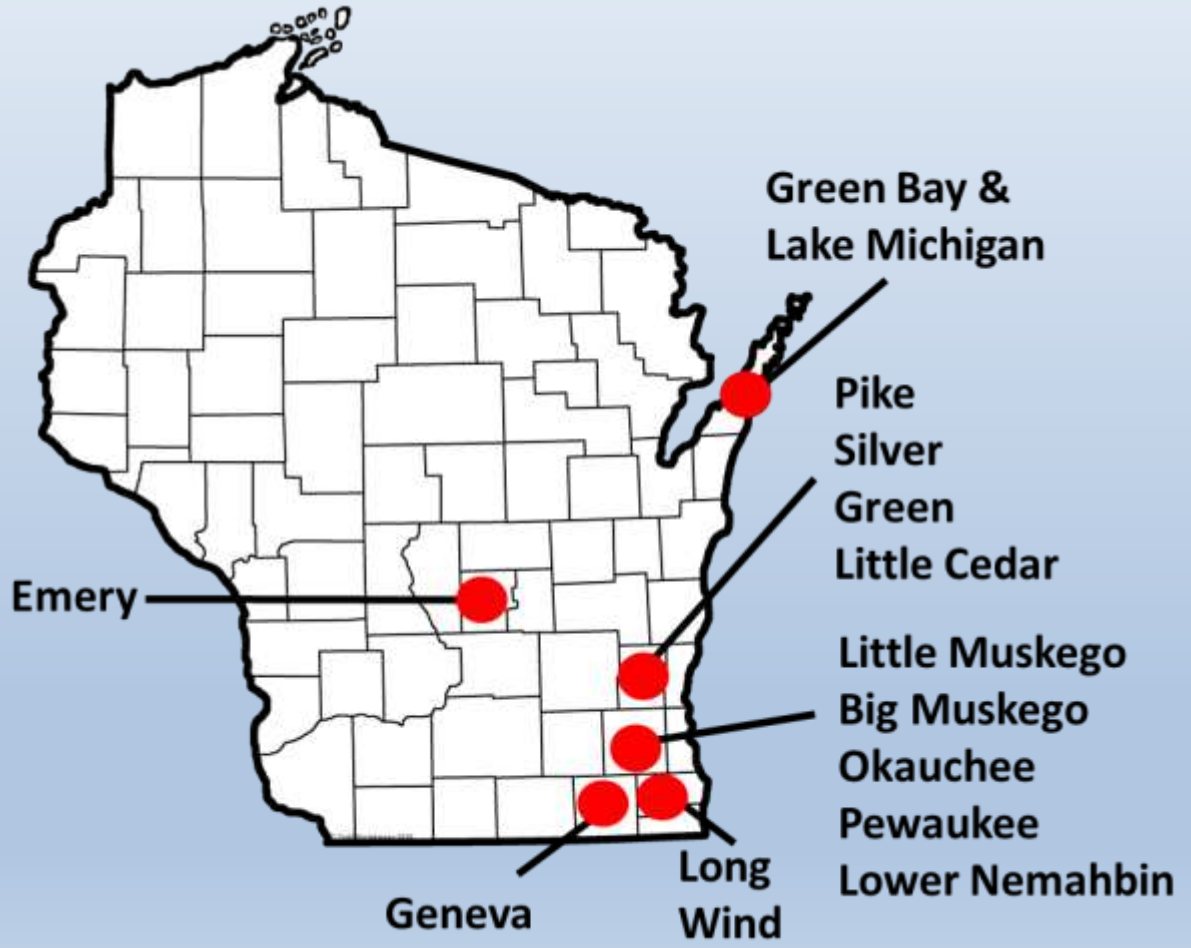
2015
- Big Muskego
- Long
- Pike
- Silver

2016
- Green
- Lake Michigan/Green Bay

2017
- Wind

2018
- Geneva
- Little Cedar

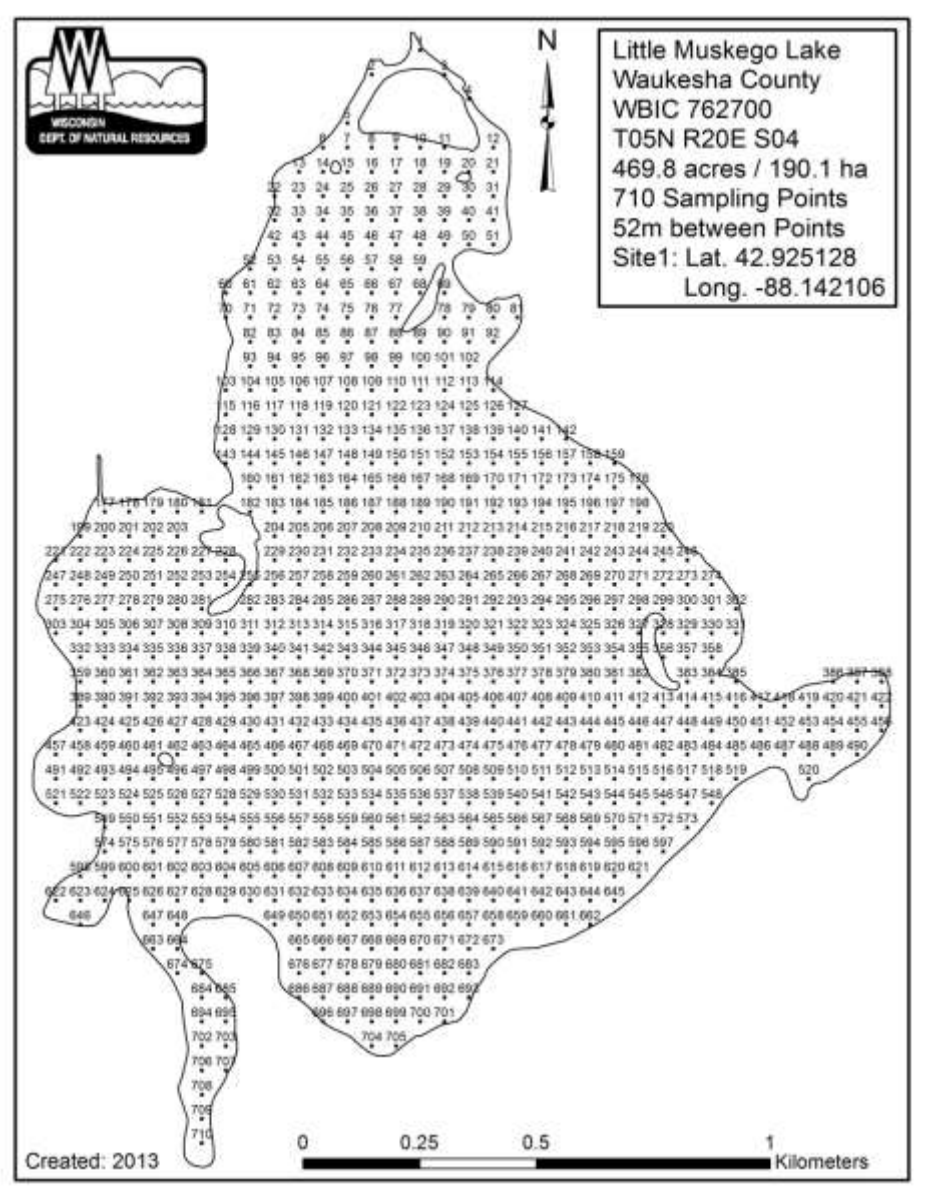
2019
- Okauchee
- Pewaukee
- Nemahbin
- Emery

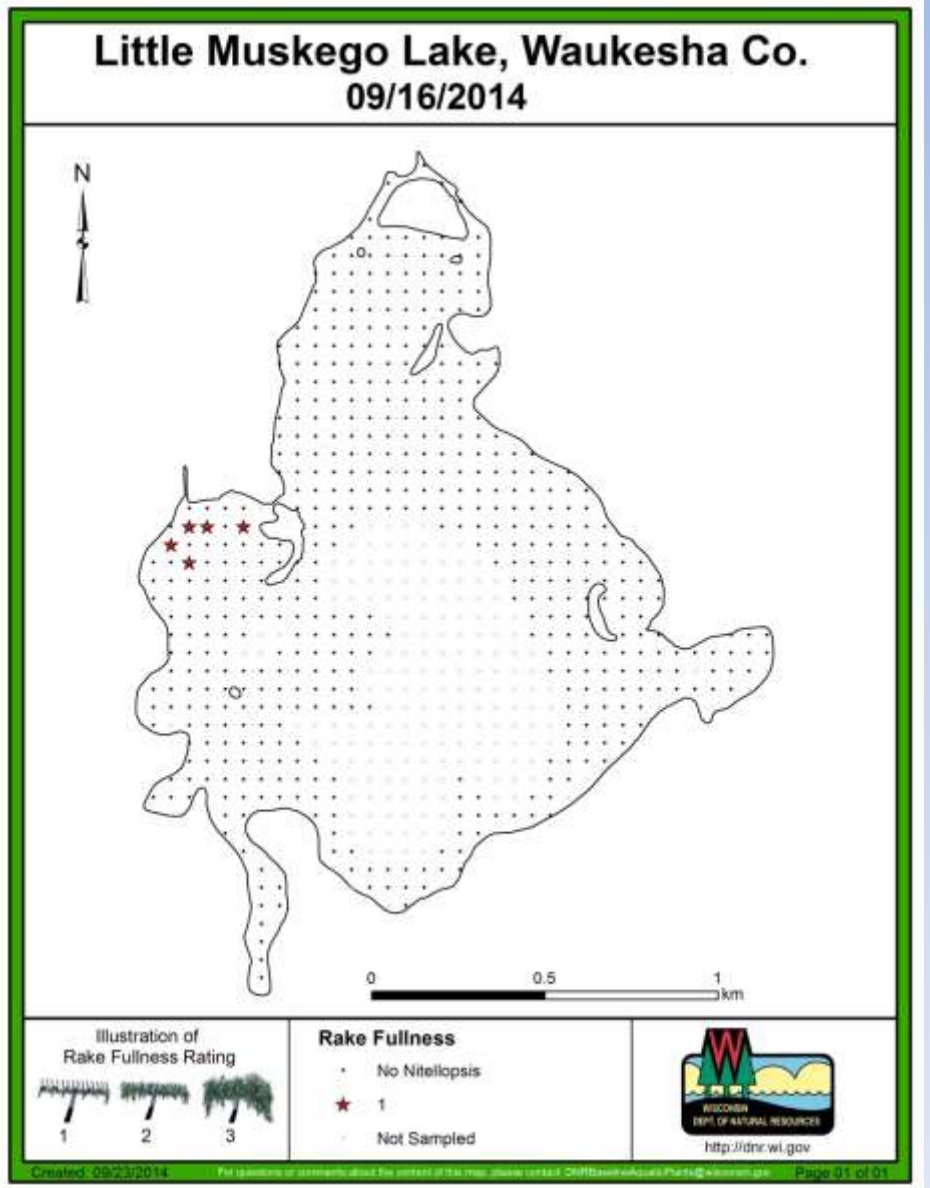


Monitoring Approach

- Lakewide SSW Monitoring
  - Aquatic plant point-intercept (PI) surveys conducted on an annual basis on the majority of verified SSW lakes
  - Standardized PI methodology allows for quantitative data collection
  - PI data used to look at plant community changes over time within a lake, as well as changes amongst different lakes
  - PI methodology is relatively easy to implement and provides statistically robust geolocated data
  - Data collected on SSW as well as native plant community

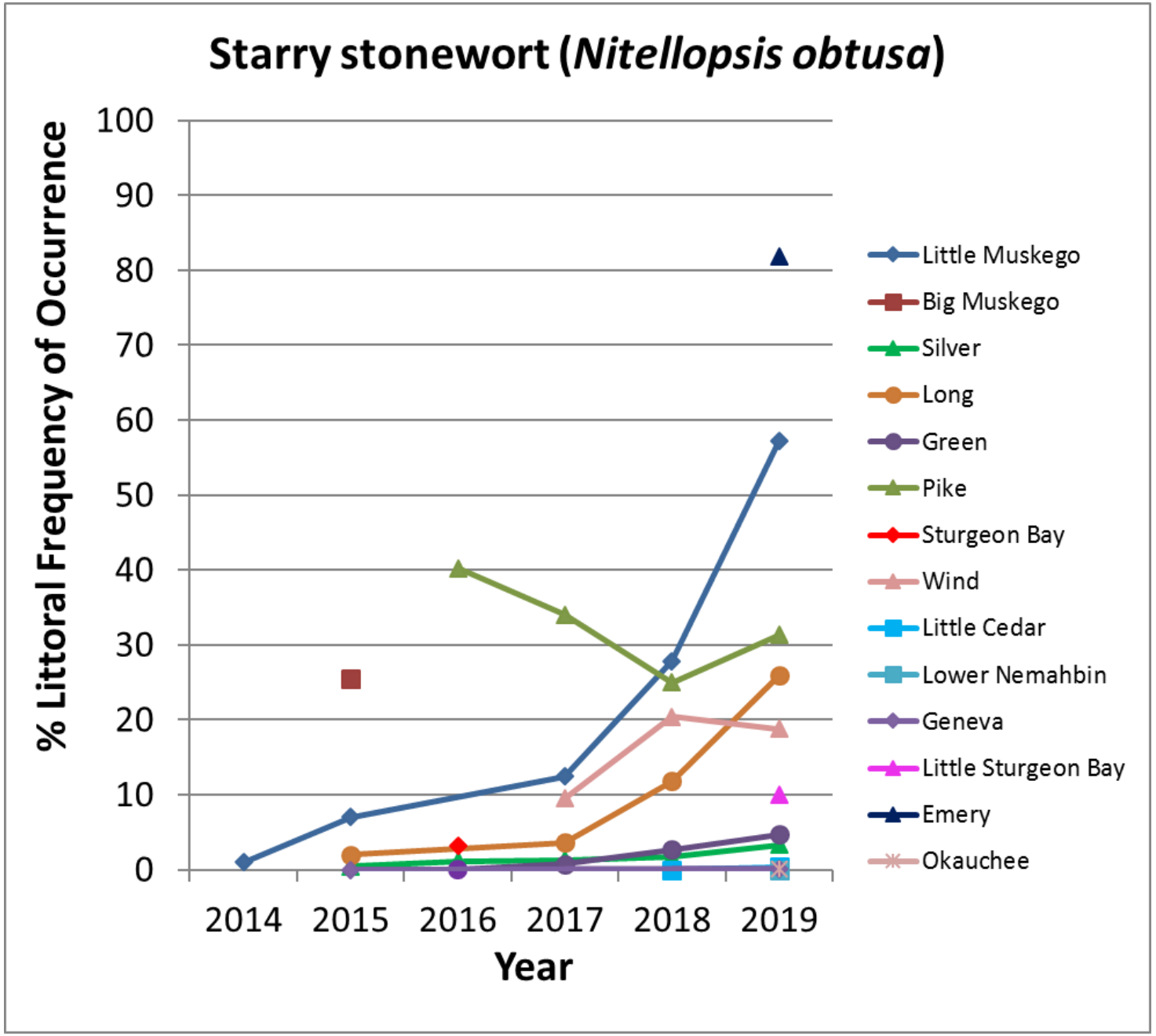
Lakewide SSW Monitoring





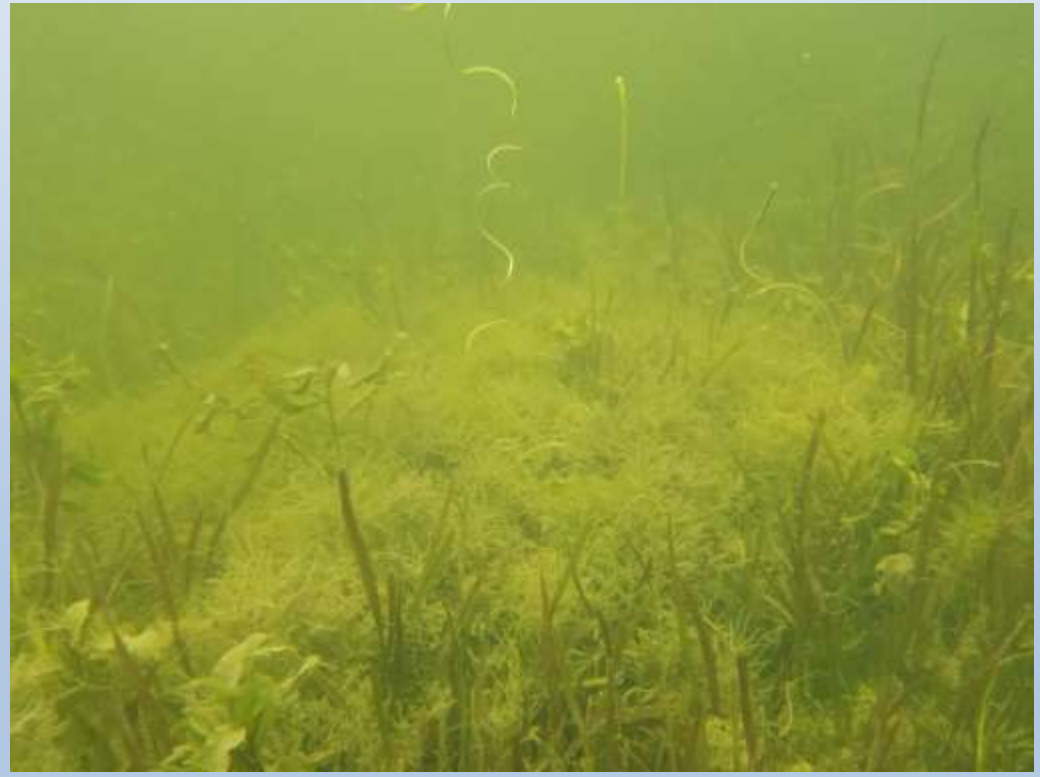
Lakewide SSW Monitoring

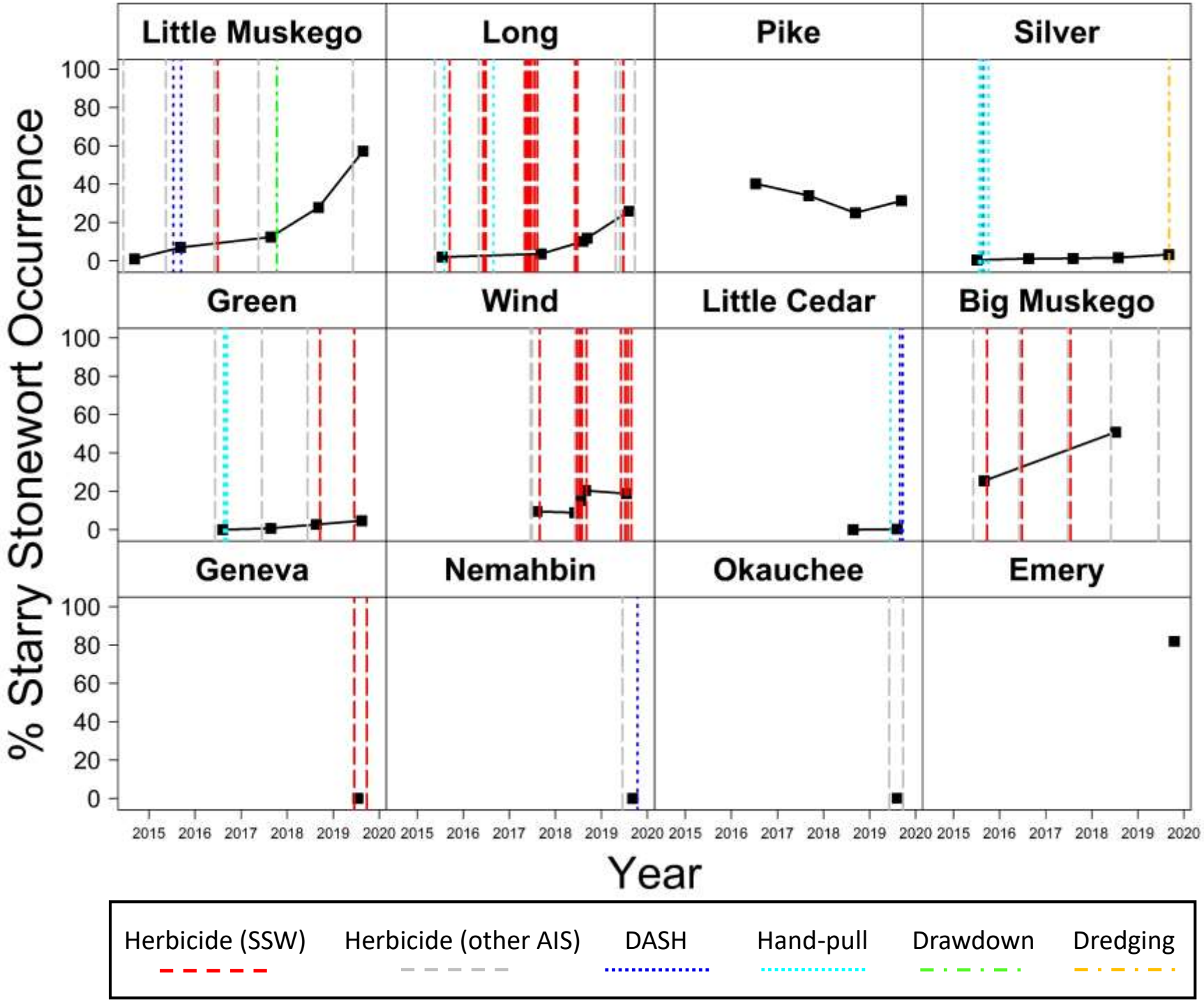
SSW % littoral frequency of occurrence has ranged from 0 – 82%



Implementation and Evaluation of Starry Stonewort Control Efforts

- Chemical treatment
  - open water and barrier curtain
- Drawdown
- Diver Assisted Suction Harvest (DASH)
- Hand pulling
- Dredging
- No management




Little Muskego
Long
Pike
Silver
Green
Wind
Little Cedar
Big Muskego
Geneva
Nemahbin
Okauchee
Emery
% Starry Stonewort Occurrence
0
20
40
60
80
100
2015
2016
2017
2018
2019
2020
Year
Herbicide (SSW)
Herbicide (other AIS)
DASH
Hand-pull
Drawdown
Dredging

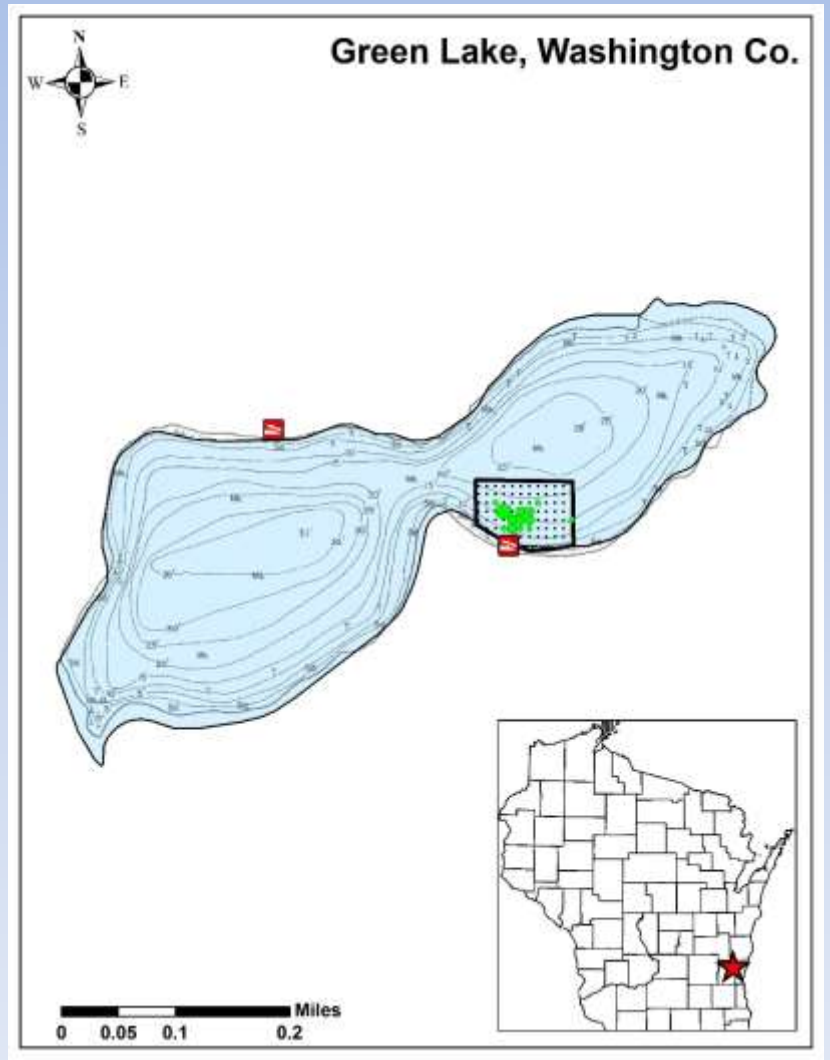
Starry Stonewort Management Projects

- **Green Lake, Washington Co.**
  - Small-scale herbicide treatments within limno-barrier
- **Lake Geneva, Walworth Co.**
  - Small-scale herbicide treatments within limno-barrier
- **Wind Lake, Racine Co.**
  - Large-scale herbicide treatments
- **Little Muskego Lake, Waukesha Co.**
  - Water level winter drawdown
- **Little Cedar Lake, Washington Co.**
  - DASH & Hand-pulling
- **Silver Lake, Washington Co.**
  - DASH & Dredging
- **Pike Lake, Washington Co.**
  - No management

Green Lake, Washington Co.

- Management Approach: Chemical Control w/ Limno-barrier

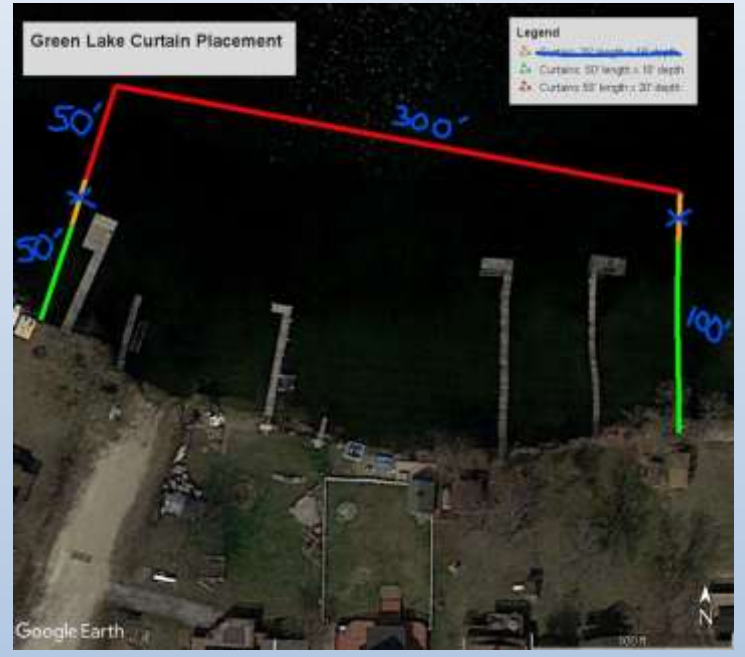
- 70 acre seepage lake
- 37 feet max depth
- 17 feet mean depth
- SSW discovered in July 2016 near public boat access
- Great Lakes Restoration Initiative (GLRI) funding obtained to help support monitoring and control efforts



Green Lake

Management Approach: Chemical Control w/ Limno-barrier

- Localized area of SSW near south public access
- Goal: Apply herbicide within a barrier to increase time plants are exposed to chemical with the hope of achieving greater control of SSW



- 1st Barrier treatment: Sept. 17, 2018 – Sept. 27, 2018
- 2nd Barrier treatment: June 17, 2019 – June 27, 2019
- Treated ~1 ac with Cutrine Ultra (0.8 ppm) & Hydrothol 191 (0.17 ppm)

Green Lake

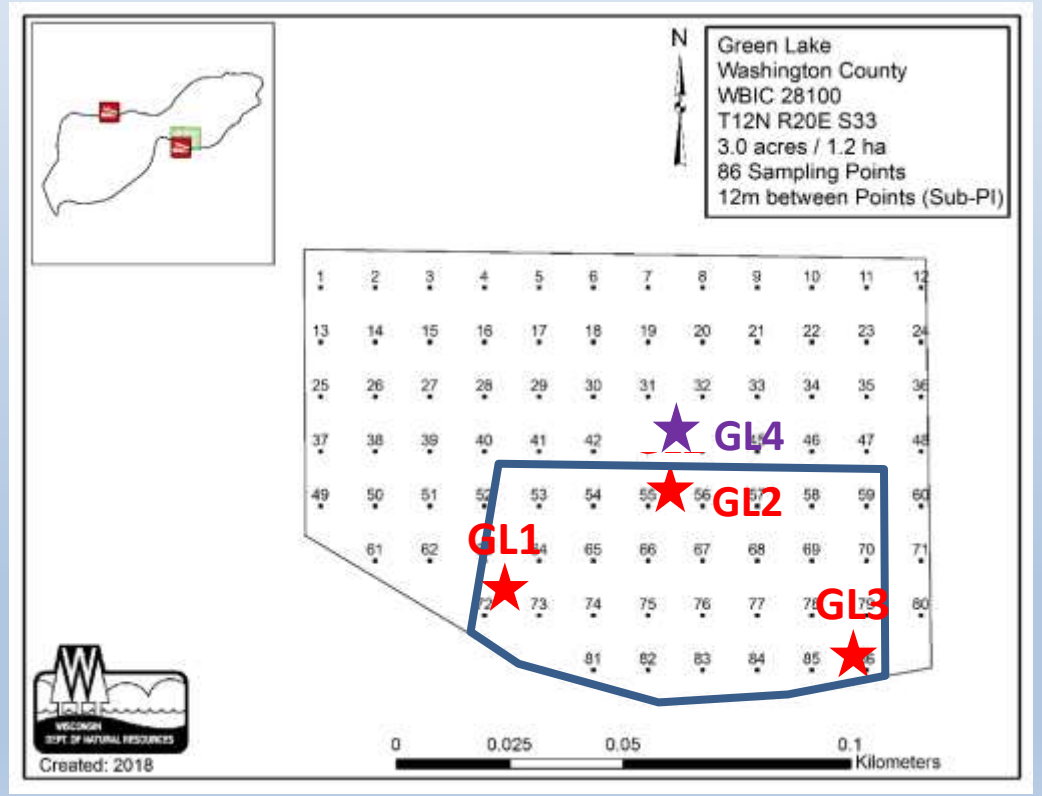
Management Approach: Chemical Control w/ Limno-barrier

Herbicide Concentration Monitoring

- 2018 Sites: GL1, GL2, GL3
- 2019 Sites: GL1, GL2, GL3, GL4
  - Water samples collected at: 1, 2, 3, 6, 9, 24, 48, 72, 96, 144, & 216 HAT
- Analyzed at WSLH for copper and endothall

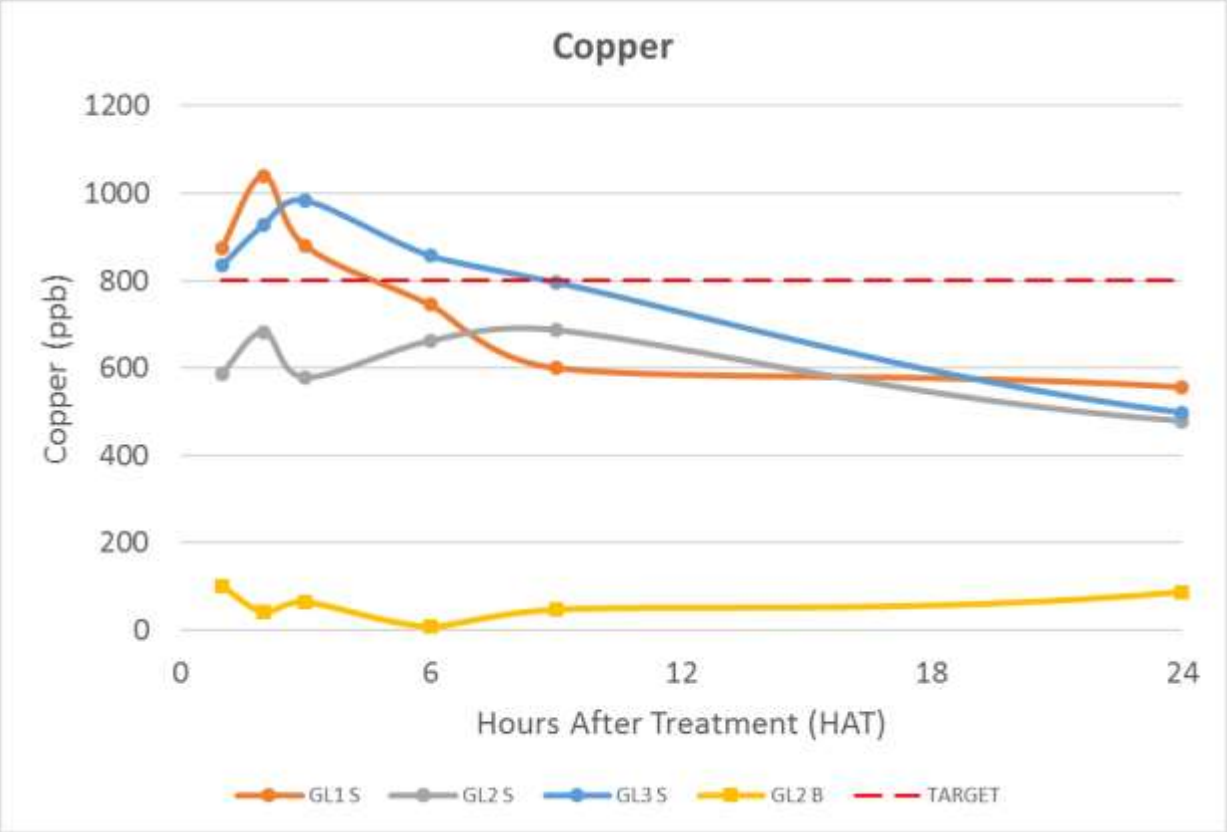
Aquatic Plant Monitoring

- Pre- and Post-Treatment sub-PI plant surveys
  - June, August & October 2018
  - June, July & August 2019
- Lakewide PI surveys conducted annually 2016-2019

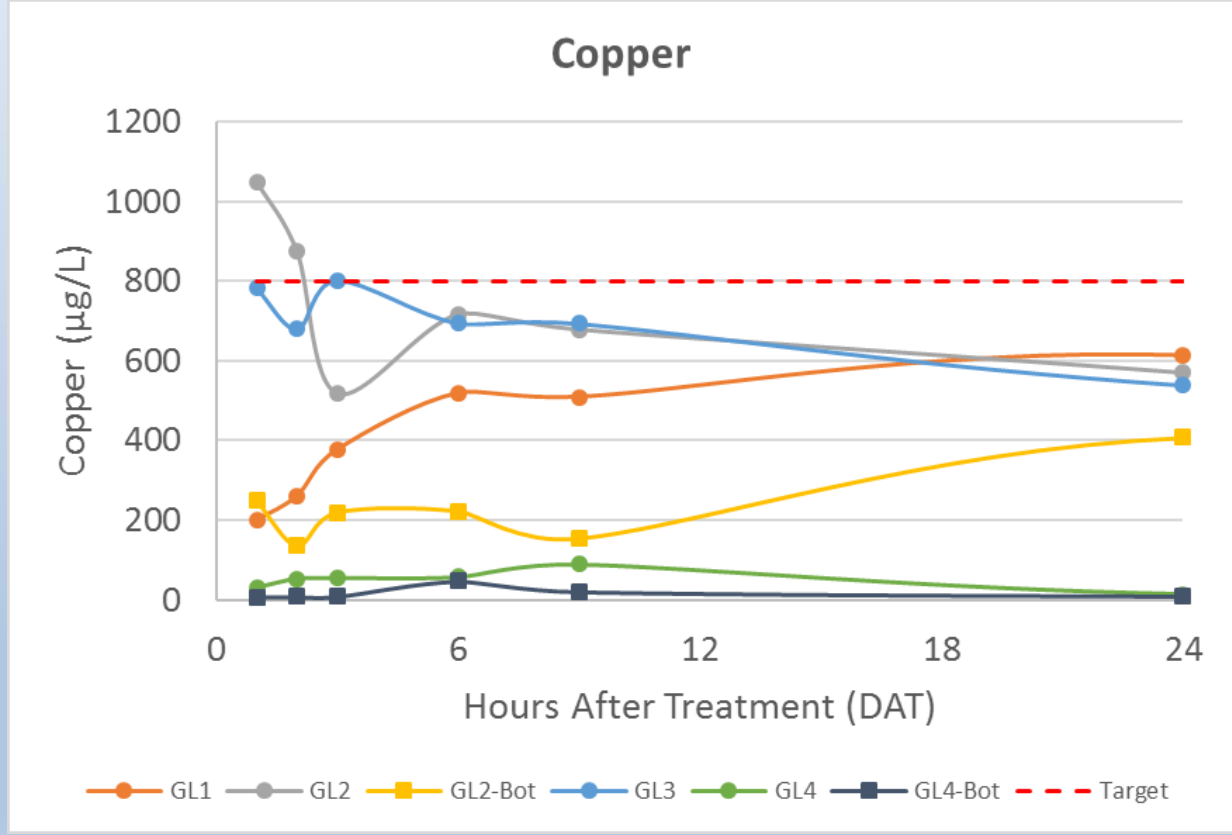


Green Lake

2018 Results

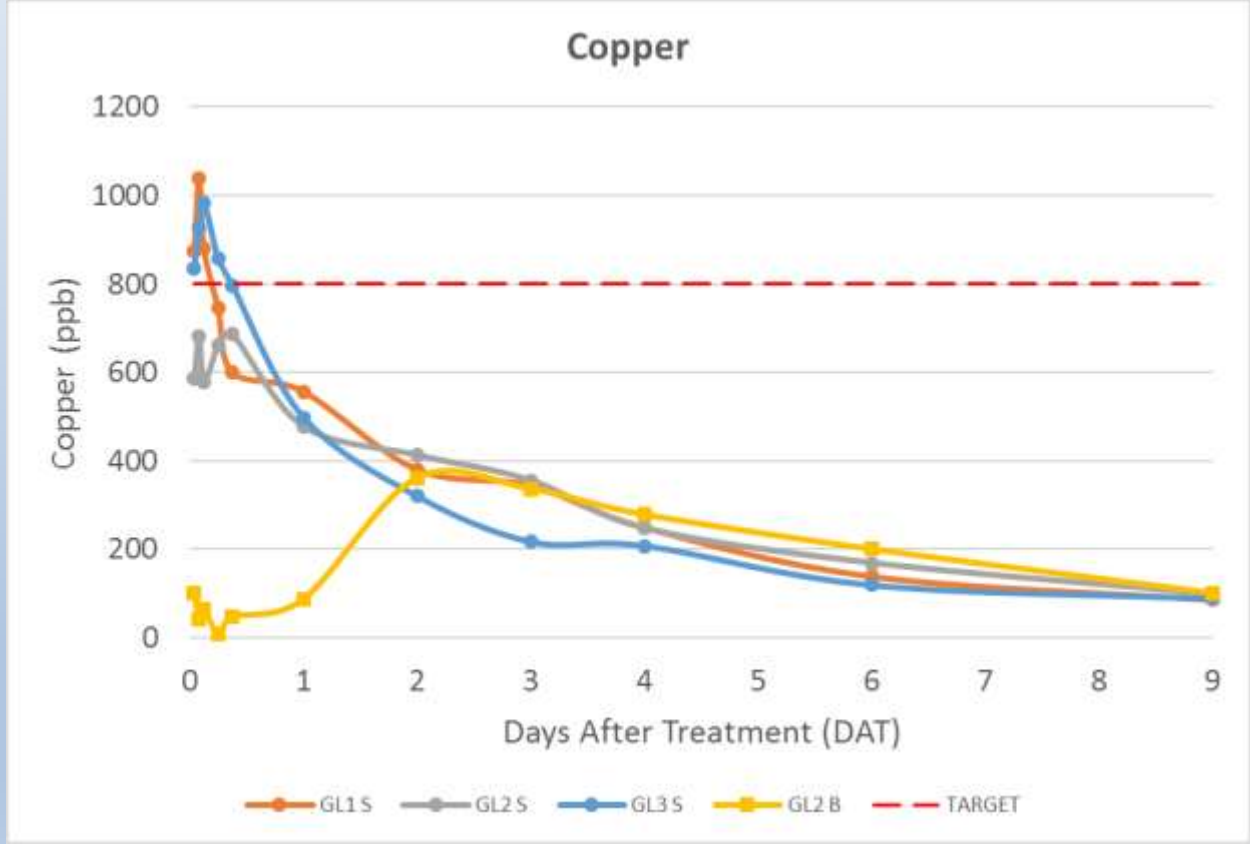


2019 Results

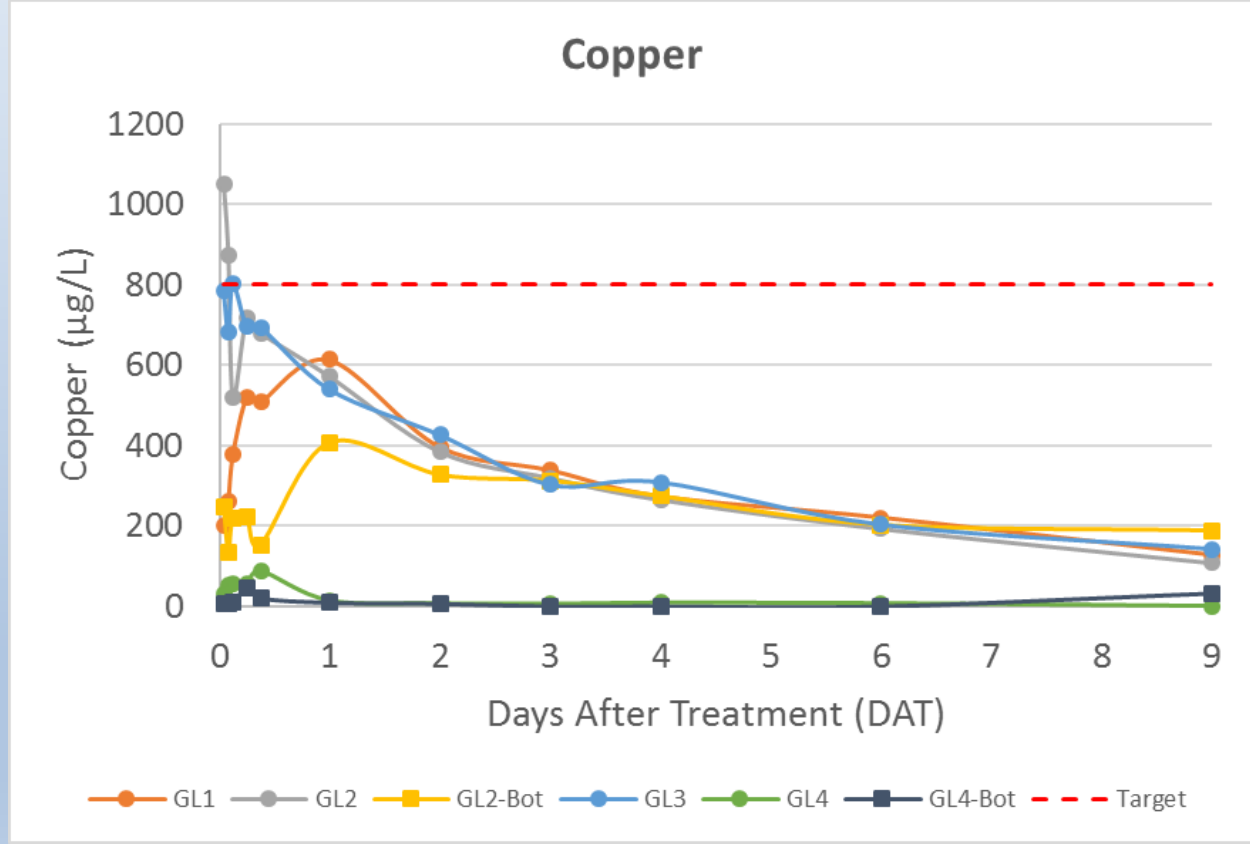


Green Lake

2018 Results

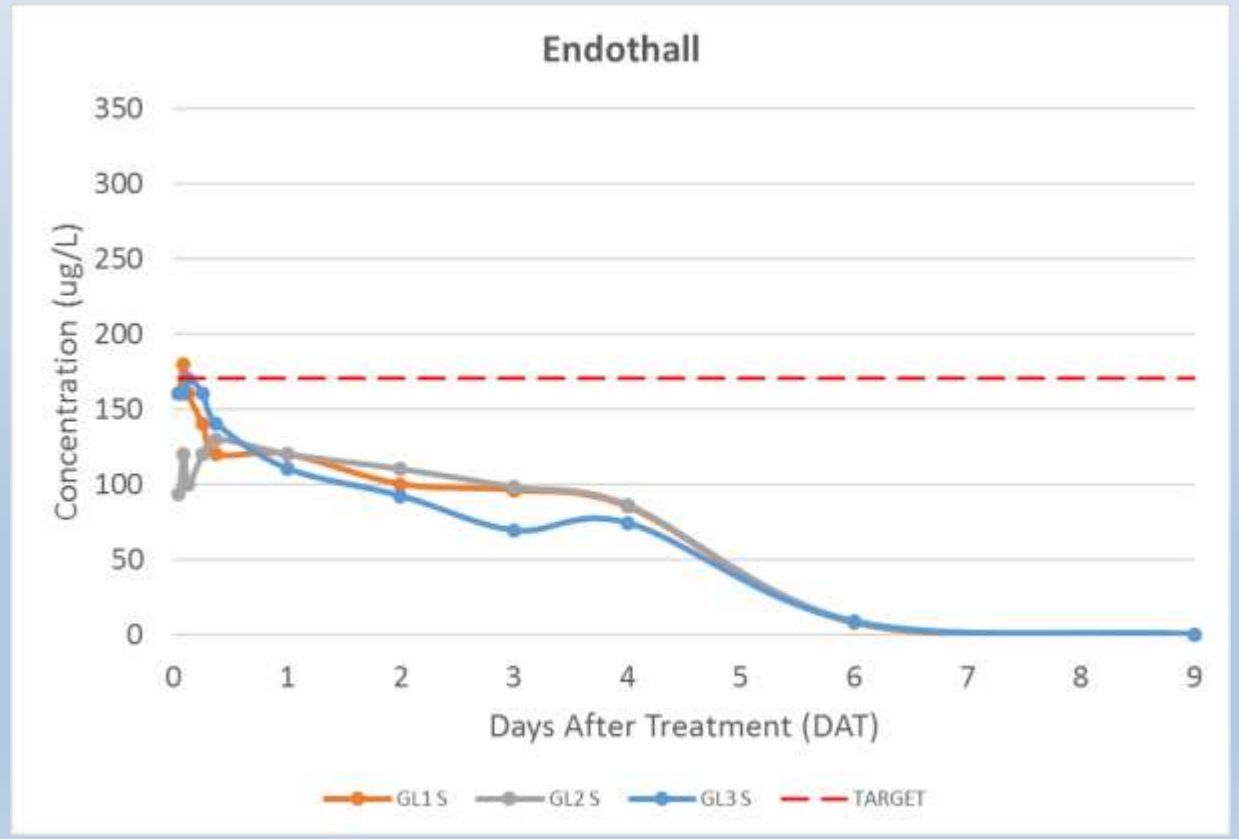


2019 Results

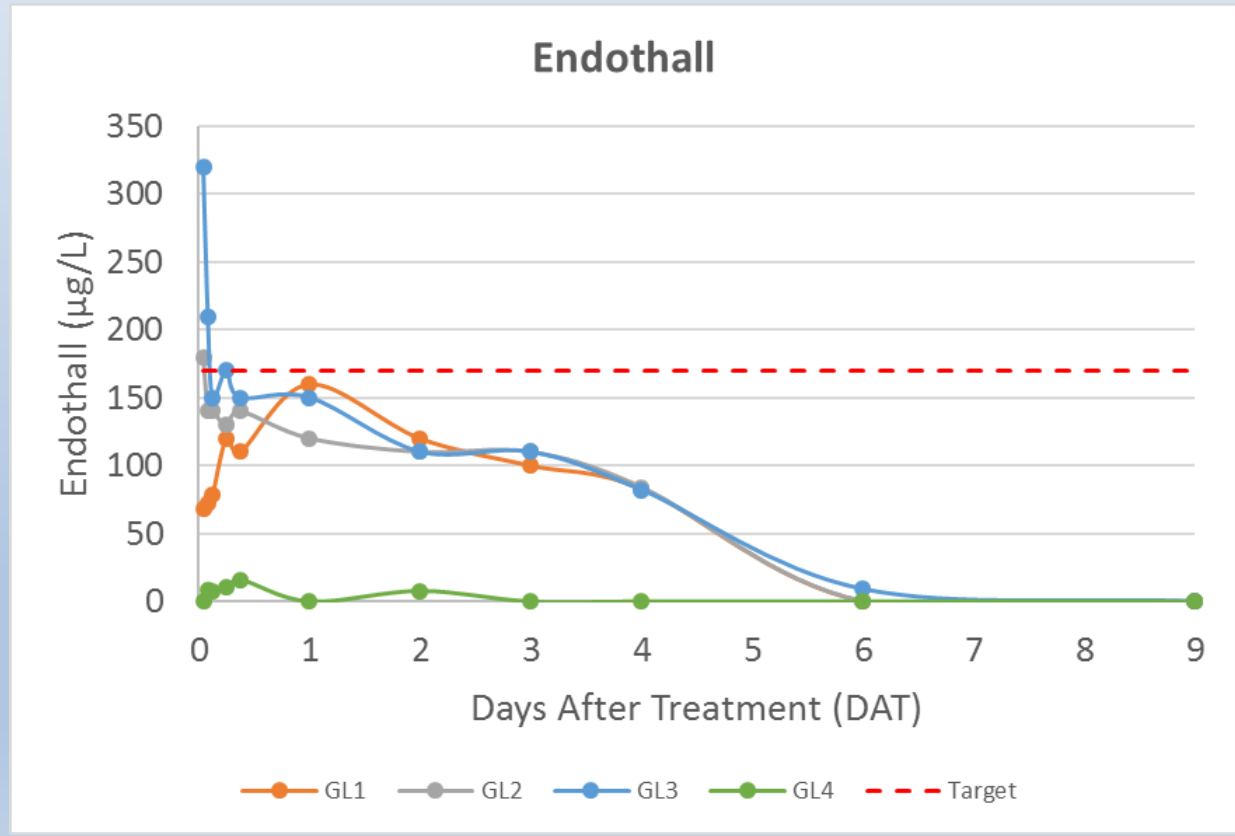


Green Lake

2018 Results



2019 Results



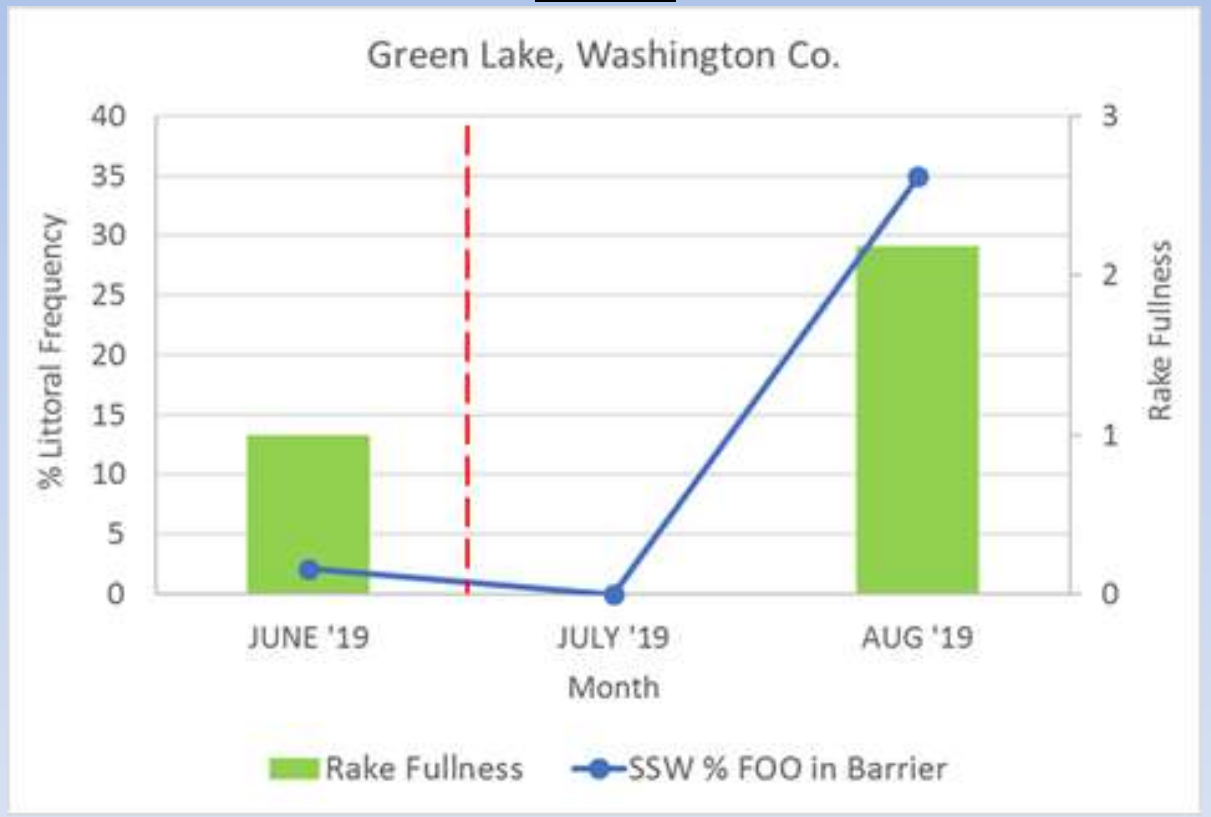
Green Lake

- Management Approach: Chemical Control w/ Limno-barrier

2018

SURVEYS	PRE	POST	CHANGE	P-VALUE
AUG '17 vs OCT '18	21.0	21.1	↑	0.991

2019

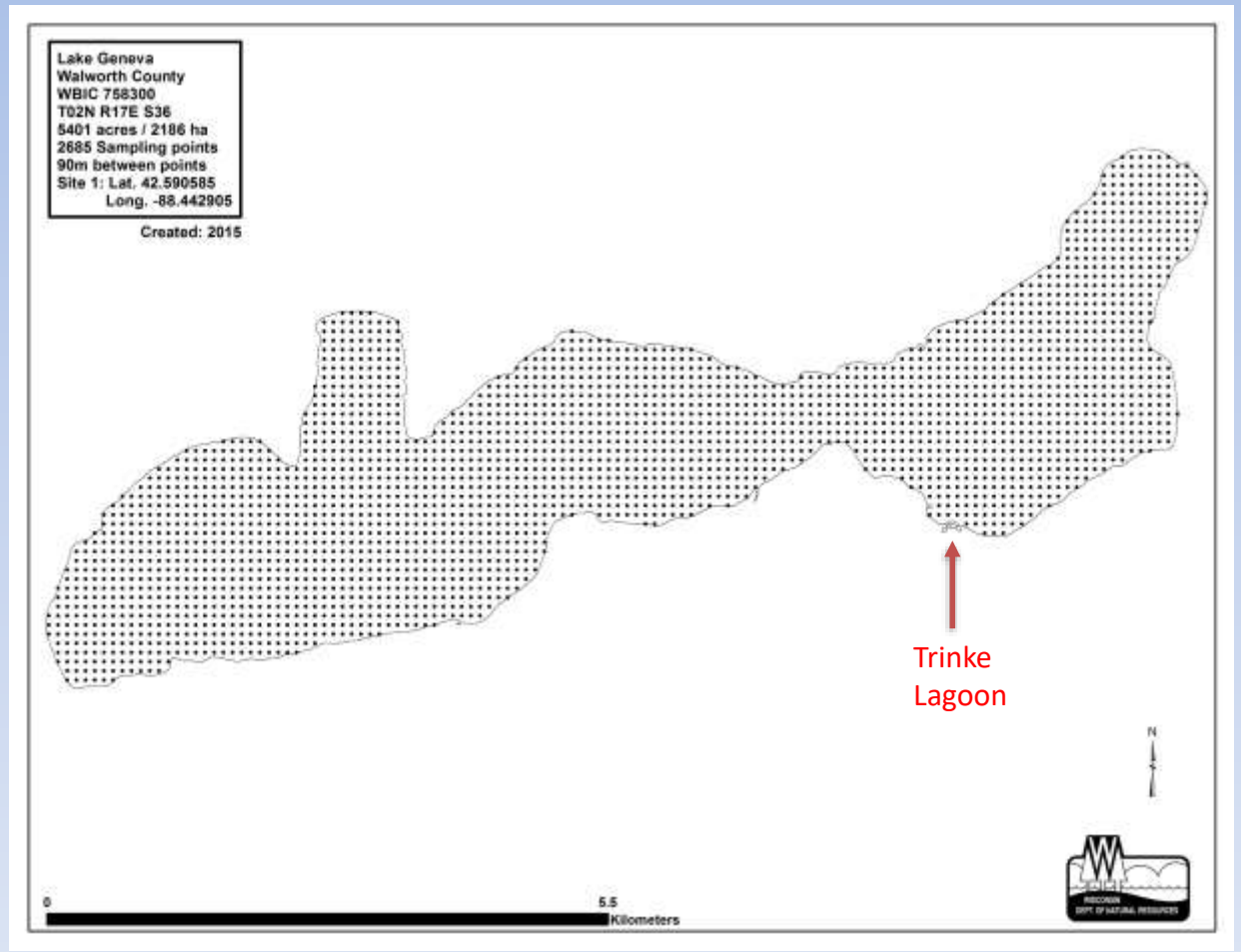


SURVEYS	PRE	POST	CHANGE	P-VALUE
JUNE '19 vs JULY '19	2.1	0	↓	0.39
JULY '19 vs AUG '19	0	34.9	↑	0.00009
JUNE '19 vs AUG '19	2.1	34.9	↑	0.00003

Lake Geneva, Walworth Co.

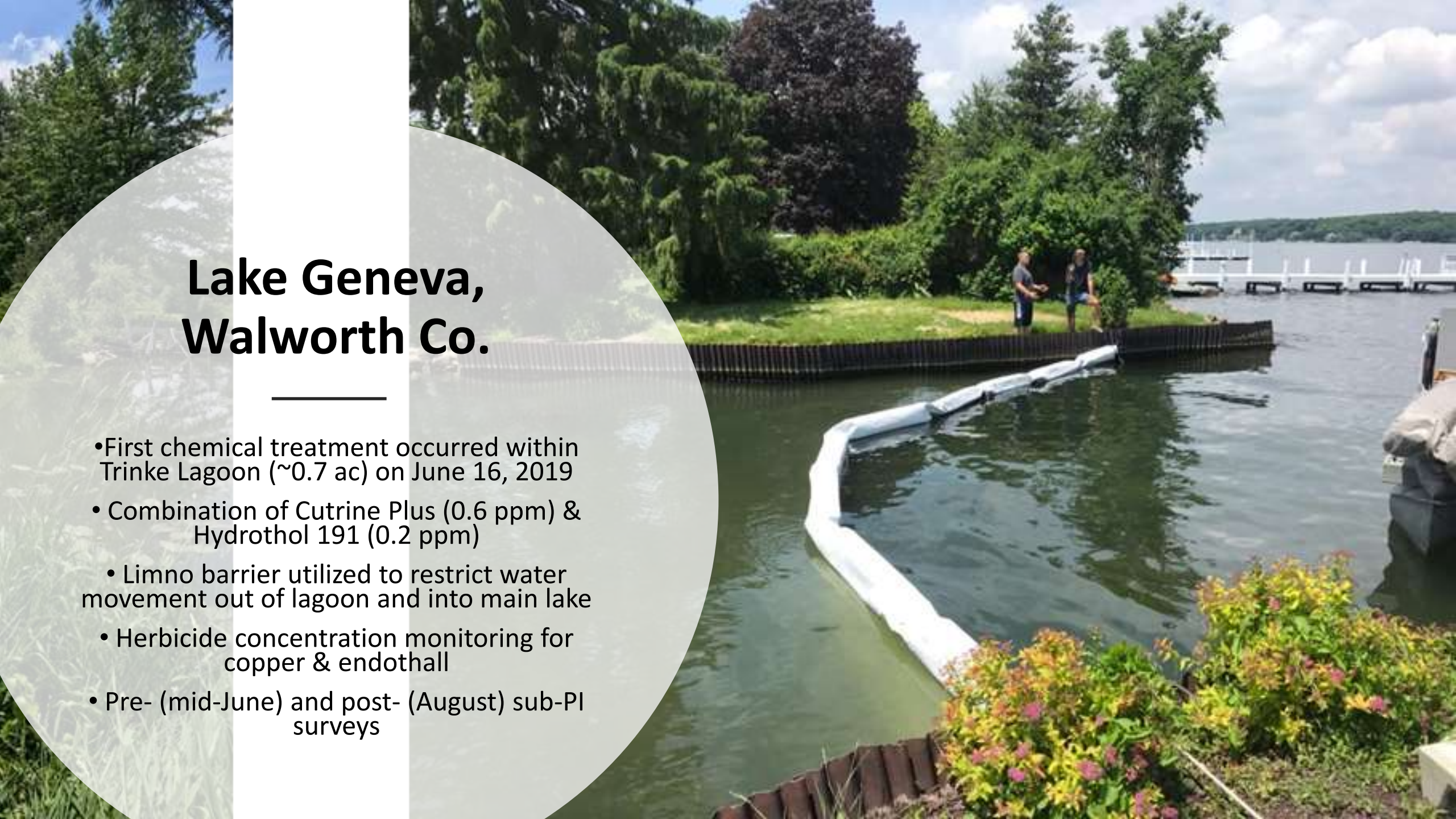
- Management Approach: Chemical Control w/ Limno-barrier

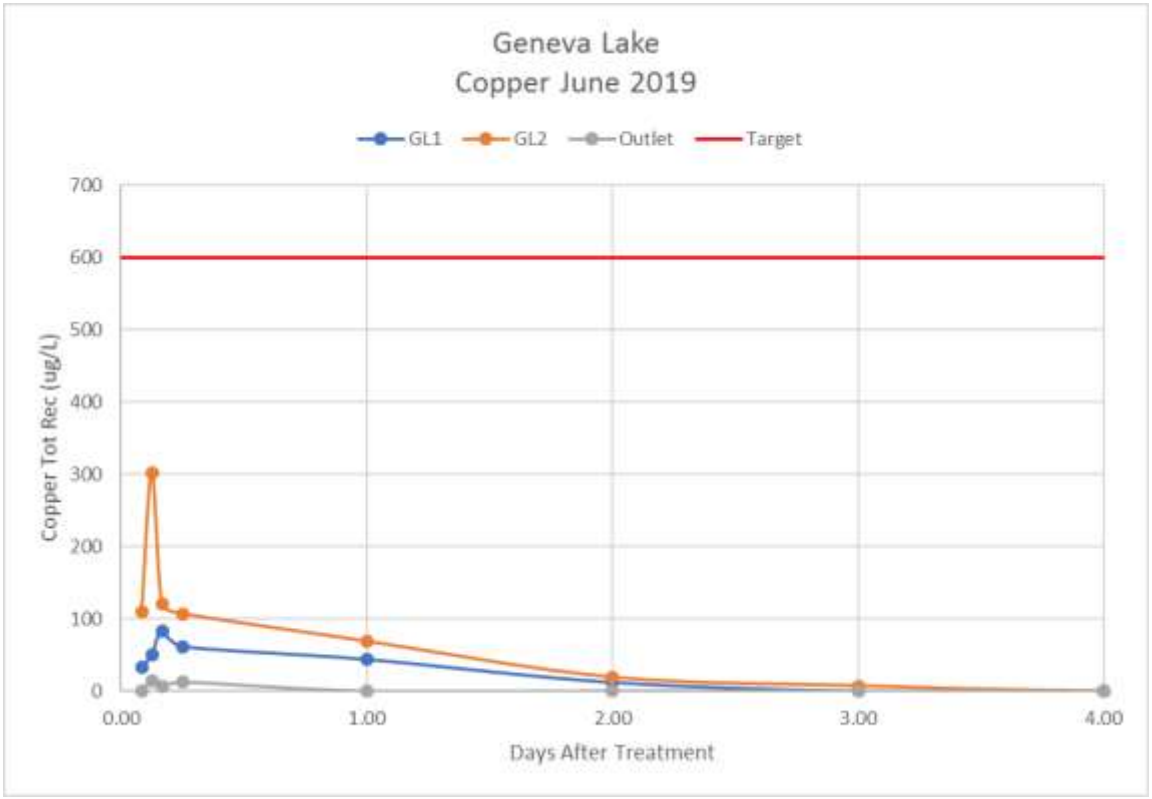
- 5401 acre spring lake
- 135 feet max depth
- 61 feet mean depth
- SSW discovered in August 2018 within small lagoon
- WDNR Rapid Response grant obtained to help support monitoring and control efforts



Lake Geneva, Walworth Co.

- First chemical treatment occurred within Trinke Lagoon (~0.7 ac) on June 16, 2019
- Combination of Cutrine Plus (0.6 ppm) & Hydrothol 191 (0.2 ppm)
- Limno barrier utilized to restrict water movement out of lagoon and into main lake
- Herbicide concentration monitoring for copper & endothall
- Pre- (mid-June) and post- (August) sub-PI surveys

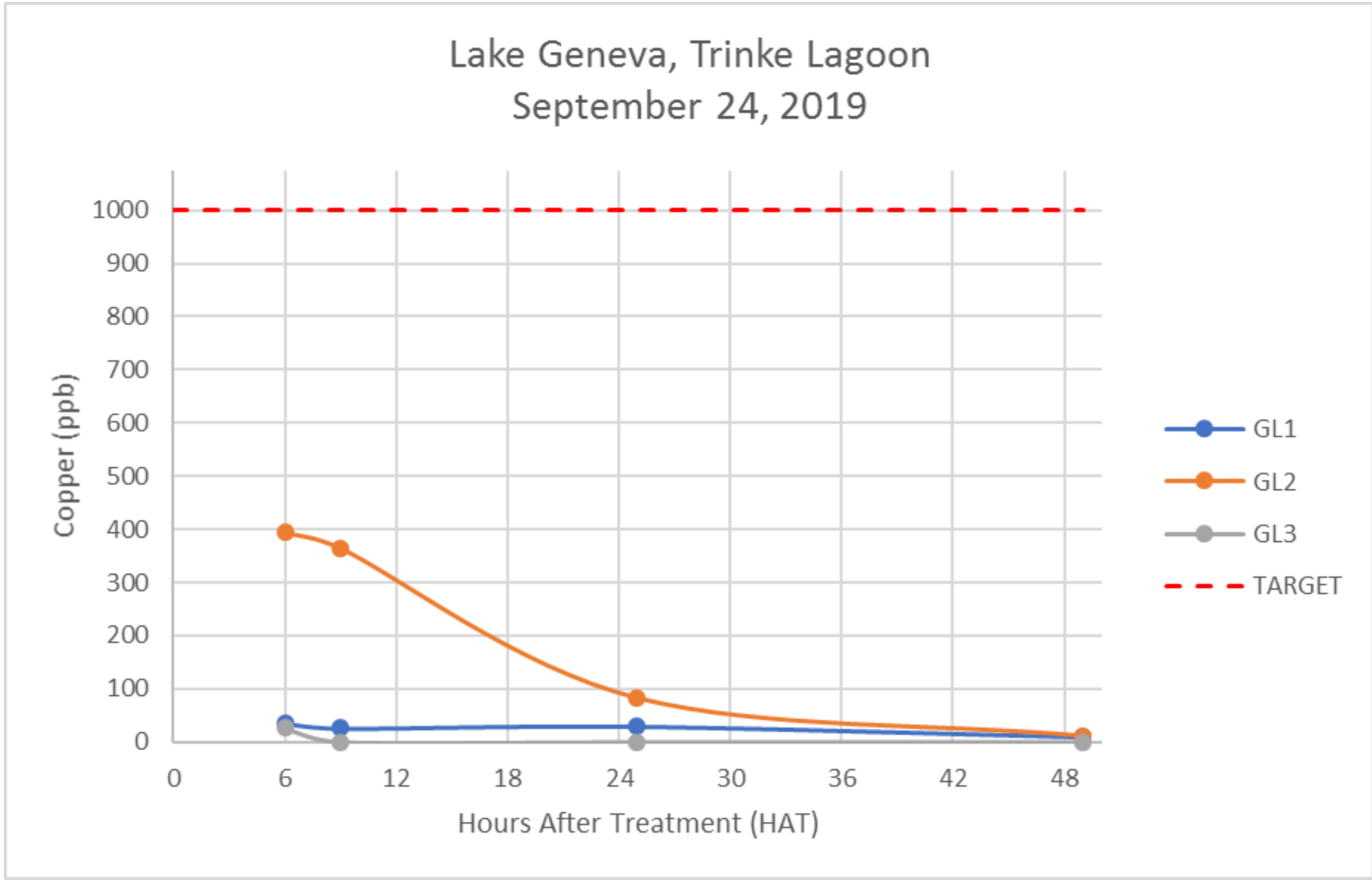




Lake Geneva Herbicide Monitoring

Lake Geneva, Walworth Co.

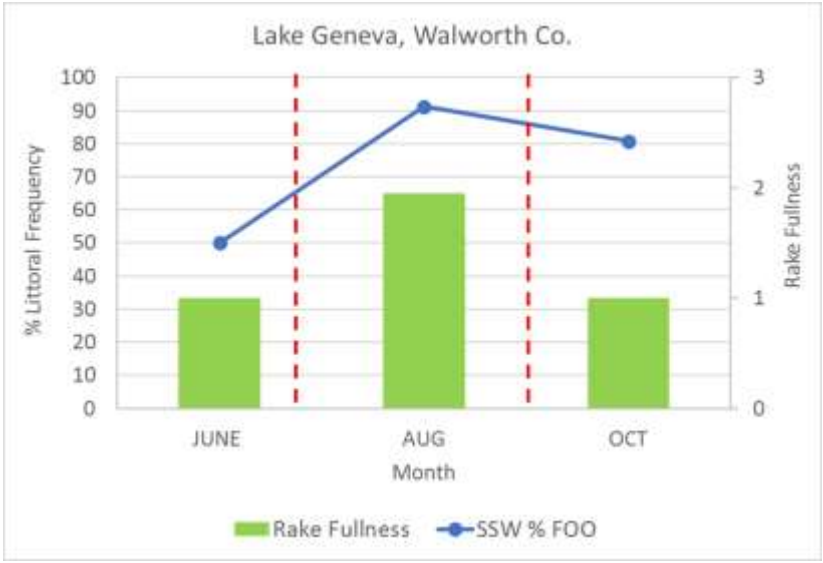
- Second chemical treatment occurred within Trinke Lagoon (~0.7 ac) on Sept 24, 2019
- Combination of Cutrine Plus (1.0 ppm) & Clipper (300 ppb)
- No limno barrier utilized
- Herbicide concentration monitoring for copper
- Pre- (August) and post- (October) sub-PI surveys


Lake Geneva, Trinke Lagoon
September 24, 2019
Copper (ppb)
1000
900
800
700
600
500
400
300
200
100
0
0
6
12
18
24
30
36
42
48
Hours After Treatment (HAT)
GL1
GL2
GL3
TARGET

Lake Geneva, Walworth Co.

SSW % Frequency

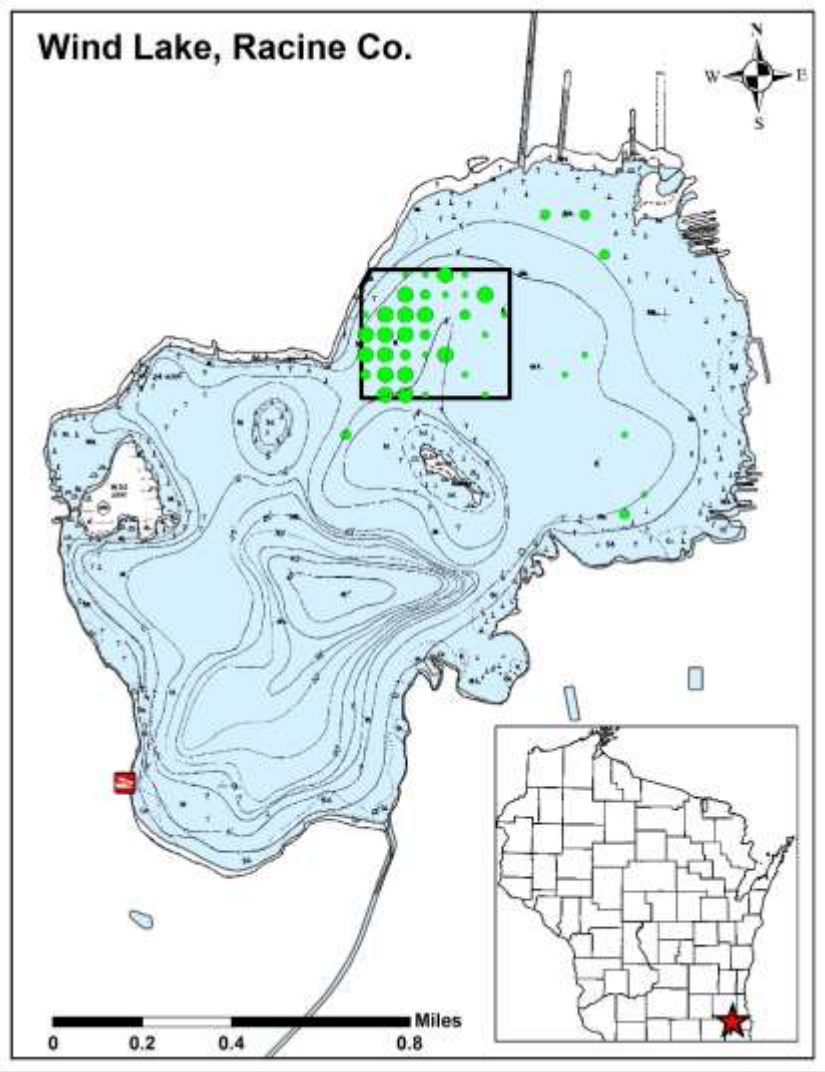
- June 13, 2019: 11/22 sites (50.0%)
- August 22, 2019: 21/23 sites (91.3%)
- October 23, 2019: 21/26 sites (80.8%)
  - Difficult to determine if brown/black material was dying/dead – did not count towards rake fullness. If the brown/black SSW is still viable, SSW would be at 26/26 sites, and most sites (especially in the middle of the lagoon) would have had a rake fullness = 2.



Wind Lake, Racine Co.

- Management Approach: Large-scale herbicide

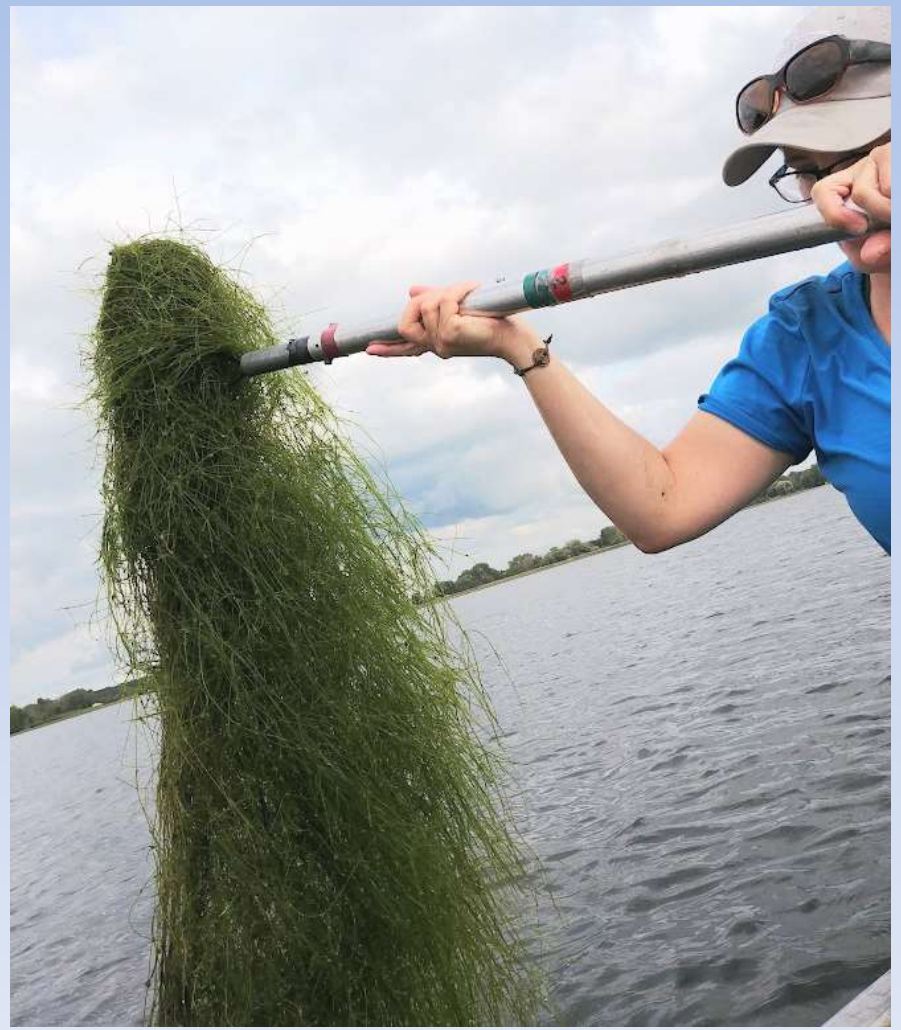
- 919 acre drainage lake
- 47 feet max depth
- 90% muck, 5% gravel, 5% sand
- SSW discovered in August 2017
- August 2017: Treated five isolated SSW patches (5 acres total) with Cutrine Ultra (0.8 ppm) & Hydrothol 191 (0.17 ppm)
- Large, but relatively localized population of SSW within large lake



Wind Lake

- Management Approach: Large-scale herbicide

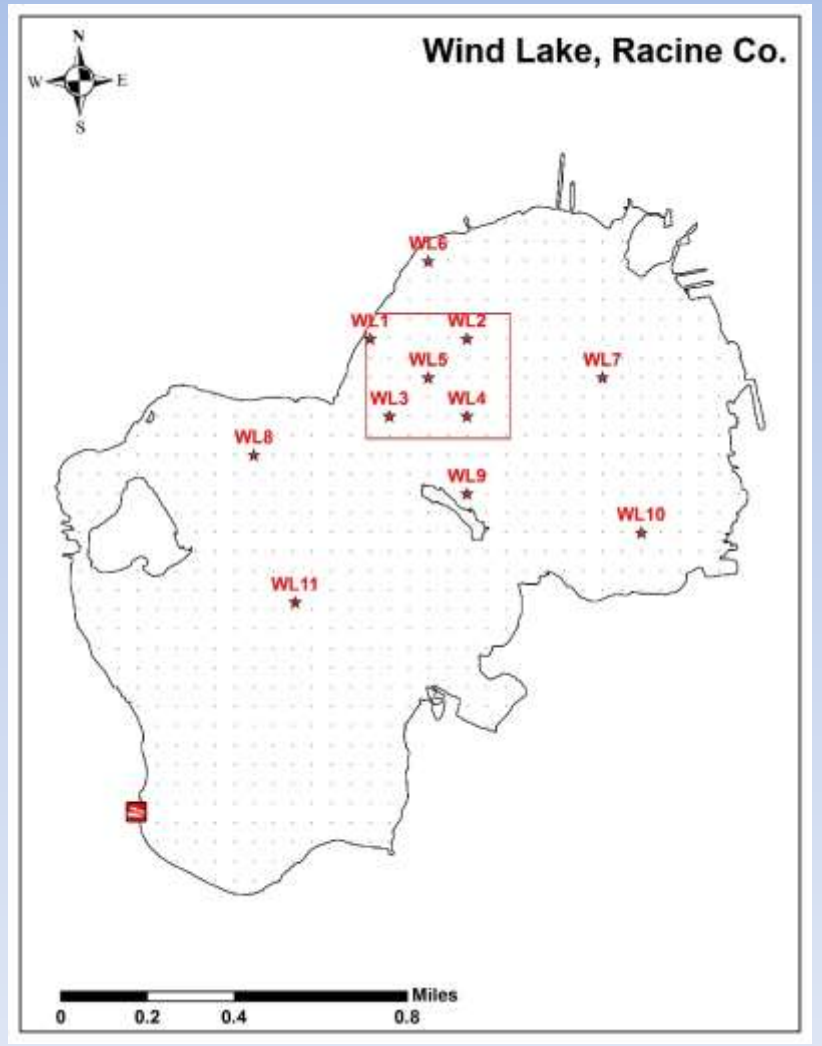
- Goal: Apply herbicide to large established population and satellite populations to prevent spread to other areas of the lake
- June 20, 2018: Cutrine Ultra (0.8 ppm) & Hydrothol 191 (0.17 ppm) treatment
  - 50.3 acres + 3 acres + [1 acre x 5]
- July 30, 2018: Cutrine Ultra (0.8 ppm) & Hydrothol 191 (0.17 ppm) treatment
  - 51.2 acres + 2.6 acres + 0.5 acre + [1 acre x 4]
- 2018 & 2019: Localized navigation channel treatments for SSW with Cutrine Ultra (0.8 ppm) & Tribune (1.0-1.5 gal/ac)



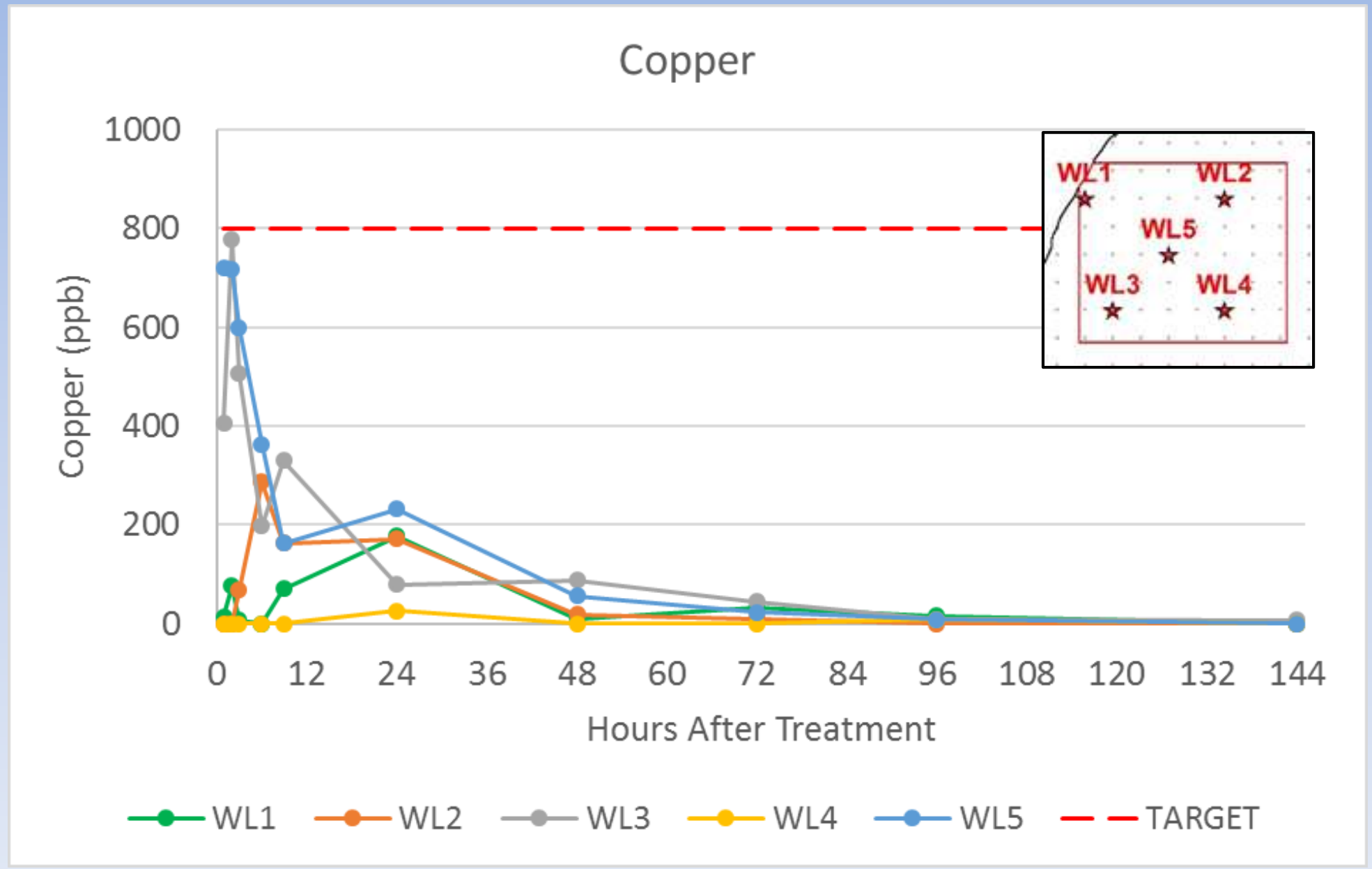
Wind Lake

- Management Approach: Large-scale herbicide

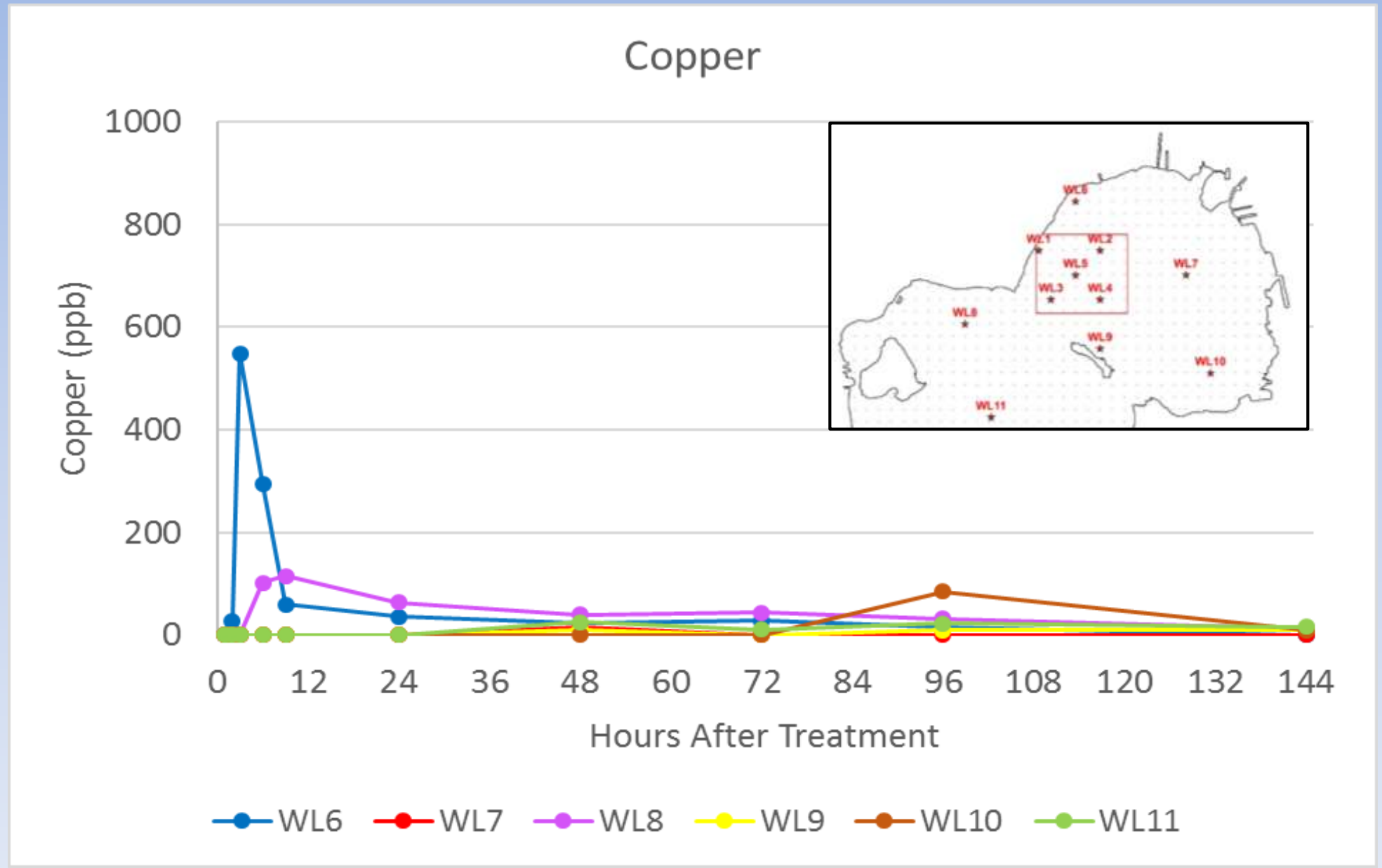
- Herbicide Concentration Monitoring
  - Water samples collected at 1, 2, 3, 6, 9, 12, 24, 48, 72, 96, 144, & 216 HAT.
  - Analyzed for copper and endothall at WI State Lab of Hygiene.
- Aquatic Plant Monitoring
  - Pre- and post-treatment lakewide PI plant surveys conducted in June, July, and August 2018.



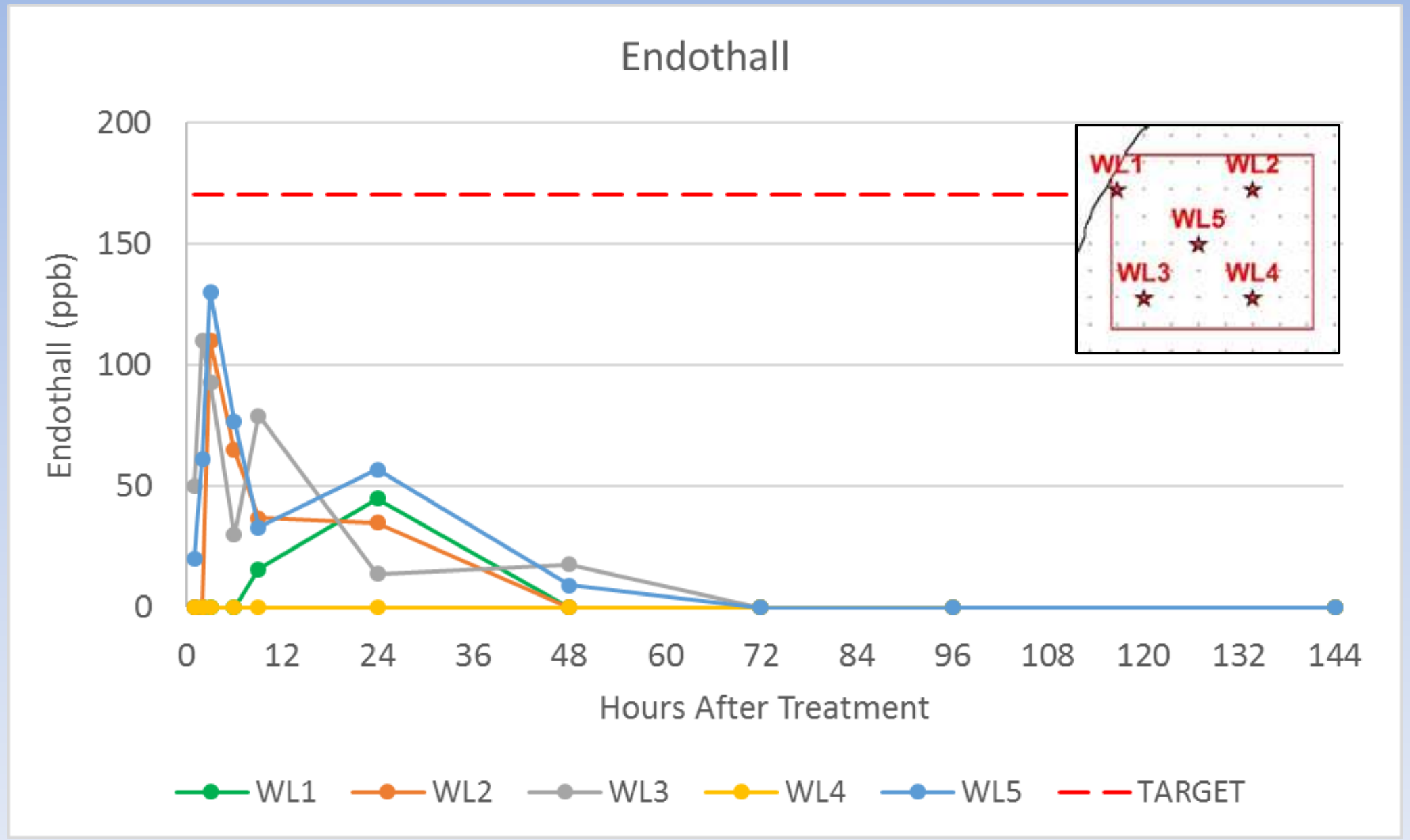
Wind Lake


Copper
1000
800
600
400
200
0
Copper (ppb)
0
12
24
36
48
60
72
84
96
108
120
132
144
Hours After Treatment
WL1
WL2
WL5
WL3
WL4
WL1
WL2
WL3
WL4
WL5
TARGET

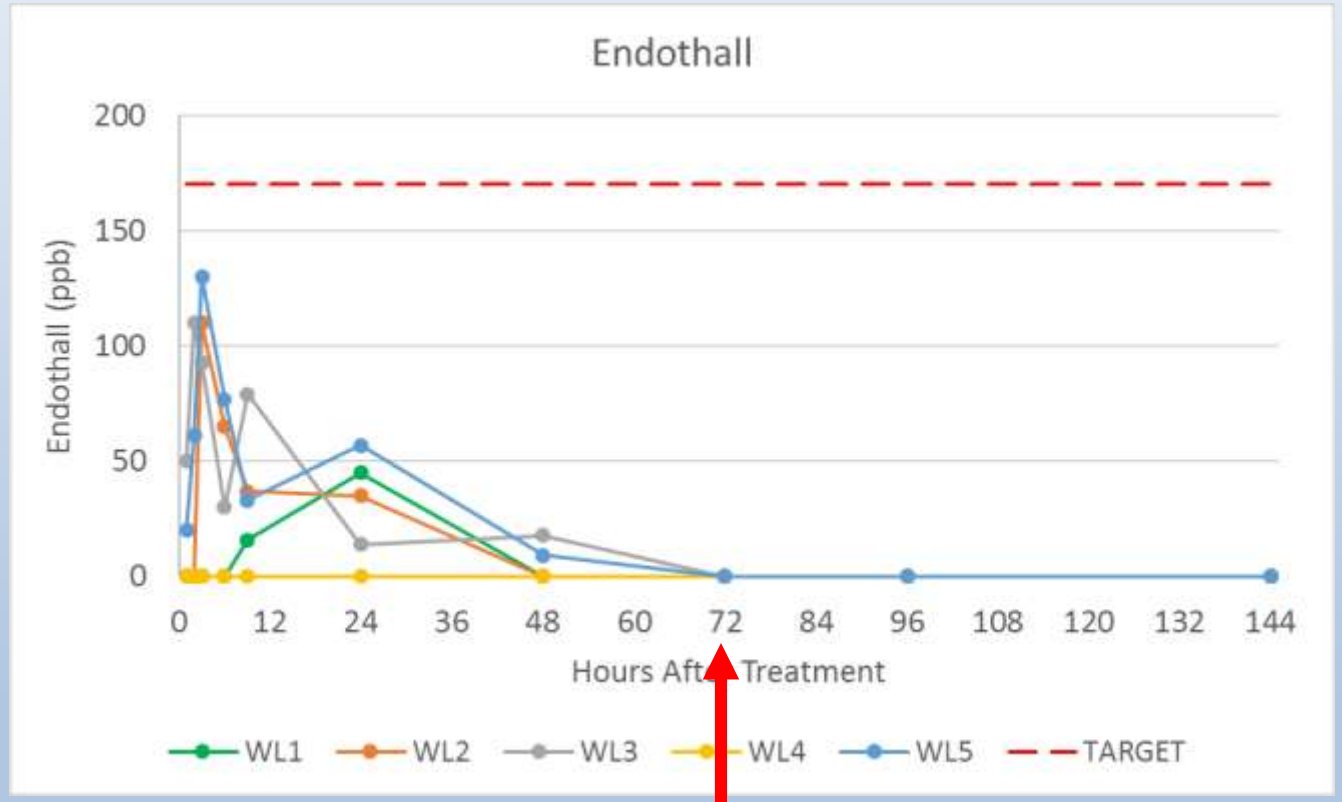
Wind Lake


Copper
Copper (ppb)
1000
800
600
400
200
0
0
12
24
36
48
60
72
84
96
108
120
132
144
Hours After Treatment
WL6
WL7
WL8
WL9
WL10
WL11
WL1
WL2
WL3
WL4
WL5
WL7
WL8
WL9
WL10
WL11

Wind Lake

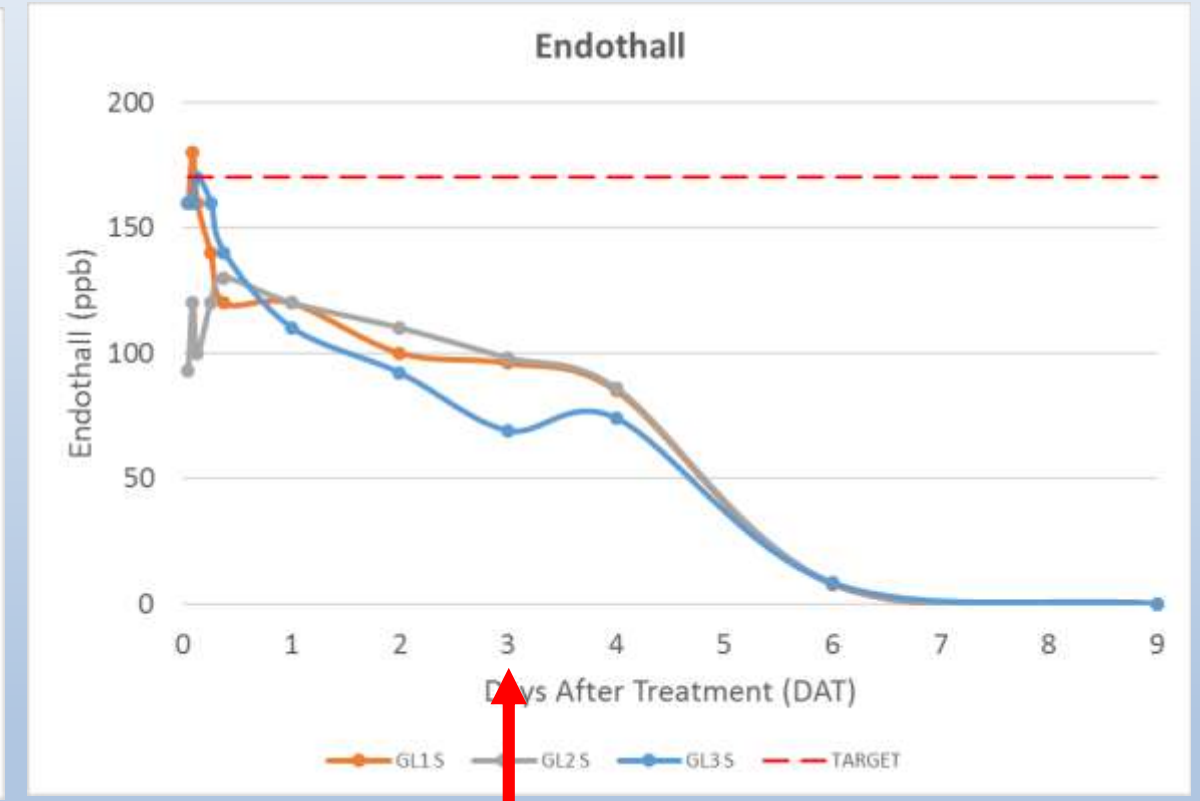

Endothall
Endothall (ppb)
200
150
100
50
0
0
12
24
36
48
60
72
84
96
108
120
132
144
Hours After Treatment
WL1
WL2
WL3
WL4
WL5
TARGET
WL1
WL2
WL5
WL3
WL4

Wind Lake – No Barrier
~50 acres



72 hours: No herbicide detected

Green Lake – Barrier (2018)
~1 acre



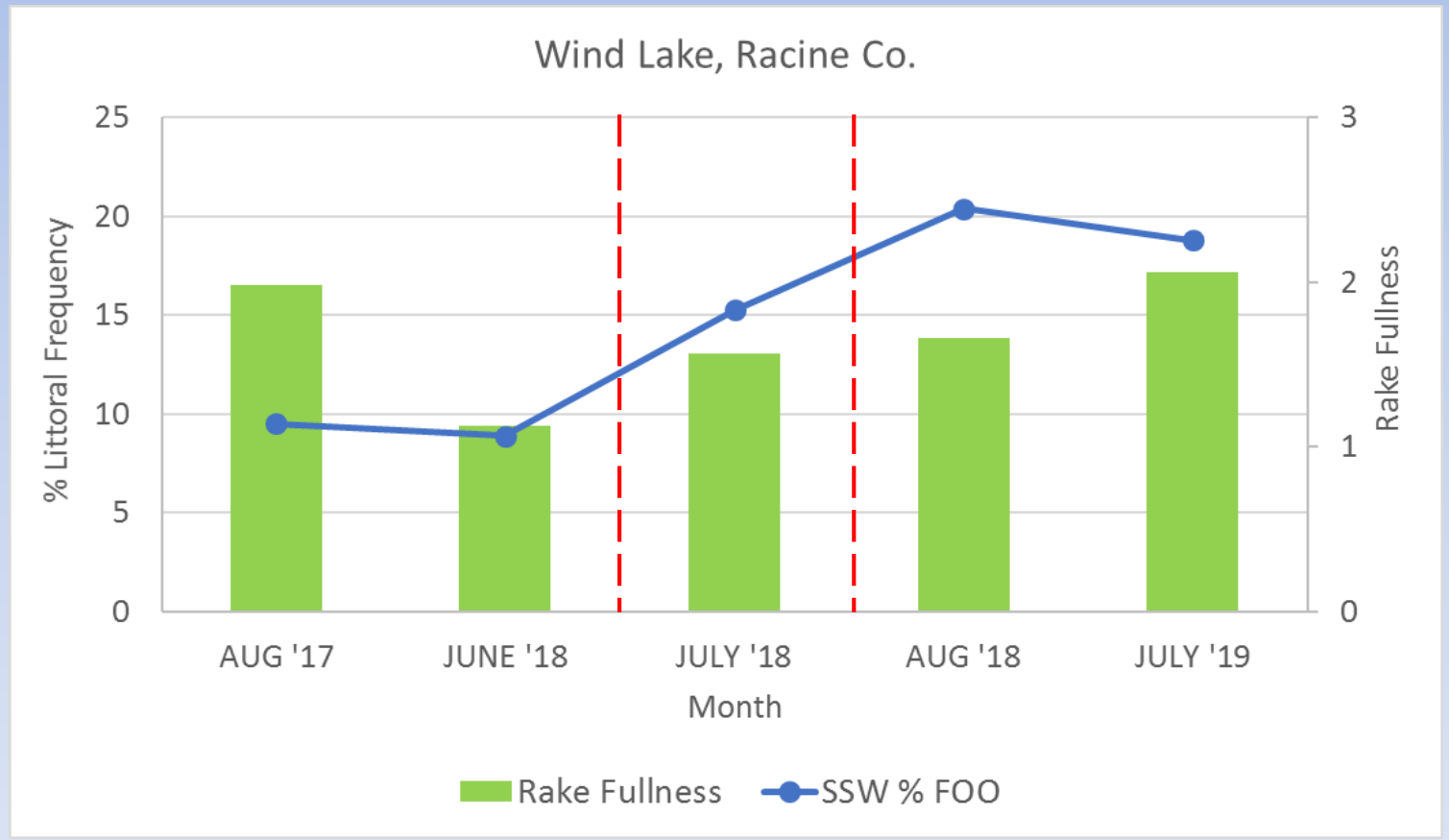
72 hours: ~100 ppb detected

Wind Lake

- Management Approach: Large-scale herbicide

- Aquatic Plant PI Monitoring
  - August ’17: **9.5%**
  - June ‘18: **8.9%**
  - July ‘18: **15.3%**
  - August ‘18: **20.4%**
  - July ‘19**: 18.8%**

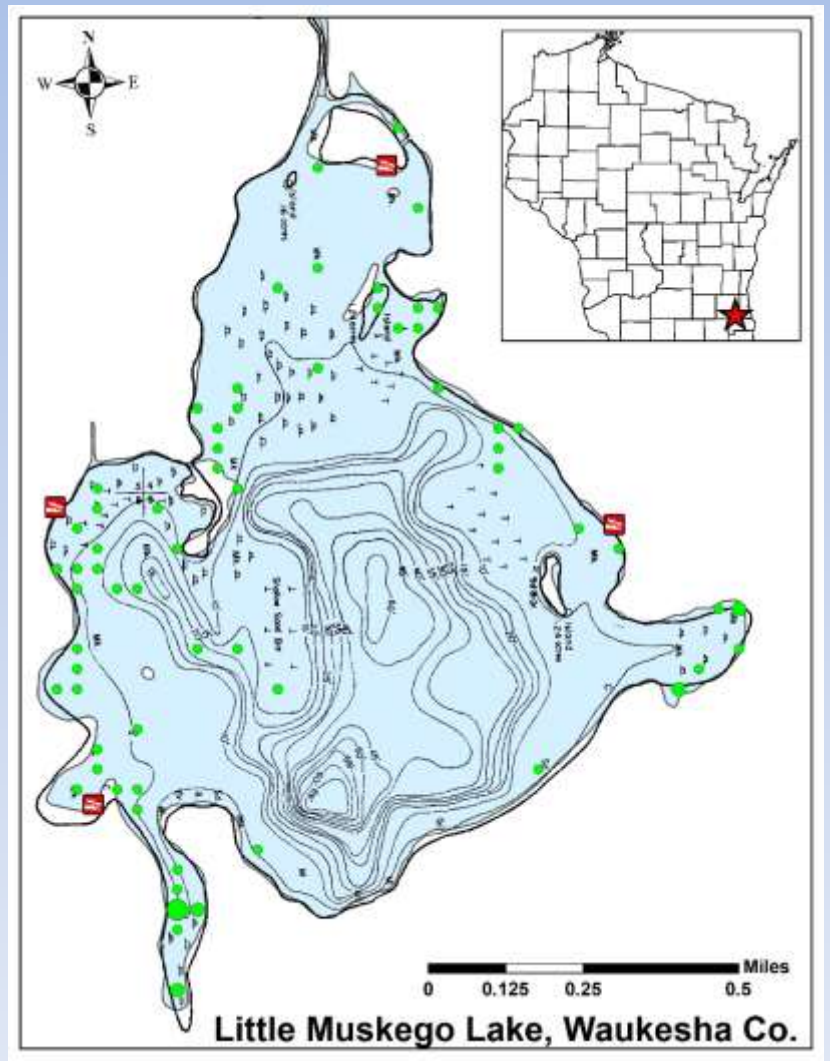
SURVEYS	PRE	POST	CHANGE	P-VALUE
JUNE '18 vs JULY '18	8.9	15.2	↑↑	0.0013
JULY '18 vs AUG '18	15.2	20.4	↑	0.0264
JUNE '18 vs AUG '18	8.9	20.4	↑↑↑	<0.001
AUG '17 vs AUG '18	9.5	20.4	↑↑↑	<0.001



Little Muskego Lake

- Management Approach: DASH, Hand pulling, Chemical Control, & Water Level Drawdown

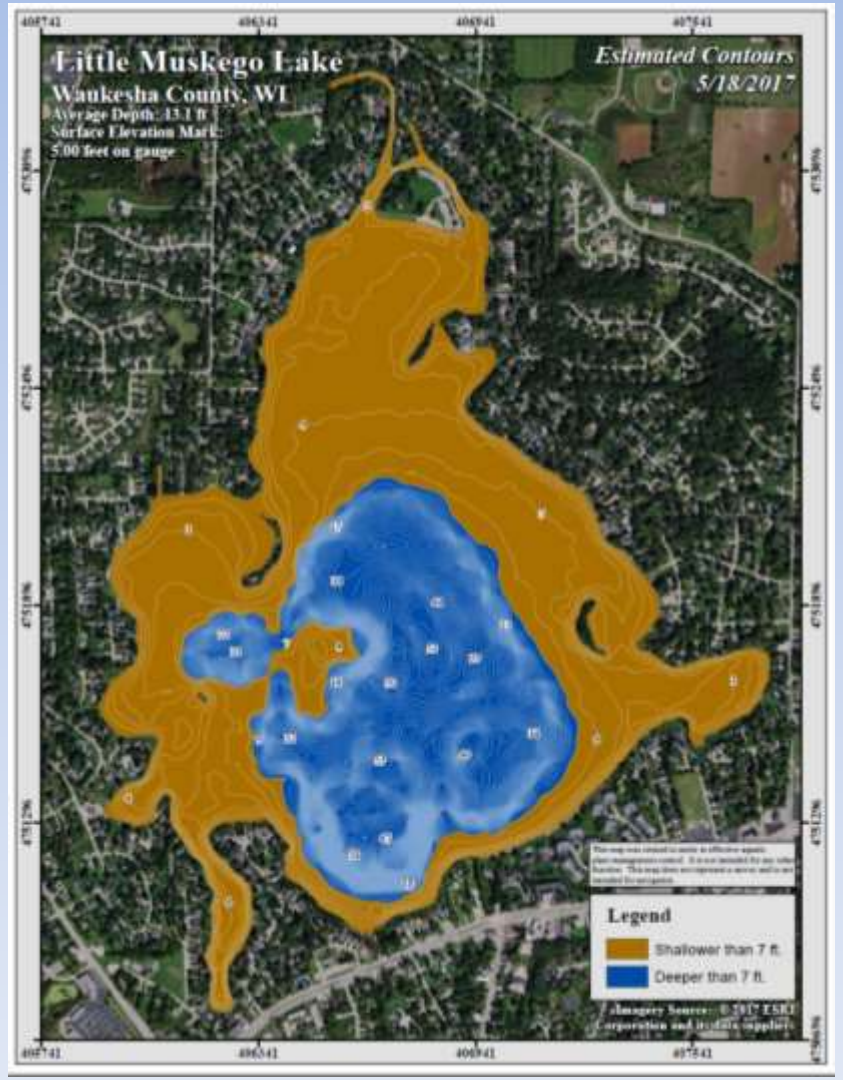
- 470 acre drainage lake
- 65 feet max depth
- 14 feet mean depth
- 70% muck, 25% gravel, 5% sand
- SSW discovered in Sept 2014
- 2015: DASH and hand pulling
- 2016: Small-scale (2.4 ac) Komeen Crystal (copper) treatment at 0.5 ppm in Hillview Bay
- 2017: Water level drawdown



Little Muskego Lake

- Management Approach: Water Level Drawdown

- Start: September 5, 2017
- Goal: Water level drawdown of 7.0 ft (84 in)
- End: October 12, 2017
  - Drawdown concluded when temperature was <60°F
  - Water level drawdown of 6.2 ft (74 in) achieved
  - Weather during the drawdown (Sept 5 - Oct 12) was ideal
- Fishery: Closed to all fishing from Nov 1 - March 4, 2018



Little Muskego Lake

Little Muskego Lake

Little Muskego Lake

- Management Approach: Water Level Drawdown

- Post-drawdown: Two days after achieving 6.2 ft (74 in) it rained for many days
  - Winter water levels ranged from (40-65 in) due to rain and groundwater discharge
- Refill: Started after ice out (April 2018) with goal of full pool by Memorial Day

Little Muskego Lake

- Management Approach: Water Level Drawdown

- Aquatic Plant Monitoring
  - Lakewide PI plant surveys conducted in 2014, 2015, 2017, 2018, & 2019
  - Hillview Bay sub-PI plant surveys conducted in 2015-2018
  - Chi-square analysis of pre- and post-drawdown plant surveys communities at lakewide and bay-wide scales

Little Muskego Lake

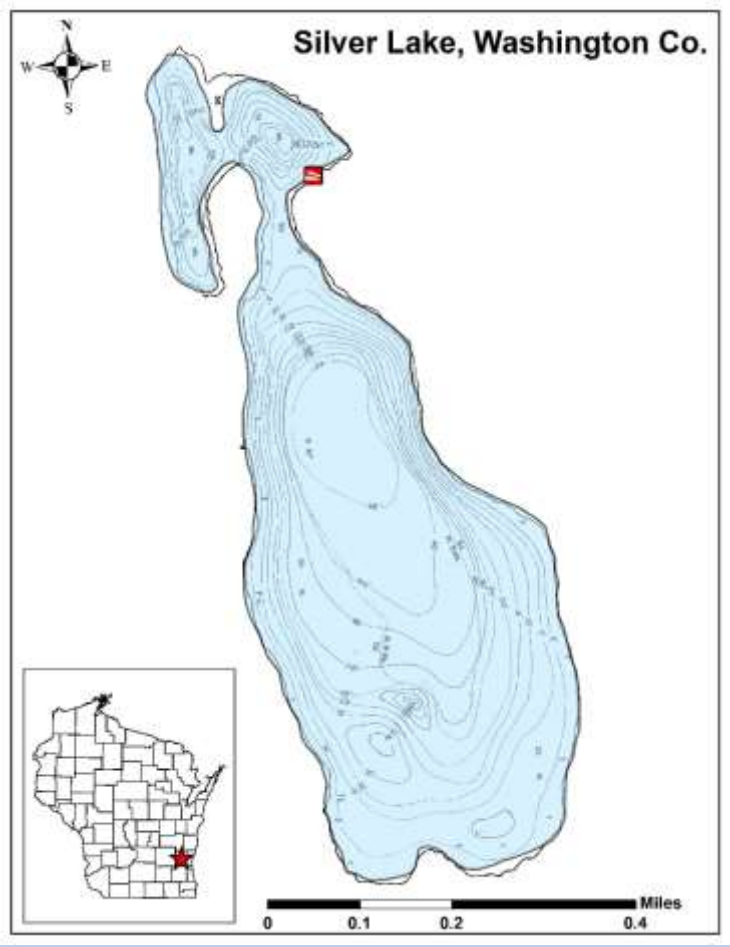
- Management Approach: Water Level Drawdown

	PRE [2017]	POST [2018]	p-value	Sig. change	Increase/ Decrease
SSW	65	124	< 0.001	***	+
Wild celery	335	196	< 0.001	***	-
Chara	195	125	0.0023	**	-
Coontail	183	69	< 0.001	***	-
EWM	152	24	< 0.001	***	-
Elodea	145	10	< 0.001	***	-
Sago pondweed	134	52	< 0.001	***	-
Illinois pondweed	96	11	< 0.001	***	-
Southern naiad	54	0	< 0.001	***	-
Slender naiad	3	34	< 0.001	***	+
Fries' pondweed	1	25	< 0.001	***	+
Clasping-leaf pondweed	18	8	0.1138	n.s.	-
Water star-grass	17	11	0.4682	n.s.	-

Silver Lake, Washington County

Management Approach: DASH and Dredging

- 122 acre drainage lake
- 47 feet max depth
- 20 feet mean depth
- SSW discovered in July 2015 near public boat access
- Great Lakes Restoration Initiative (GLRI) funding obtained to help support monitoring and control efforts



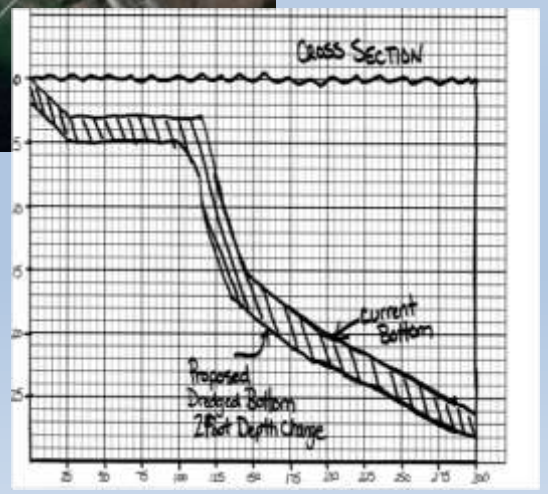
Silver Lake

Management Approach: Diver Assisted Suction Harvesting (DASH) - 2015

- 5 to 6 days of work
- Estimated ~0.90 acres controlled
- Approximately 6 inches of sediment
- Three bags of sediment buried

Silver Lake

Management Approach: Dredging - 2019



Summer 2019

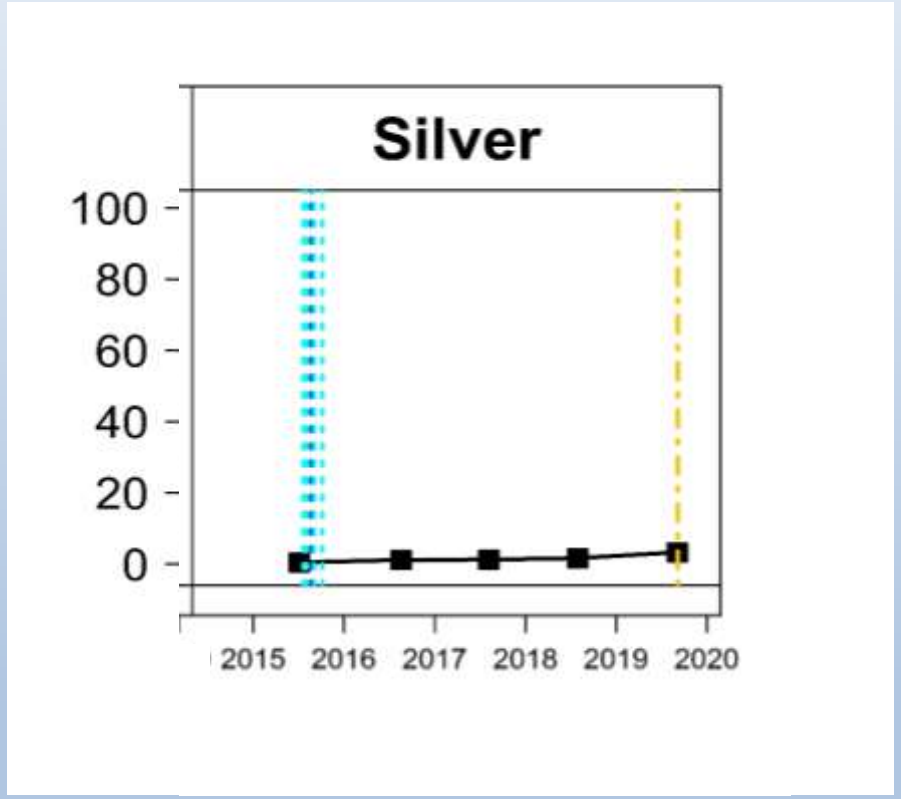
Sediment depth = 1.5 feet

Water depth = 12 feet

Total sediment = 3045 yd^3

Silver Lake

Management Approach: DASH & Dredging



Herbicide (SSW) | Herbicide (other AIS) | DASH | Hand-pull | Drawdown | Dredging

Little Cedar Lake, Washington Co.

Management Approach: Hand Pulling and DASH

- 260 acre drainage lake
- 56 feet max depth
- 13 feet mean depth
- SSW discovered August 2018 near public boat access
- Great Lakes Restoration Initiative (GLRI) funding obtained to help support monitoring and control efforts

Little Cedar

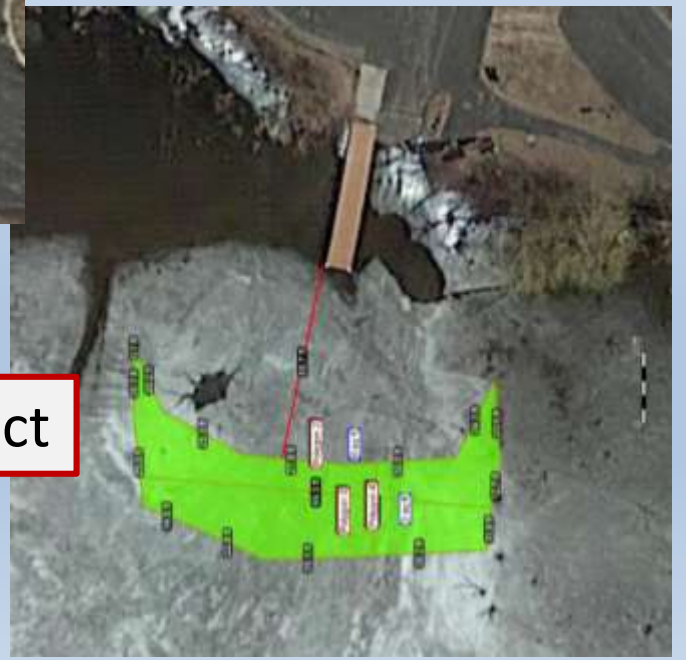
Management Approach: Hand Pulling and DASH

Hand Pull Event

- June 15, 2019
- Biomass collected ~50 square feet
  6 inches thick
- 6 Divers
- 2.5 Hours

DNR DASH Project

August 2019
~5000 square feet



Lake District DASH Project

September 2019
~3000 square feet

Little Cedar - DASH/Hand Pulling

Littoral Frequency of Occurrence - Pre and Post Management

Species	Pre-Treatment August 2019	Post-Treatment October 2019
SSW	**20.00**	**22.73**
Chara spp.	40.00	47.73
Wild celery	73.33	75.00
Illinois Pondweed	23.33	47.73
EWM	3.33	15.91
Elodea	36.67	31.82
Flat-stem Pondweed	20.00	11.36
Variable Pondweed	20.00	0
Stiff Pondweed	20.00	0

Little Cedar - DASH/Hand Pulling

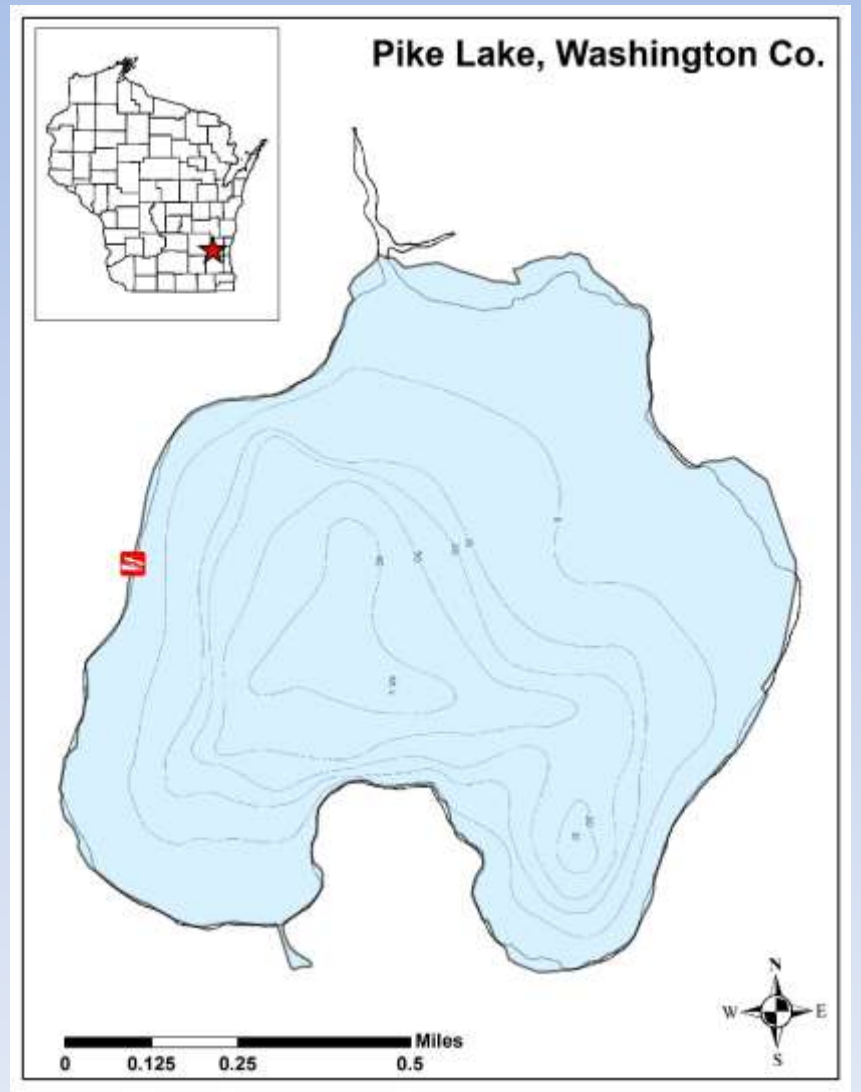
Average Rake Fullness - Pre and Post Treatment

Species	Pre-Treatment August 2019	Post-Treatment October 2019
Chara spp.	1.67	2.29
Wild celery	1.50	1.67
Illinois Pondweed	1.00	1.10
EWM	1.00	1.14
Flat-stem Pondweed	1.00	1.00
SSW	**1.33**	**1.10**
Elodea	1.27	1.14
Variable Pondweed	1.17	0
Stiff Pondweed	1.00	0

Pike Lake, Washington Co.

- Management Approach: No Active Management

- 461 acre drainage lake
- 45 feet max depth
- 50% muck, 20% sand, 30% gravel
- SSW discovered in August 2015
- No active management for SSW (or any other AIS)



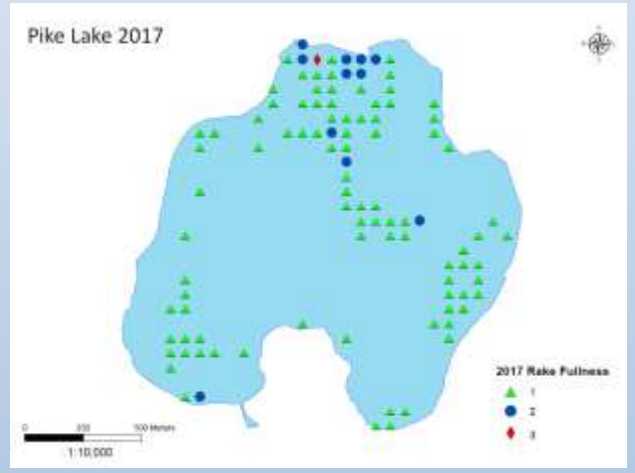
Pike Lake

Management Approach: No Active Management

- Annual Point Intercept Surveys: 2016, 2017, 2018, & 2019

2016 PI Survey

40.2%



2017 PI Survey

34.0%

2018 PI Survey

25.0%

2019 PI Survey

31.3%

Preliminary Conclusions

- Evaluation of pre and post treatment data from several lakes utilizing chemical control methods (primarily copper/hydrothol) has not resulted in control or eradication of starry stonewort
- The use of barrier curtains in conjunction with chemical applications was able to keep the herbicide concentration higher and prevent diffusion off site, however this did not result in better control of starry stonewort
- The implementation of a winter drawdown did not result in control of starry stonewort, however the sediment never fully dried
- Pre and post treatment data for two lakes utilizing DASH and/or dredging for control of starry stonewort is currently being evaluated
- The Department is working with other regional and national partners (US ACOE, University of Minnesota, University of Indiana, New York Botanical Garden) to evaluate management techniques for the control of starry stonewort

Next steps

- Prevent the further spread of starry stonewort to inland lakes.
- Search for starry stonewort at nearby heavily used lakes.
- Assess the population at newly discovered sites to help guide appropriate management.
- Engage local stakeholders in management planning and education/outreach activities (i.e. CBCW).
- If management occurs, collect quantitative data to assess efficacy and longevity of control.
- Work with other states and partners to learn and adaptively manage starry stonewort.

Questions?

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