LONG LAKE STARRY STONEWORT GRANT SUMMARY

AIRR21017

Lake and Pond Solutions Co.

December 21st, 2017

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INTRODUCTION

Long Lake is a 109-acre lake located within U.S. Public Land Survey Township 4 North, Range 20 East, Sections 5, 6, and 7, Town of Norway, in Racine County, Wisconsin. The Lake is a valuable natural resource offering a variety of recreational and related opportunities to the resident community and its visitors. In the summer of 2015, the recreational and aesthetic values of Long Lake were threatened by the discovery of Starry Stonewort (*Nitellopsis obtusa*) southeast of the boat launch by the WDNR. The Long Lake Protection District (LLPD) took immediate steps to assess its extent by applying for back to back Aquatic Invasive Species (AIS) Rapid Response Grants and contracting with Lake and Pond Solutions Co. This plan is prepared at the request of the LLPD and the WDNR to assist lake managers and regulatory agencies in directing future plant management activities.

Background

Specifically, this summary represents part of the ongoing commitment of the Long Lake community through the LLPD. It is a compilation of data from 2017 treatments, SSW height measurements, bulbil counts, and SSW surveys conducted by Lake and Pond Solutions Co. (LPS) staff. Research for this summary was funded through an AIS Rapid Response Grant (AIRR 21017) awarded to the LLPD and administered by the WDNR.

The purpose of this summary is to report the latest inventory findings along with an assessment of SSW densities and future control options.

STARRY STONEWORT MANAGEMENT

This detailed section is provided to highlight Starry Stonewort management from 2017. It includes information on treatments and public outreach.

Treatments

The ability to detect and control Starry Stonewort while in its early stages is a major factor regarding the continued health of Long Lake. The 2017 treatments focused on continual treatments to maintain a lower biomass throughout the season. Two main treatment regimens were selected based on previously successful data: Komeen Crystal at 1ppm and Captain XTR (0.8 ppm)/Clipper (150ppb)/enzyme.

May 4th, 2017

With that in mind, Polygon 6 on the western portion of Long Lake was selected for the initial treatment in 2017. This was based on increasing SSW densities and a change in algal color from pale green to olive green (previous survey work indicated this was a precursor to biomass expansion). A 1.97-acre treatment was performed by Lake and Pond Solutions Co. on May 4th, 2017 with Komeen Crystal at 0.93 ppm. This regime was selected to minimize impacts to existing native vegetation Figure 1 depicts the area and exact path of this treatment.

Figure 1: Long Lake SSW Treatment Map - May 4th, 2017

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May 23rd, 2017

The previous treatment maintained SSW heights in Polygon 6 despite increase in other sites over this time frame. The decision to retreat Polygon 6 this visit was made because of the historically aggressive growth in this bed. The treatment on 5/23/17 occurred in Polygons 4N, 6 and 8 based on increasing densities and algal color changes (Figure 2). Polygons 6 (0.35 acres) and 8 (0.10 acres) were treated with Komeen Crystal at 0.99 ppm while polygon 4N (0.90 acres) was injected with Captain XTR (0.79 ppm), Clipper SC (147 ppb) and enzyme.

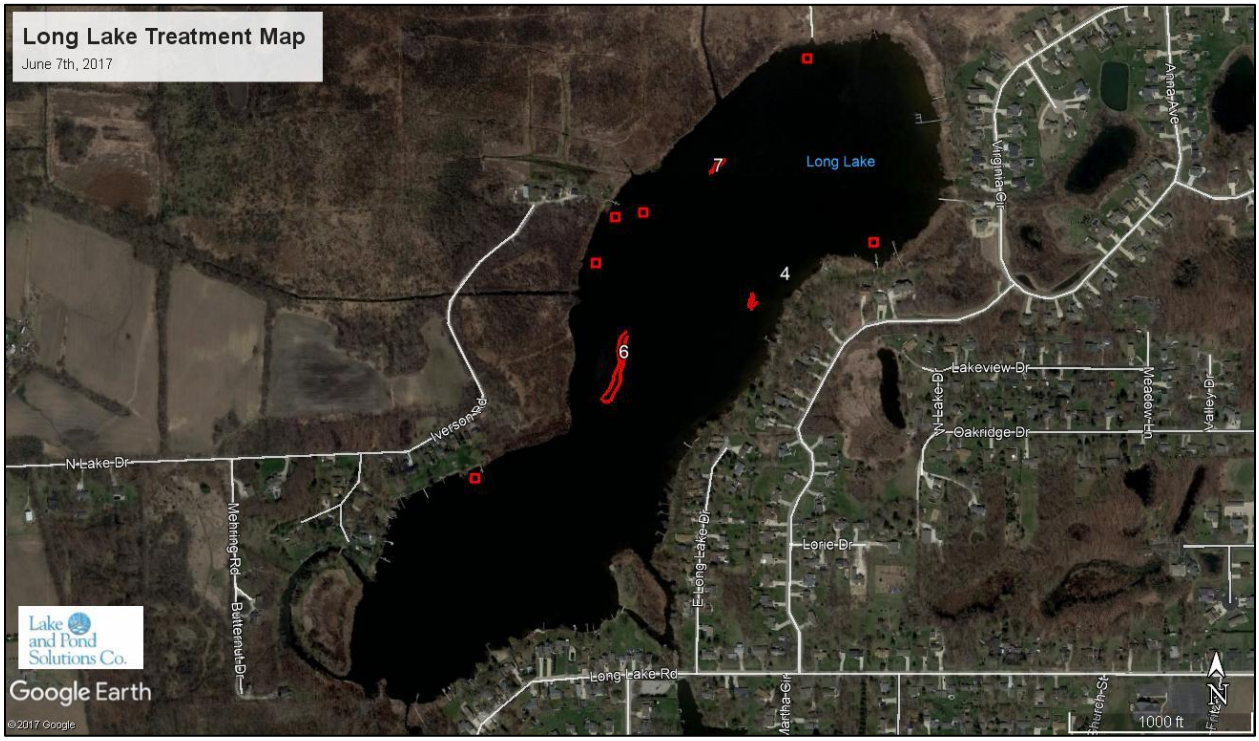
June 7th, 2017

The beginning of June revealed more widespread SSW height increases as lake water temperature pushed above 65-degrees F. Previous treatments on Polygon 4N and 8 were successful as no observable SSW growth was observed. SSW height measurements on Polygon 6 again revealed very little height increase despite large increases in other untreated sites. In fact, average height one-year prior was 1.3 feet greater than current measurements. The treatment on 6/7/17 occurred in Polygons 4S, 6, 7, and several individual sites (Figure 3). Polygons 4S (0.15 acres), 6 (0.50 acres) and 7 (0.11 acres) were treated with Komeen Crystal at 0.97 – 0.99 ppm while all individual sites (total of 0.65 acres) were treated with Komeen Crystal at 0.98 ppm.

Figure 2: Long Lake SSW Treatment Map - May 23rd, 2017

Lake and Pond Solutions Co. (2017)

Figure 3: Long Lake SSW Treatment Map - June 7th, 2017

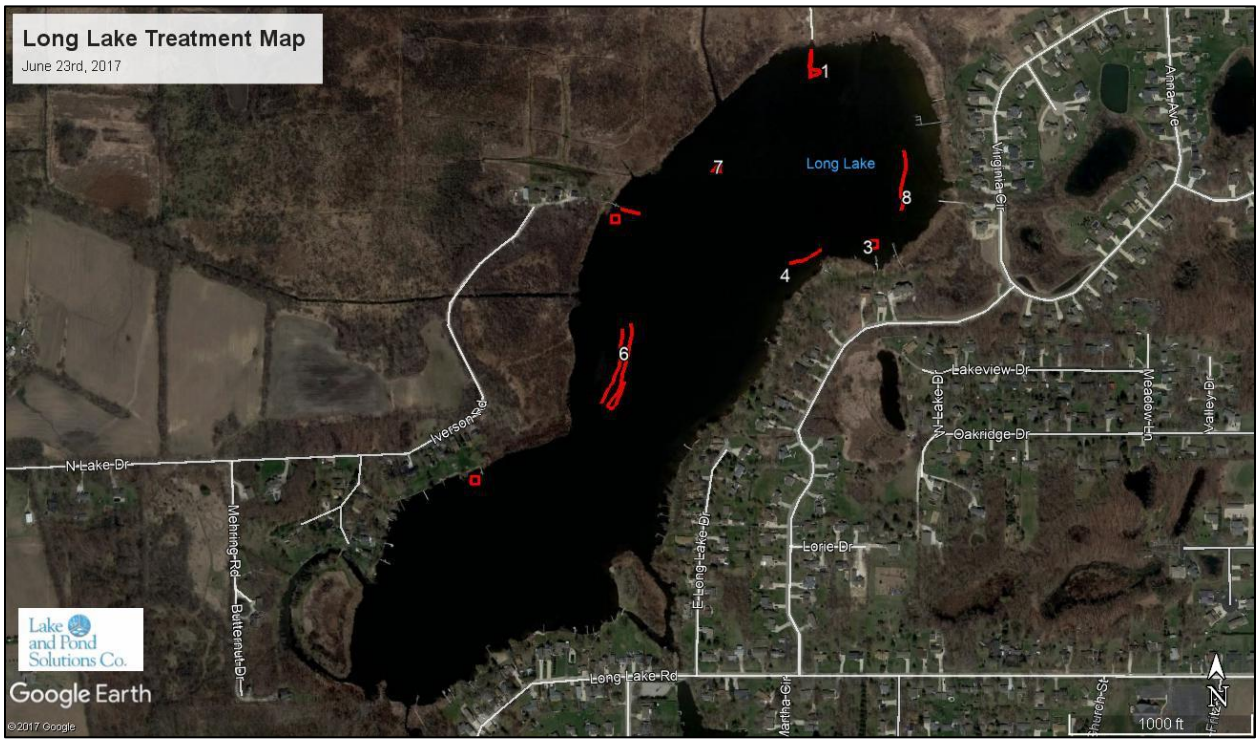


Lake and Pond Solutions Co. (2017)

June 23rd, 2017

The end of June saw more widespread SSW height increases as lake water temperature pushed as high as 80-degrees F (an increase of 15-degrees F over 2 weeks). The previous round of treatments were only about 50% successful in reducing biomass. Overall, average SSW heights were still being maintained approximately 0.5 feet less than the previous season. The treatment on 6/23/17 occurred in Polygons 1, 3, 4N, 6, 7, 8 and several individual sites (Figure 4). Polygons 1 (0.26 acres), 4N (0.29 acres), 6 (0.59 acres) and 8 (0.61 acres) were treated with Captain XTR (0.81 ppm), Clipper SC (153 ppb), and enzyme. Polygons 3 (0.10 acres), 7 (0.11 acres) and individual sites were treated with Komeen Crystal at 1ppm.

Figure 4: Long Lake SSW Treatment Map - June 23rd, 2017

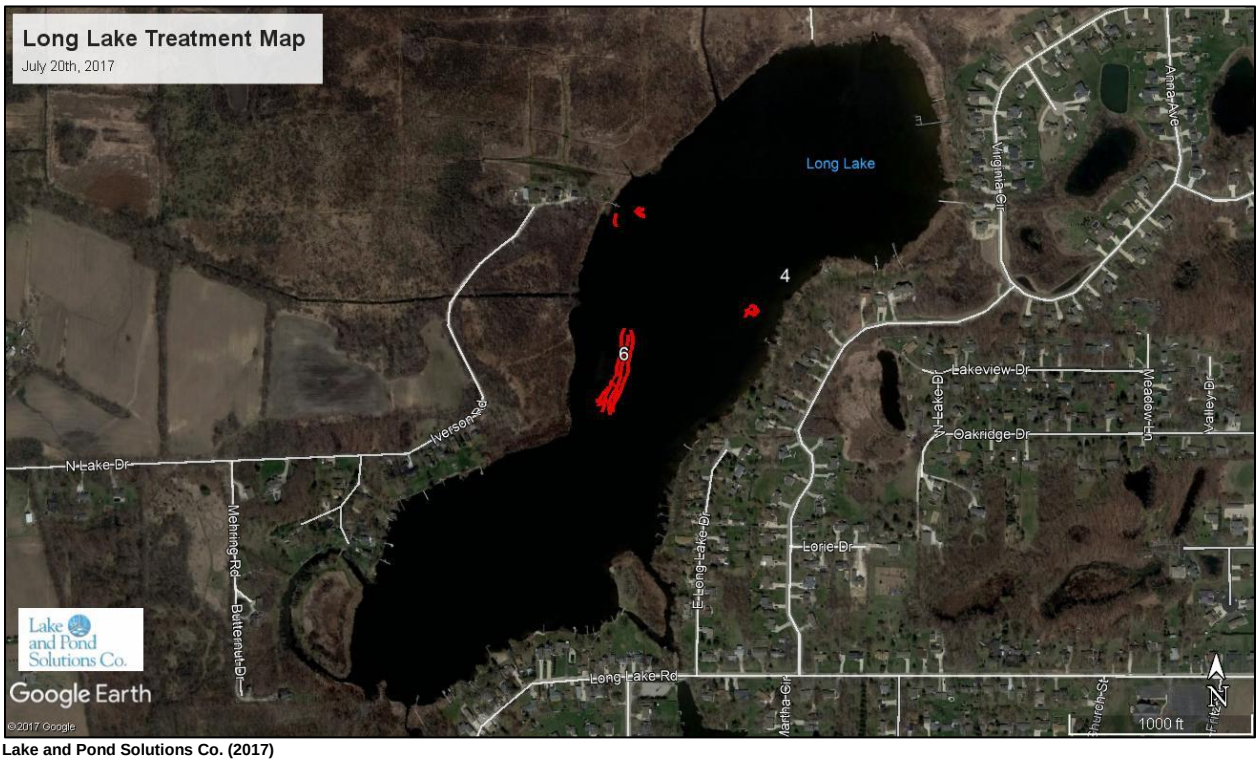


Lake and Pond Solutions Co. (2017)

July 20th, 2017

By the end of July, average lakewide SSW heights were down roughly 0.5 feet from the previous visit and 0.75 feet from this time last year. Water temperatures ranged from 70 degrees F to 83 degrees F over the past month. The previous round of treatments were largely successful in reducing SSW height with only one location (Polygon 6) showing no change. Since it was nearly a month since our last treatment, this result was promising. The treatment on 7/20/17 occurred in Polygons 4S and 6 along with a few individual points (Figure 5). Polygons 4S (0.10 acres) and 6 (0.60 acres) along with the individual sites were treated with Komeen Crystal at 0.99 ppm.

Figure 5: Long Lake SSW Treatment Map - July 20th, 2017



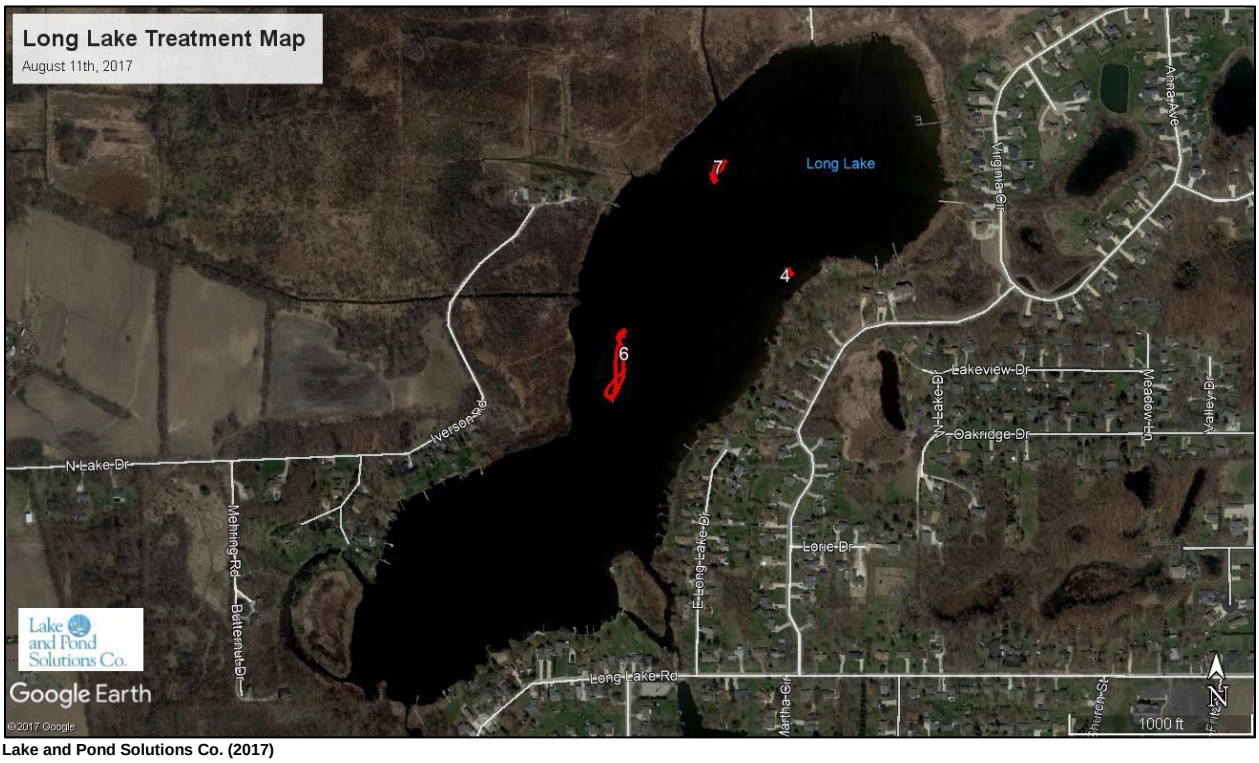
Lake and Pond Solutions Co. (2017)

August 11th, 2017

Average lakewide SSW heights were down roughly 1.38 feet from this time last year. Water temperatures remained above 75 degrees F since the last visit. The previous round of treatments revealed mixed results with Polygon 4S heights decreasing, Polygon 6 heights remaining constant, and the individual site showing an increase. The treatment on 8/11/17 (our last) occurred in Polygons 4N, 6 and 7 (Figure 6). Polygons 4N (0.10 acres) and 7 (0.11 acres) were treated with Komeen Crystal at 0.99 ppm. Polygon 6 (0.57 acres) was treated with Captain XTR (0.84ppm), Clipper (195 ppb), and enzyme. Since there was a struggle to reduce SSW in Polygon 6, a decision was made to increase flumioxazin concentrations slightly (from 150 ppb to 195 ppb).

During our subsequent visit on August 29th, average lakewide SSW heights were down almost 1.5 feet from the previous season. All three treatment areas showed positive results including a 1.45-foot reduction in Polygon 6. This was the lowest average height since the beginning of March.

Figure 6: Long Lake SSW Treatment Map - August 11th, 2017



Lake and Pond Solutions Co. (2017)

Treatment Summary

In 2017, 21 of 26 treatments (80.77%) were considered successful by either reducing SSW heights or maintaining them over the sampling period. Komeen Crystal treatments were 75% successful (15 of 20) showing an average SSW reduction of 40.54%. Captain XTR/Clipper/enzyme treatments were 100% successful (6 of 6) showing an average SSW reduction of 70.87% (Figure 7). Sites that received the Captain XTR/Clipper SC/enzyme treatments finished the season with average heights under 0.06' tall (compared to 0.41' for Komeen only sites).

Figure 7: 2017 Treatment Regimen Summary

Treatment Regime	# of Success	% of Success	Avg Pre Treatment Height	Avg Post Treatment Height	Avg % Reduction	Avg Length of Control
Komeen Crystal	15 of 20	75.00%	1.48 feet	0.88 feet	40.54%	23.8 days
Captain/Clipper	6 of 6	100.00 %	1.27 feet	0.37 feet	70.87%	36.2 days

Lake and Pond Solutions Co. (2017)

It should be noted that if the failures are taken out of the data for Komeen crystal, then the average percent reduction is comparable to Captain XTR/Clipper/enzyme at 67.55% (versus 70.87%). Additionally, the length of control increases to 31.7 days. Most of the failures in Komeen crystal treatments were related to small established satellite populations. Although both SSW treatment regimens do have merit, we believe that Captain XTR/Clipper/enzyme should be used when possible. In areas with extensive native vegetation, Komeen crystal may give similar results with less impact to native plants.

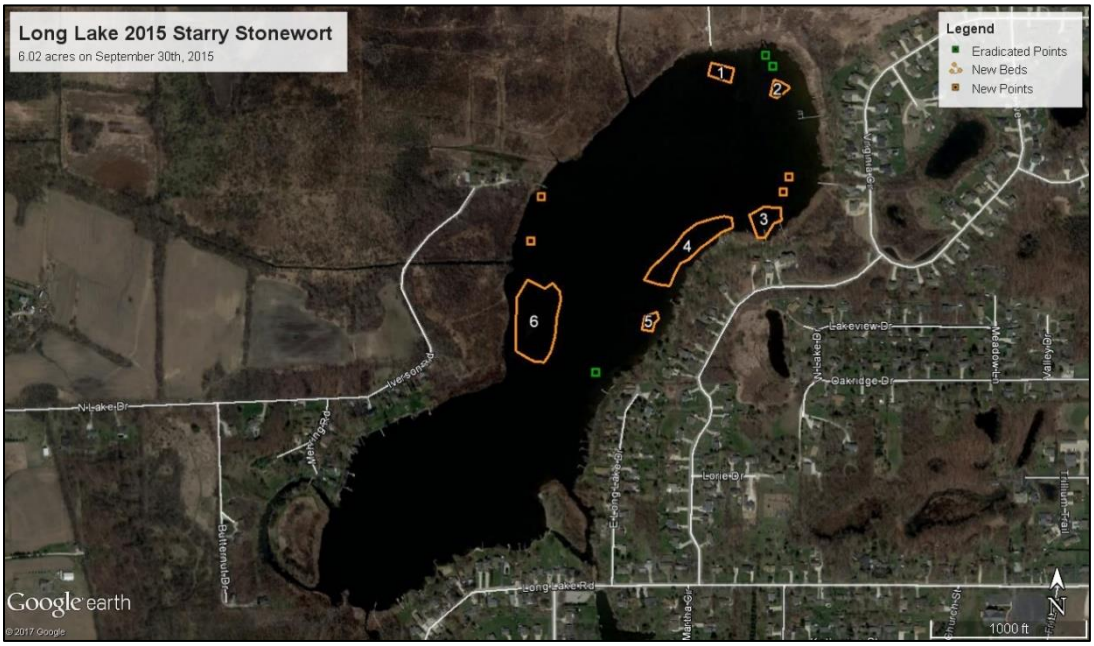
Historical SSW Growth Comparison

Starting in 2015, Lake and Pond Solutions Co. conducted an intensive survey focusing solely on Starry Stonewort. It incorporated small motorized boats, kayaks and a snorkel team along with GPS units to locate and define beds. A separate survey was then conducted to define SSW beds (denoted by polygons). By the end of 2015, 6.02 acres of SSW was present in the lake (Figure 8).

The 2016 survey work built on previous data by adding new points and expanding bed configuration based on current growth. Figure 9 shows a 6.63-acre SSW population at present at the end of August.

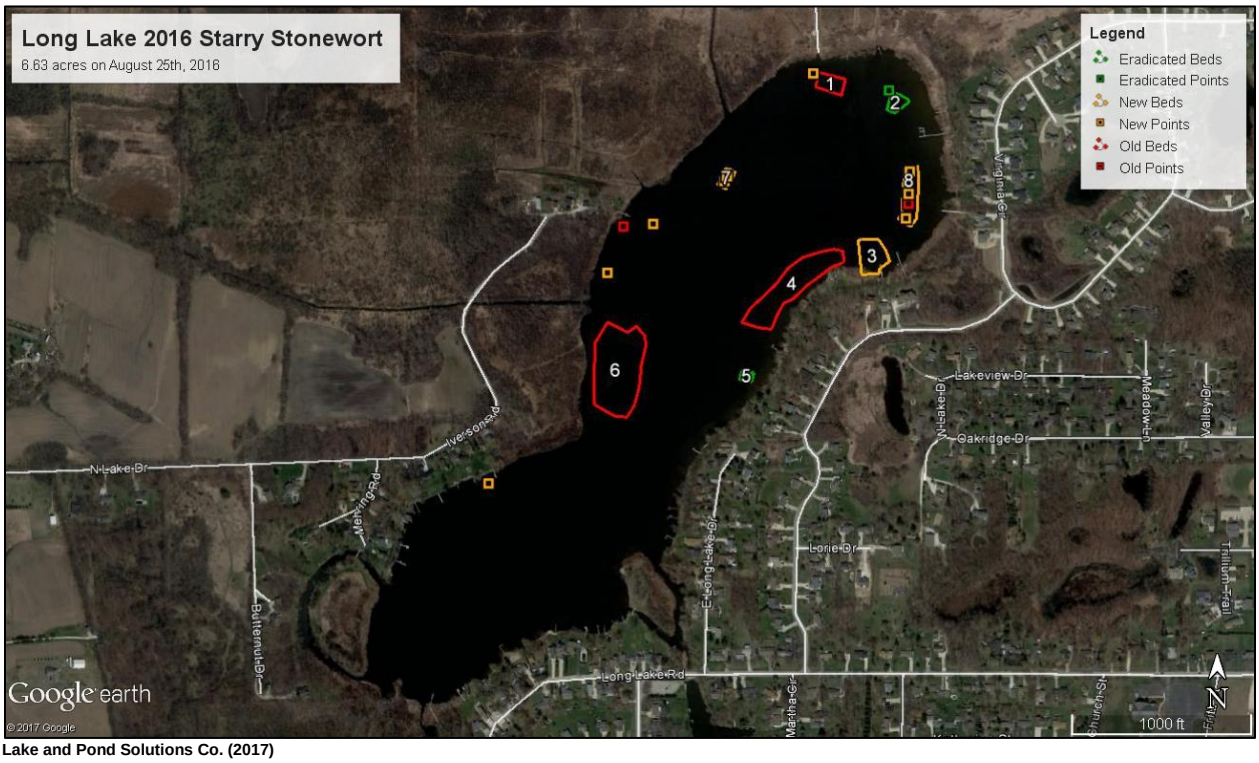
The 2017 survey work continued to build on previous data by adding new points and refining bed delineations. A final full shoreline meander survey was performed in September on a calm and sunny day to locate any additional beds or SSW migration. Figure 10 shows that 3.73 acres of SSW remained on September 19th, 2017. Aggressive treatment techniques have helped to reduce SSW beds by 43.7% in the last calendar year. Additionally, only three new satellite populations were found.

Figure 8: Long Lake 2015 Starry Stonewort Growth



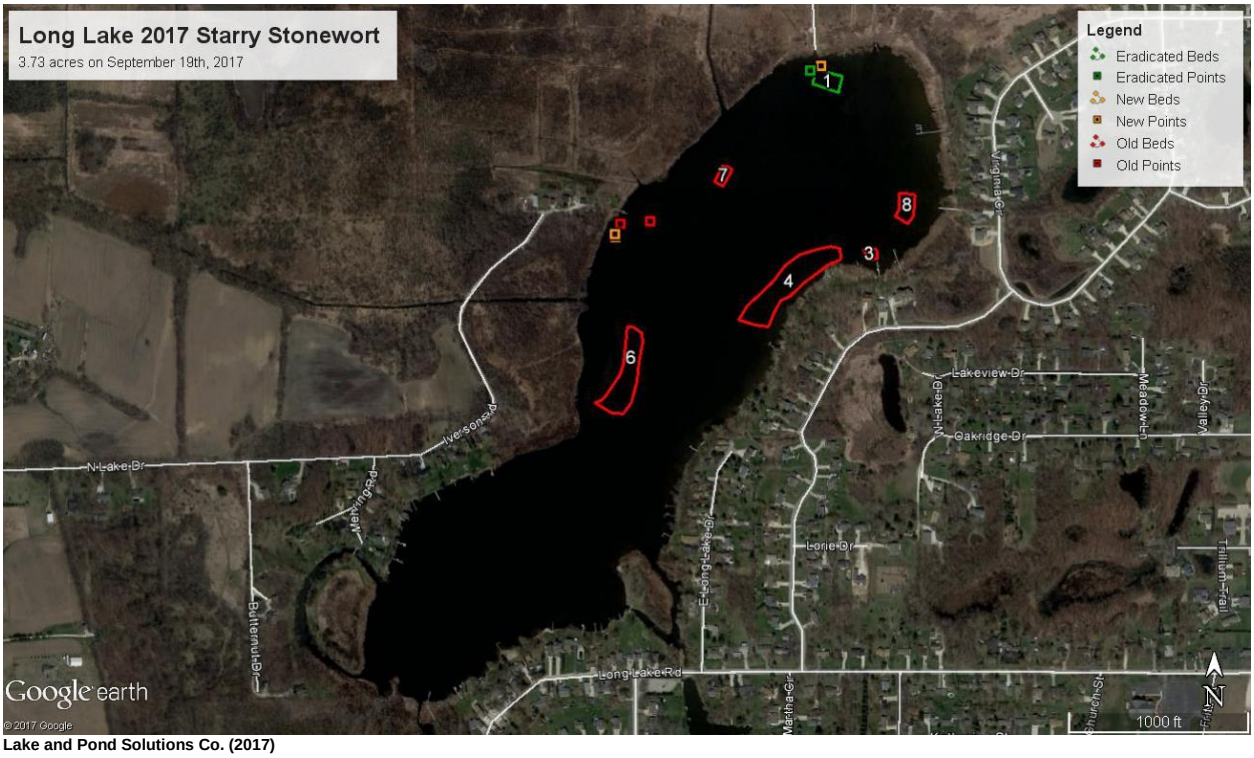
Lake and Pond Solutions Co. (2016)

Figure 9: Long Lake 2016 Starry Stonewort Growth



Lake and Pond Solutions Co. (2017)

Figure 10: Long Lake 2017 Starry Stonewort Growth



Lake and Pond Solutions Co. (2017)

Public Outreach

Lake and Pond Solutions Co. (LPS) staff have had countless interactions with residents, boaters, and fishermen while performing field work on Long Lake. We've attended the Long Lake Protection District (LLPD) Annual meetings on October 13th, 2016 and October 19th, 2017. During these meetings, a PowerPoint presentation was given to update members on current progress and present initial findings. On January 20th, 2017, three members of LPS staff attended the SSW Summit in Burlington, WI to present a summary of current findings to industry peers. Lastly, a Long Lake SSW presentation was given at the annual Midwest Aquatic Plant Management Society (MAPMS) meeting in Milwaukee, WI on March 1st.

STARRY STONEWORT HEIGHT MEASUREMENTS

Starting in September of 2015 and continuing into October of 2017, SSW height measurements were taken at least once per month at twenty-six sites (Figure 11). Polygon numbers reference the maps in Figures Figure 8, Figure 9, and Figure 10 while the columns labeled "single points" reference individual points not associated with a larger bed. Bolded numbers show a date when treatment occurred while boxes highlighted in red, green, or yellow respectively show a negative, positive, or "no change" result following a treatment.

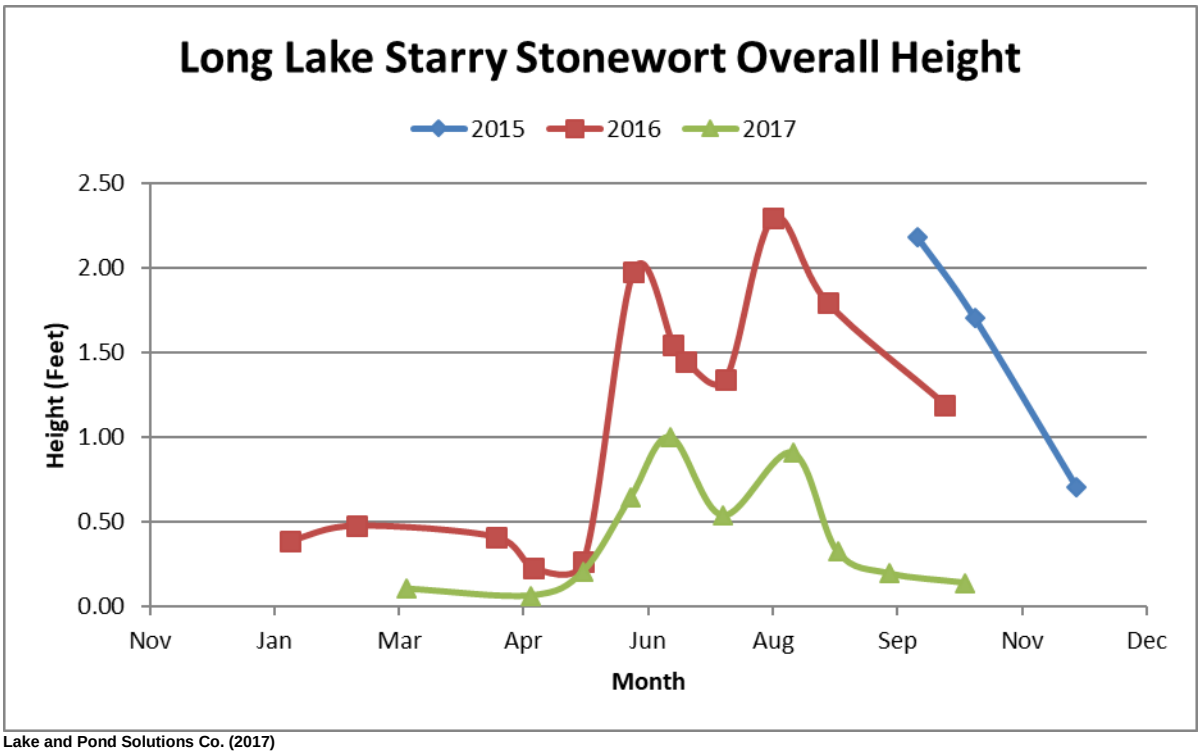
Figure 11: Long Lake SSW Plant Height Summary

Date	OVERALL Avg Plant Height	OVERALL % of Water Column	Avg Plant Height Polygon 1	% of Water Column Polygon 1	Avg Plant Height Polygon 2	% of Water Column Polygon 2	Avg Plant Height Polygon 3	% of Water Column Polygon 3	Avg Plant Height Polygon 4 N	% of Water Column Polygon 4 N	Avg Plant Height Polygon 4 S	% of Water Column Polygon 4 S	Avg Plant Height Polygon 5	% of Water Column Polygon 5	Avg Plant Height Polygon 6	% of Water Column Polygon 6	Avg Plant Height Polygon 7	% of Water Column Polygon 7	Avg Plant Height Polygon 8	% of Water Column Polygon 8	Avg Plant Height Single Points	% of Water Column Single Points
9/30/2015	2.18	60.69%	2.50	71.43%	x	x	x	x	1.80	48.81%	x	x	x	x	2.50	70.43%	x	x	x	x	x	x
10/23/2015	1.70	52.38%	1.50	50.00%	x	x	x	x	1.30	44.09%	x	x	x	x	2.15	61.15%	x	x	x	x	x	x
12/3/2015	0.70	19.59%	0.25	8.33%	x	x	x	x	0.80	25.30%	x	x	x	x	0.70	16.13%	x	x	x	x	x	x
1/21/2016	0.39	10.45%	0.00	0.00%	x	x	x	x	0.25	9.76%	x	x	x	x	0.60	13.22%	x	x	x	x	x	x
2/17/2016	0.48	15.40%	0.50	22.22%	x	x	x	x	0.32	12.26%	x	x	x	x	0.63	17.17%	x	x	x	x	x	x
4/14/2016	0.41	13.82%	0.00	0.00%	x	x	x	x	0.42	17.49%	x	x	x	x	0.48	12.92%	x	x	x	x	x	x
4/29/2016	0.23	7.40%	0.00	0.00%	x	x	x	x	0.33	11.76%	x	x	x	x	0.17	4.51%	x	x	x	x	x	x
5/19/2016	0.26	7.90%	0.08	2.96%	x	x	x	x	0.25	8.08%	x	x	x	x	0.32	8.72%	x	x	x	x	x	x
6/8/2016	1.98	58.34%	**1.75**	**70.00%**	x	x	x	x	**2.15**	**62.50%**	x	x	x	x	**1.85**	**51.85%**	x	x	x	x	x	x
6/24/2016	1.55	42.54%	2.00	57.14%	x	x	x	x	1.10	33.68%	x	x	x	x	1.90	48.48%	x	x	x	x	x	x
6/29/2016	1.45	45.40%	**2.25**	**75.00%**	**2.25**	**75.00%**	**1.75**	**70.00%**	0.55	17.58%	**0.75**	**13.04%**	**0.50**	**15.38%**	**2.05**	**51.41%**	x	x	**1.38**	**39.59%**	**2.13**	**95.00%**
7/15/2016	1.34	40.50%	0.75	25.00%	0.25	6.67%	0.50	20.00%	0.55	18.30%	2.25	39.13%	0.00	0.00%	2.30	60.72%	x	x	2.00	54.30%	1.75	87.50%
8/3/2016	2.29	66.44%	1.75	58.33%	0.00	0.00%	1.50	60.00%	1.95	57.04%	3.50	70.00%	0.00	0.00%	3.35	84.81%	x	x	2.88	82.35%	2.25	100.00%
8/25/2016	1.79	56.98%	1.25	51.67%	0.00	0.00%	2.00	72.73%	1.45	44.02%	2.75	57.89%	0.00	0.00%	2.71	81.40%	1.63	45.24%	1.63	47.65%	2.19	83.57%
10/11/2016	1.19	40.84%	1.13	45.00%	0.00	0.00%	2.25	90.00%	1.15	41.29%	2.50	52.63%	0.00	0.00%	1.85	58.00%	0.50	13.33%	0.63	19.38%	1.38	62.14%
3/9/2017	0.10	2.77%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.15	5.56%	0.33	7.33%	0.00	0.00%	0.20	3.81%	0.00	0.00%	0.06	2.50%	0.13	2.63%
4/28/2017	0.06	1.48%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	**0.35**	**8.01%**	0.00	0.00%	0.00	0.00%	0.00	0.00%
5/19/2017	0.21	5.13%	0.38	10.00%	0.00	0.00%	0.00	0.00%	**0.47**	11.87%	0.00	0.00%	0.00	0.00%	**0.40**	8.98%	0.00	0.00%	**0.13**	3.57%	0.00	0.00%
6/7/2017	0.64	19.05%	**0.88**	26.92%	0.00	0.00%	**1.00**	33.33%	0.00	0.00%	**0.75**	13.64%	0.00	0.00%	**0.50**	11.75%	**1.63**	39.34%	0.02	0.35%	**2.00**	67.84%
6/23/2017	1.00	25.74%	**1.00**	28.57%	0.00	0.00%	2.00	66.67%	**0.70**	18.69%	0.50	9.52%	0.00	0.00%	1.60	37.10%	**1.25**	30.00%	**0.94**	21.75%	**1.05**	30.03%
7/14/2017	0.54	14.57%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.25	5.00%	**1.00**	20.00%	0.00	0.00%	**1.60**	38.79%	0.00	0.00%	0.00	0.00%	**0.85**	30.91%
8/11/2017	0.91	25.67%	0.00	0.00%	0.00	0.00%	0.50	16.67%	**0.45**	**8.33%**	0.25	5.00%	0.00	0.00%	**1.75**	**50.68%**	**3.50**	**87.06%**	0.19	5.56%	1.00	36.00%
8/29/2017	0.32	9.89%	0.13	3.85%	0.00	0.00%	0.50	18.18%	0.25	5.75%	0.75	15.79%	0.00	0.00%	0.30	6.14%	0.13	2.94%	0.25	7.64%	0.65	25.88%
9/19/2017	0.19	6.69%	0.00	0.00%	0.00	0.00%	0.25	10.00%	0.15	4.06%	0.50	10.53%	0.00	0.00%	0.23	5.62%	0.25	6.25%	0.06	2.08%	0.38	18.17%
10/19/2017	0.14	6.10%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.03	0.48%	0.00	0.00%	0.00	0.00%	0.08	2.10%	0.00	0.00%	0.00	0.00%	0.65	30.36%

Lake and Pond Solutions Co. (2017)

The aggressive treatment regime in 2017 was consistently able to maintain SSW heights that were, on average, 58.96% reduced from 2016. By season end, heights were down 88.24% from the previous year. Similar trends were observed during the growing season (June – August). In 2016, SSW occupied an average of 40 – 67% of the water column during the growing season compared to just 5 – 25% in 2017. Figure 12 shows the lake wide average height over the past 2.5 seasons.

Figure 12: Long Lake SSW Height Graph (2015 – 2017)

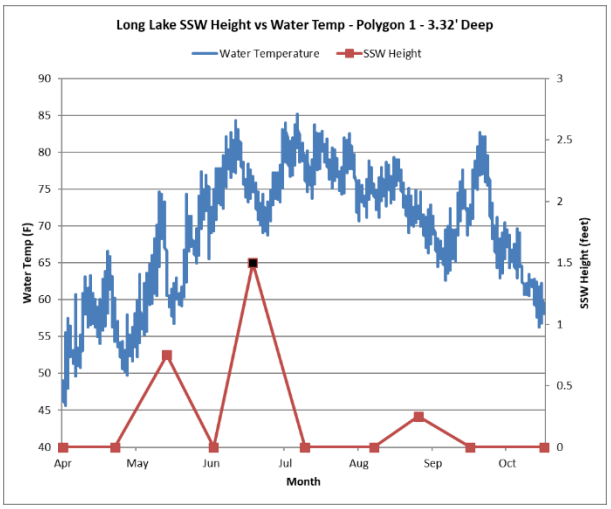


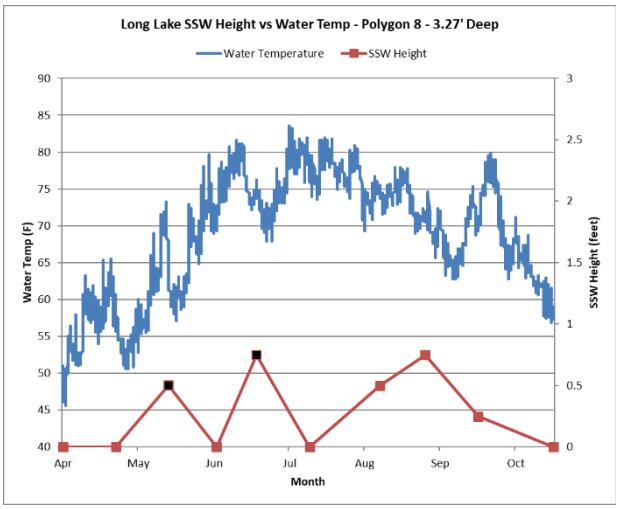
Lake and Pond Solutions Co. (2017)

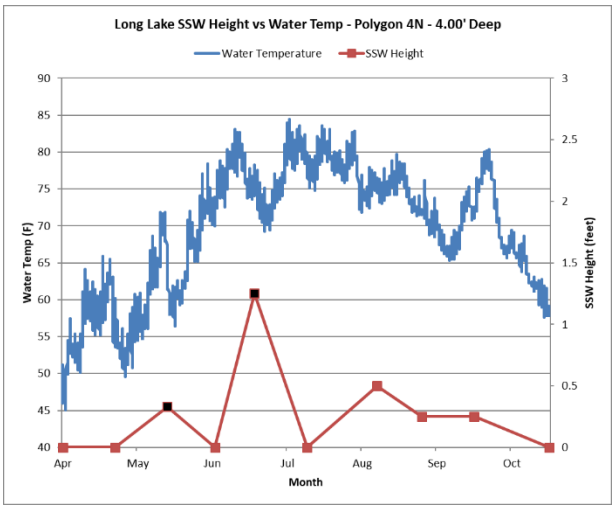
Despite the different management strategies each year, growth spikes look to occur in the beginning of June and August. Based on temperature probes (HOBO meters) installed in the lake, the initial June growth surge occurred as water temperatures pushed over 65 degrees F. The secondary growth surge occurred when water temperatures maintained above 75 degrees F. For future management, treatments timed during these known growth spikes may help to reduce overall height. With height reduced, the chance of in-lake spreading theoretically goes down.

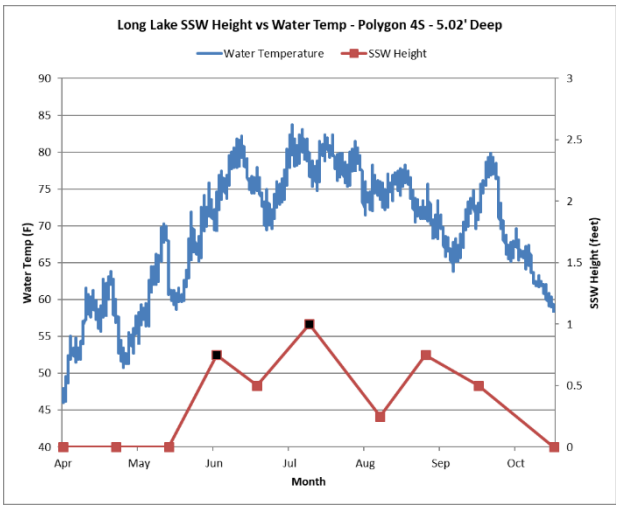
Figure 13 below show SSW height at each of the six HOBO meter sites plotted against water temperature. Black points for the SSW height indicate when a treatment occurred. Referenced polygons can be found in Figure 10.

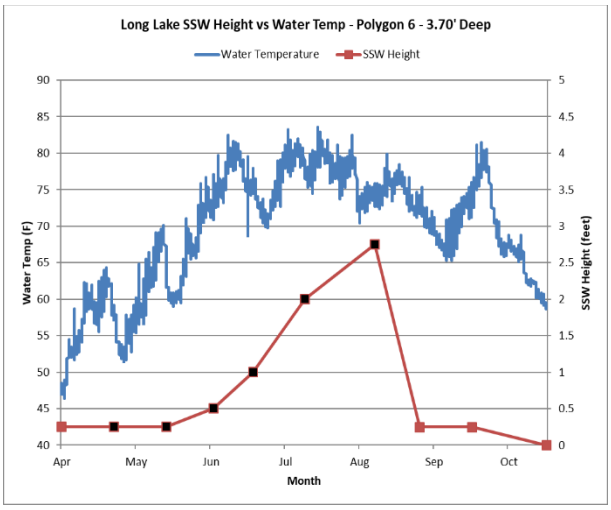
Figure 13: Long Lake SSW Height vs Water Temperature - 2017

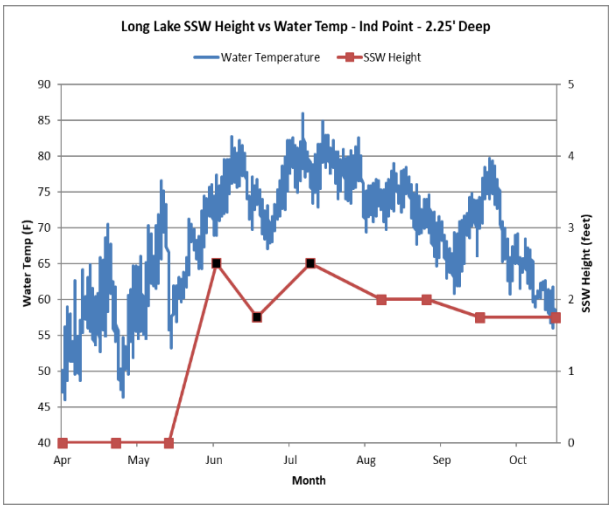










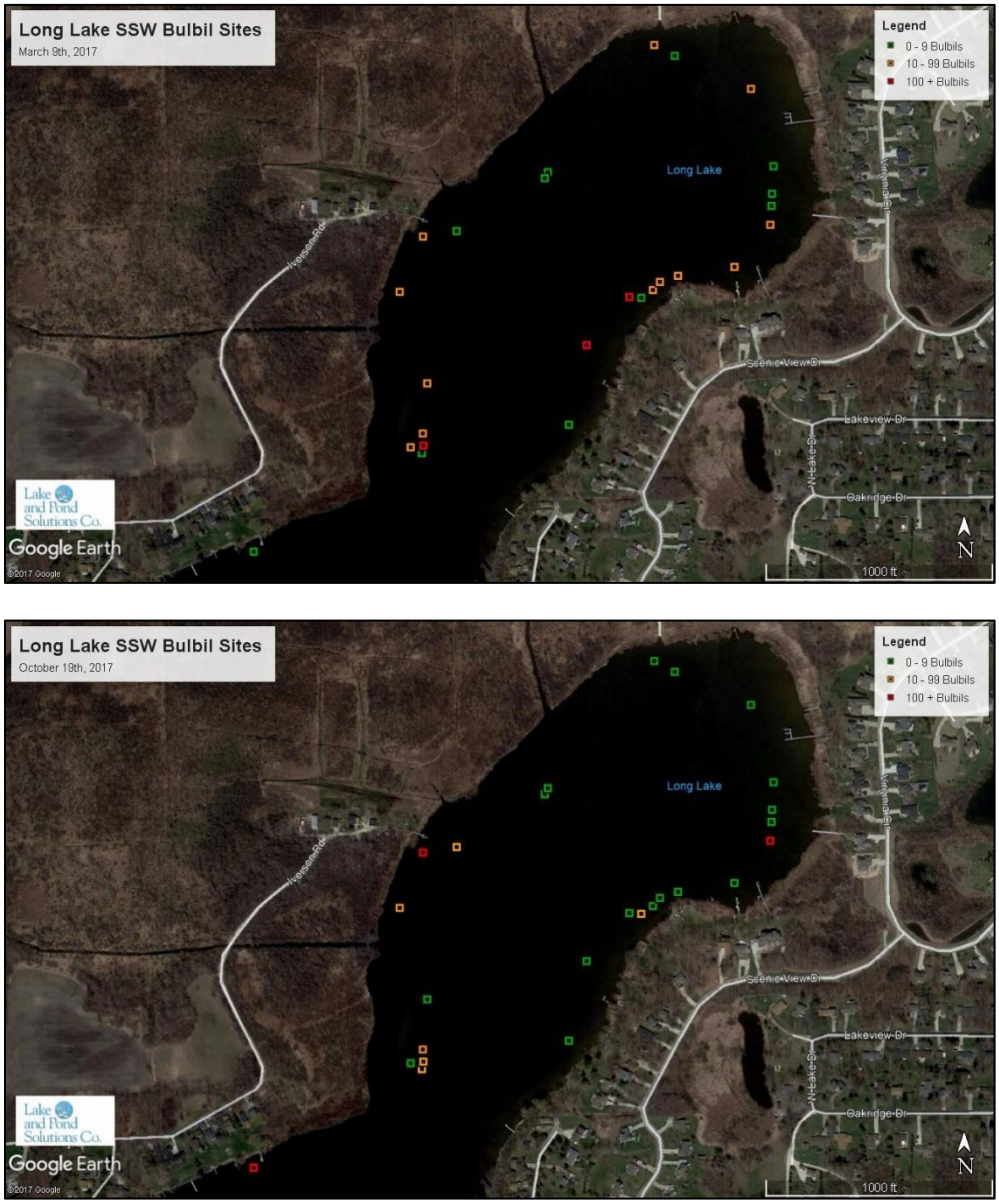


Lake and Pond Solutions Co. (2017)

STARRY STONEWORT BULBIL STUDY

An aggressive treatment approach was implemented for 2017 to keep SSW biomass low. It was theorized that with low biomass, bulbil counts would decline leading to less future growth and in-lake spreading. Bulbils were collected at twenty-six known SSW sites in the spring (March 9th, 2017) and again in the fall (October 19th, 2017) using an Eckman dredge. Each site had approximately 0.1875 cubic feet of sediment collected. Samples were placed in buckets and taken back to the LPS in Elkhorn, WI where they were filtered through a double screen and hand counted. Figure 14 shows the sample sites for spring and fall along with ranges for bulbils collected while Figure 15 includes data from each sampling period.

Figure 14: Long Lake SSW Bulbil Sampling Sites



Lake and Pond Solutions Co. (2017)

Figure 15: Long Lake SSW Bulbil Counts

3/9/2017									10/19/2017											
Polygon	Point	Substrate	SSW Height	Bulbil Count	Avg/Bed	Avg/acre	2016 Max SSW Height	2016 Jun - Aug Avg SSW Height	Substrate	SSW Height	Bulbil Count	Percent Change	Bulbil Avg/Bed	Bulbil Avg/acre	2017 Max SSW Height	Percent Change	2017 Jun-Aug Avg SSW Height	Treatments	Captain/ Clipper	Komeen Crystal
1	WPT20	Sand	0	10	5	861,200	1.75	1.75	sandy muck	0.00	0	-100.0%	0	0	1.75	0.00%	0.45	2	1	1
	WPT1	Muck	0	0			2.25	1.54	sandy muck	0.00	0	0.0%			1.50	-33.33%	0.35	1	1	
2	WPT12	Muck	0	35	35	6,028,400	2.25	0.63	Fiberous	0.00	0	-100.0%	0	0	0.00	-100.00%	0.00	0		
8	WPT21	Muck	0	0	9	1,507,100	1.00	1.00	Sandy muck	0.00	0	0.0%	292	50,294,080	0.50	-50.00%	0.10	1	1	
	WPT22	Muck	0	0			1.50	1.50	Muck	0.00	0	0.0%			0.50	-66.67%	0.22	1	1	
	WPT13	Muck	0	0			2.75	1.88	FIberous	0.00	0	0.0%			2.00	-27.27%	0.40	1	1	
	WPT14	Muck	0.25	35			3.00	2.25	Fiberous	0.00	1168	3237.1%			0.75	-75.00%	0.40	2	1	1
3	WPT19	Sandy	0	45	45	7,750,800	2.25	1.44	Sandy muck	0.00	0	-100.0%	0	0	2.00	-11.11%	0.80	2		2
4	WPT11	Muck	0	55	76	13,090,240	3.00	1.33	Fiberous	0.00	0	-100.0%	18	3,043,481	1.25	-58.33%	0.40	2	2	
	WPT7	Sand	0.50	23			2.25	1.54	Sandy	0.00	6	-73.9%			0.25	-88.89%	0.00	2	2	
	WPT8	Sand	0	14			2.25	1.50	Sandy	0.00	0	-100.0%			1.75	-22.22%	0.35	2	2	
	WPT9	Sand	0.25	1			1.25	0.88	Sandy	0.00	98	9700.0%			0.25	-80.00%	0.05	1	1	
	WTP10	Sand	0	195			2.50	1.21	Sandy	0.13	0	-100.0%			1.75	-30.00%	0.85	3	2	1
	WPT18	Muck	0.33	170			3.50	2.31	Sandy muck	0.00	2	-98.8%			1.00	-71.43%	0.65	2		2
5	WPT17	Sand	0	0	0	0	0.50	0.50	Sandy	0.00	0	0.0%	0	0	0.00	-100.00%	0.00	0		
Ind	WPT23	Sand	0	1	1	172,240	2.25	2.25	Sandy muck	0.50	131	13000.0%	131	22,563,440	2.00	-11.11%	0.80	2		2
6	WPT4	Muck	1.00	9	87	15,053,776	4.25	2.83	Fiberous	0.13	30	233.3%	16	2,755,840	2.00	-52.94%	0.95	6	2	4
	WPT5	Muck	0	33			2.50	1.67	Fiberous	0.13	0	-100.0%			2.00	-20.00%	0.90	6	2	4
	WPT3	Muck	0	312			4.50	2.92	Fiberous	0.00	29	-90.7%			2.50	-44.44%	1.15	6	2	4
	WPT2	Muck	0	70			3.50	2.76	Muck	0.00	16	-77.1%			2.75	-21.43%	1.30	6	2	4
	WPT6	Muck	0	13			3.25	1.63	Fiberous	0.13	5	-61.5%			3.00	-7.69%	1.45	6	2	4
Ind	WPT16	Muck	0	20	20	3,444,800	2.25	2.06	Muck	1.00	18	-10.0%	18	3,100,320	2.00	-11.11%	0.40	1		1
Ind	WPT15	Muck	0	51	51	8,784,240	2.25	2.06	Muck	1.75	155	203.9%	155	26,697,200	2.50	11.11%	2.15	3		3
Ind	WPT24	Muck	0.50	0	0	0	2.25	2.25	Muck	0.00	67	13000.0%	67	11,540,080	3.00	33.33%	1.70	3		3
7	WPT25	Muck	0	0	0	0	2.00	2.00	Muck	0.00	0	0.0%	0	0	4.00	100.00%	1.25	3		3
	WTP26	Muck	0	0			1.25	1.25	Muck	0.00	0	0.0%			3.00	140.00%	1.35	3		3

Lake and Pond Solutions Co. (2017)

During the spring bulbil sampling, bulbil counts ranged from 0 to 312 per site with a lake wide average of 42 bulbils per site. The two dominant SSW beds (Polygons 4 and 6) had average counts of 76 and 87 bulbils per site which extrapolates to 13 – 15 million bulbils per acre of SSW! In the fall, bulbil counts ranged from 0 to 1168 per site with a lake wide average of 66 bulbils per site. Although it seems bulbils increased, one site (WPT 14 in Polygon 8) accounted for nearly 68% of the count. If this one site is thrown out of the fall data as an extreme outlier, then the average bulbils are reduced to 22 per site and bulbils were reduced by 51% lake wide. In fact, the top 4 bulbil sites in the fall accounted for a staggering 90% of the total count. The top 4 sites in the spring accounted for 68% of the bulbils.

Generally, bulbils decreased or remained at zero in 77% of the sites. Of the twenty-six sites, thirteen saw bulbil decreases, seven remained at zero, and six increased. The two dominant SSW beds (Polygons 4 and 6) saw average counts decrease to 18 and 16 bulbils per site (from 76 and 87 bulbils per site). Figure 16 shows a bulbil count breakdown of the increasing and decreasing sites between seasons.

Figure 16: Long Lake SSW Bulbil Comparison

	Spring Bulbil Count	% of Total	Fall Bulbil Count	% of Total
Sites w/ decrease (13)	995	91.11%	76	4.40%
Sites w/ increase (6)	97	8.89%	1649	95.60%

Lake and Pond Solutions Co. (2017)

The thirteen sites that saw decreases in the fall only accounted for 4.40% of the total bulbils versus 91.11% at the same sites in the spring. Conversely, the six sites that saw increases in the fall accounted for 95.60% of the total bulbils versus 8.89% in spring. It is important to note that none of the six sites that saw fall increases were in the top five for bulbil counts in the spring.

Figure 17 groups sites based on bulbil counts in the spring versus the fall. The first number represents the number of sites in the category while the second number represents the overall percentage of bulbils represented by that category. The number of sites with 0 – 9 bulbils increased from eleven (42%) to seventeen (65%) while all other categories decreased except for the 500+ column. This further demonstrates that bulbils generally decreased with only a few sites significantly skewing overall data.

Figure 17: Long Lake SSW Bulbil Count Distribution

	0-9 bulbils	10 – 49 bulbils	50 – 99 bulbils	100 – 499 bulbils	500 + bulbils
SPRING	11 (1.0%)	9 (20.9%)	3 (16.1%)	3 (62.0%)	0 (0.0%)
FALL	17 (0.8%)	4 (5.4%)	2 (9.6%)	2 (16.6 %)	1 (67.7%)

Lake and Pond Solutions Co. (2017)

We assessed the cause for increases across the six sites by looking at 2016/2017 maximum SSW heights, 2016/2017 average growing season heights, substrate, and treatment frequencies. There was no correlation between any of the data to explain the outliers.

Additionally, sites with increases were spread across all three treatment regimens (Captain XTR/Clipper/enzyme (1), Komeen crystals (3), and a combo of both treatments (2)) indicating no correlation between treatment regimens and bulbil increase.

Although we observed a general decline in bulbils on a site by site basis and in the "major" SSW beds, further research is necessary to understand what triggers excessive bulbil production in seemingly random sites.

PROJECT SUMMARY

Management, and more specifically eradication, has proven to be a difficult task. Many of the experimental management techniques would not be appropriate for Long Lake. Hand pulling small populations in 2015 resulted in inconclusive data as half of the sites returned as larger populations in 2016. Diver Assisted Suction Harvesting (DASH) was not considered as an option due to the shallow nature of the large littoral zone, the extensive water lily growth, and the overall cost. Lake drawdown is currently an un-tested method of control (although it is being examined on Little Muskego Lake this winter) and not feasible due to the absence of a dam.

Pesticide treatments showed promise as a way to manage SSW biomass but no product or product combination was able to demonstrate the ability to eradicate the species. An aggressive treatment regimen was implemented in 2017 using the most successful products from 2016. Below are some key takeaway points from the season. It is important to note that successful treatments were defined as those that demonstrated a reduction or no change in population heights over a 3-week period.

- Only three new satellite populations were located compared to eight in 2016
- 80.77% of treatments were successful and SSW acreage was reduced by 43.7% from the previous season
- Captain XTR/Clipper SC/enzyme treatments were 100% successful with the longest control at 36.2 days and an average height reduction of 70.87%
- Any site that received a Captain XTR/Clipper SC/enzyme treatment finished the season with average heights under 0.06' (compared to 0.41' for Komeen crystal sites)
    - Captain XTR/Clipper SC/enzyme would be the preferred treatment especially when native vegetation doesn't dominate. Care should be taken to only inject this treatment when lilies are present to limit non-target impacts.
- SSW only occupied 5 – 25% of the water column during the growing season (June – August) compared to 40 – 67% in 2016
- SSW heights were down 88.24% compared to the previous end of season measurements
- Growth spikes in early June correlate with 65-degrees F water temperatures
- Growth spikes in early August correlate with sustained water temperatures over 75-degrees F
- Bulbil counts decreased or remained at zero in 77% of sites following a season of treatments
- The most aggressive beds (4 and 6) saw average bulbil decreases of 76 – 82%

- Only 35% of sites in the fall had more than 9 bulbils (compared to 58% in the spring)
- The top four bulbil sites in the fall (including one which had 1168 bulbils) accounted for 90% of the total collected (vs 68% in spring)
- Bulbils per site decreased from 42 in the spring to 22 in the fall (if the one large outlying site is removed from the data)
- Bulbil counts in spring and fall still show the potential for tens of millions bulbils per acre of SSW.

RECOMMENDATIONS

Since no further state funding is available due to a lack of state-defined "public access", the LLPD is in a difficult situation. There are only 42 riparian homeowners on the lake and the taxing base is proportionately small. Limited private funds coupled with multiple invasive species (Eurasian water-milfoil, curly-leaf pondweed, purple loosestrife, and starry stonewort) mean that concessions must be made on the management side. Although further study pertaining to the current grant would be ideal, it may not be worth sacrificing management of the aforementioned invasive species.

For 2018 and beyond, we recommend that the LLPD put a portion of the invasive budget towards well-timed SSW treatments. Specifically, the focus should be on treatments in early June (when water temps reach 65 degrees F) and again in early August (when water temps are sustained above 75 degrees F). The goal of these treatments would solely focus on reducing biomass at key points during the growing season in an attempt to improve recreation and limit the potential of in-lake spreading. Isolated SSW populations in areas with limited recreation may be left un-treated. Treatments should be performed using a mix of Captain XTR (0.8ppm), Clipper (150 – 200 ppb) and enzyme or Komeen Crystal (1ppm) when natives are dominant.

Although not critical, we strongly recommend a seasonal SSW survey at the end of August or beginning of September to identify any areas of change. This survey will help provide a comparison to past seasons while also providing future treatment guidance

Lastly, since in-lake transport still looks to be a significant vector of distribution, it is important to explore other methods of notifying boaters and residents of infested areas. Limiting boat traffic through established beds should help reduce new "satellite populations".