LONG LAKE STARRY STONEWORT GRANT SUMMARY

AIRR19516

Lake and Pond Solutions Co.

January 12th, 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 an Aquatic Invasive Species (AIS) Rapid Response Grant 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 a point-intercept survey conducted by Lake and Pond Solutions Co. (LPS) staff during July of 2015 using guidelines adopted by the WDNR for point-intercept survey methods. It also provides data from an extensive Starry Stonewort mapping survey conducted in July of 2015 around the entire littoral zone of the lake by LPS staff via snorkel gear and kayaks. Research for this summary was funded through an AIS Rapid Response Grant (AIRR 19516) awarded to the LLPD and administered by the WDNR.

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

2015 LONG LAKE POINT-INTERCEPT SURVEY RESULTS

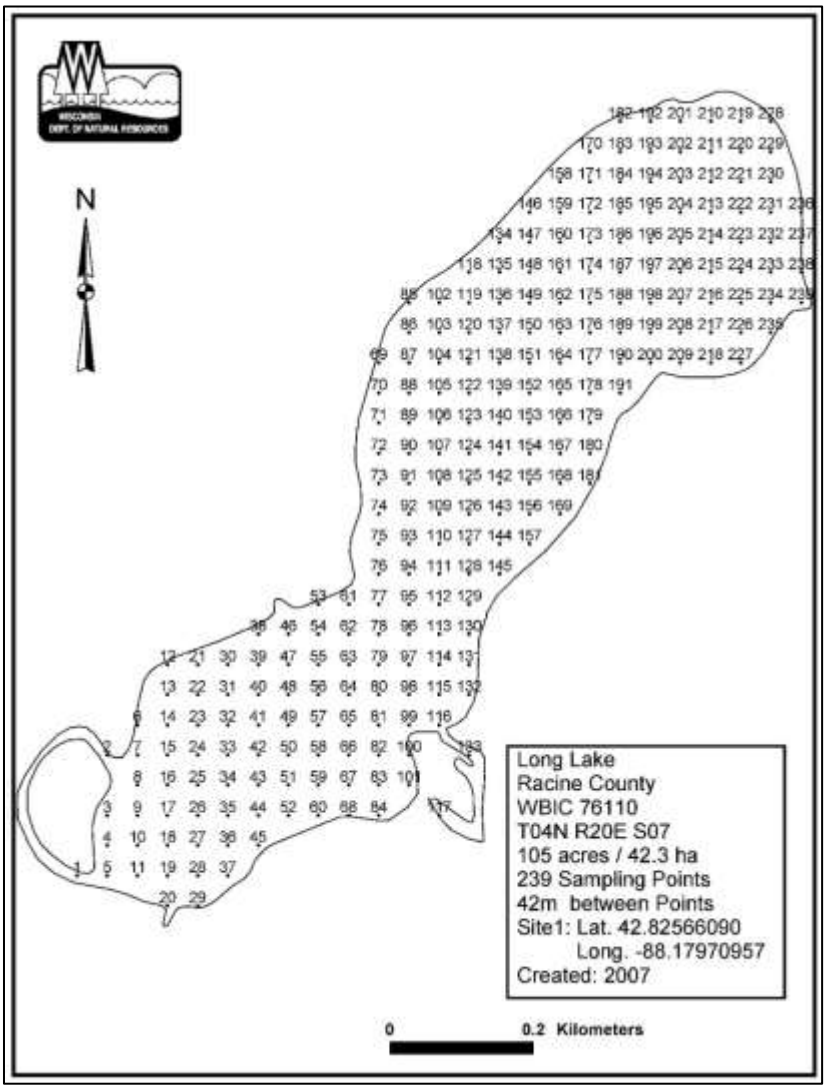
The 2015 aquatic plant survey was conducted using the guidelines adopted by the WDNR for point-intercept survey methods. This method utilizes a grid system that takes into account the size and morphology of the lake. For the survey, the 239 WDNR established points (Figure 1) were transferred to a DeLorme PN-60 GPS unit before field sampling. At each established point, a sample was taken with a plant sampling rake on a 10' graduated pole. Data collection included depth, substrate type, species present, species density, overall rake density and any visuals of species located within a 5-foot radius of the boat. Ultimately, data was used to calculate frequency of occurrence, relative frequency of occurrence, average rake density, total sites with vegetation, maximum depth of plants, average native species per site, average of all species per site, species richness and floristic quality (FQI).

Overall Summary

Plants were surveyed on July 20th, 2015 using 226 of the 239 pre-determined WDNR points (Figure 1). Thirteen of these points were located either in too shallow of water or within large beds of cattails where depth and sediment type metrics were not sampled. Twenty-eight different species of plants were found covering approximately 62% of the Lake. On average,

there were nearly 3 native species found at each vegetated site which is representative of a diverse plant community. Due to the relatively shallow nature of Long Lake, it has been demonstrated that over 85% of the entire Lake has the potential for plant growth.

Figure 1: Overview of 2015 Plant Sampling Points



WDNR (2007)

Plant Species Summary

The twenty-eight different species of plants were sampled during the 2015 PI survey (Figure 2). Species are listed from most to least frequent, including visual sightings. Also shown is the overall frequency (percentage plant was found compared to all sites), relative frequency (percentage plant was found compared to vegetated sites), the average relative density rating (based on a scale of 1 for "least dense" and 3 for "densest" at vegetated sites) and the C-Value. For Figure 2 and Figure 3, plants that were field recorded as "visual" were changed to a density rating of "1". This was done to ensure that many of the plant species that do not readily come up on a rake head (spatterdock, white water lily, etc.) were represented in the data.

The seven most common native aquatic plant species (not including algae or cattails) within Long Lake based on relative frequency are Coontail (72.86%), Common Bladderwort (64.29%), White Water Lily (52.14%), Muskgrass (32.14%), Forked Duckweed (26.43%), Common Watermeal (22.86%), and Slender Naiad (15.00%). There is a good distribution of native plants, which includes three species listed as "high value" by the WDNR. The average C-Value which indicates the sensitivity an aquatic plant species is to disturbance, has remained constant (5.27 in 2008 to 5.21 in 2015). The floristic quality which evaluates how close an area is to its undisturbed counterpart, also increased from 20.4 in 2008 to 22.7 in 2015. Despite the recent infestation of Starry Stonewort, the lake vegetation appears to be remaining constant.

Figure 2: Long Lake 2015 Plant Sampling Species Summary

Common Name	Scientific Name	Total Number of Sites Found (Includes Visuals)	% Overall Frequency of Occurrence (Includes Visuals)	% Relative Frequency of Occurrence (Includes Visuals)	Relative Average Density Rating	C-Value
Coontail	*Ceratophylum demersum*	102	45.13	72.86	1.34	3
Common Bladderwort	*Utricularia vulgaris*	90	39.82	64.29	1.18	7
White Water Lily	*Nymphaea odorata*	73	32.30	52.14	1.61	6
Filamentous Algae	*n/a*	62	27.43	44.29	1.15	-
Muskgrass	*Chara sp.*	45	19.91	32.14	1.35	7
Broad-leaved Cattail	*Typha sp.*	37	16.37	26.43	n/a	1
Forked Duckweed	*Lemna trisulca*	37	16.37	26.43	1.06	6
Common Watermeal	*Wolffia columbiana*	32	14.16	22.86	1.20	5
Eurasian Water Milfoil**	*Myriophyllum spicatum*	27	11.95	19.29	1.00	-
Slender Naiad	*Najas flexilis*	21	9.29	15.00	1.00	6
Large Duckweed	*Spirodela polyrhiza*	18	7.96	12.86	1.00	5
Sago Pondweed*	*Stuckenia pectinata*	17	7.52	12.14	1.00	3
Wild Celery*	*Vallisneria americana*	16	7.08	11.43	1.00	6
Arrowhead	*Sagittaria sp.*	13	5.75	9.29	1.08	-
Softstem Bulrush	*Schoenoplectus tabernaemontani*	12	5.31	8.57	n/a	-
Small Duckweed	*Lemna minor*	12	5.31	8.57	1.00	4
Common Waterweed	*Elodea canadensis*	12	5.31	8.57	1.00	3
Spatterdock	*Nuphar variegata*	8	3.54	5.71	1.00	6
Illinois Pondweed*	*Potamogeton illinoensis*	7	3.10	5.00	1.00	6
Fetid Stonewort	*Chara contraria*	6	2.65	4.29	1.50	6
Curly-leaf Pondweed**	*Potamogeton crispus*	5	2.21	3.57	1.00	-
Starry Stonewort**	*Nitellopsis obtusa*	5	2.21	3.57	1.50	-
Aquatic Moss	*n/a*	4	1.77	2.86	1.00	-
Water Stargrass	*Heteranthera dubia*	2	0.88	1.43	1.00	6
Spiny Naiad	*Najas marina*	1	0.44	0.71	1.00	-
Small Pondweed	*Potamogeton pusillus*	1	0.44	0.71	1.00	7
Globular Stonewort	*Chara globularis*	1	0.44	0.71	1.00	6
Unknown Lily 1	*n/a*	1	0.44	0.71	1.00	-

Lake and Pond Solutions Co. (2016)

* Species are considered "high value" plant species under Wisconsin Administrative Code NR 107
** Denotes non-native (exotic) species

% Overall Frequency	The percentage a plant species was found compared to all sites sampled. It is calculated by taking the number of sites a species was found and dividing by the total number of *sampled points*.
% Relative Frequency	The percentage a plant species was found compared to all sites with vegetation. It is calculated by taking the number of sites a species was found and dividing by the total number of *vegetated sites*.
Relative Average Density	The average density of each plant species comparative to the number of sites where it was found. It is calculated by dividing the sum of the site densities (for that specific plant species) by the total number of sites where it was found.

Figure 3: 2015 Long Lake P/I Survey Statistics

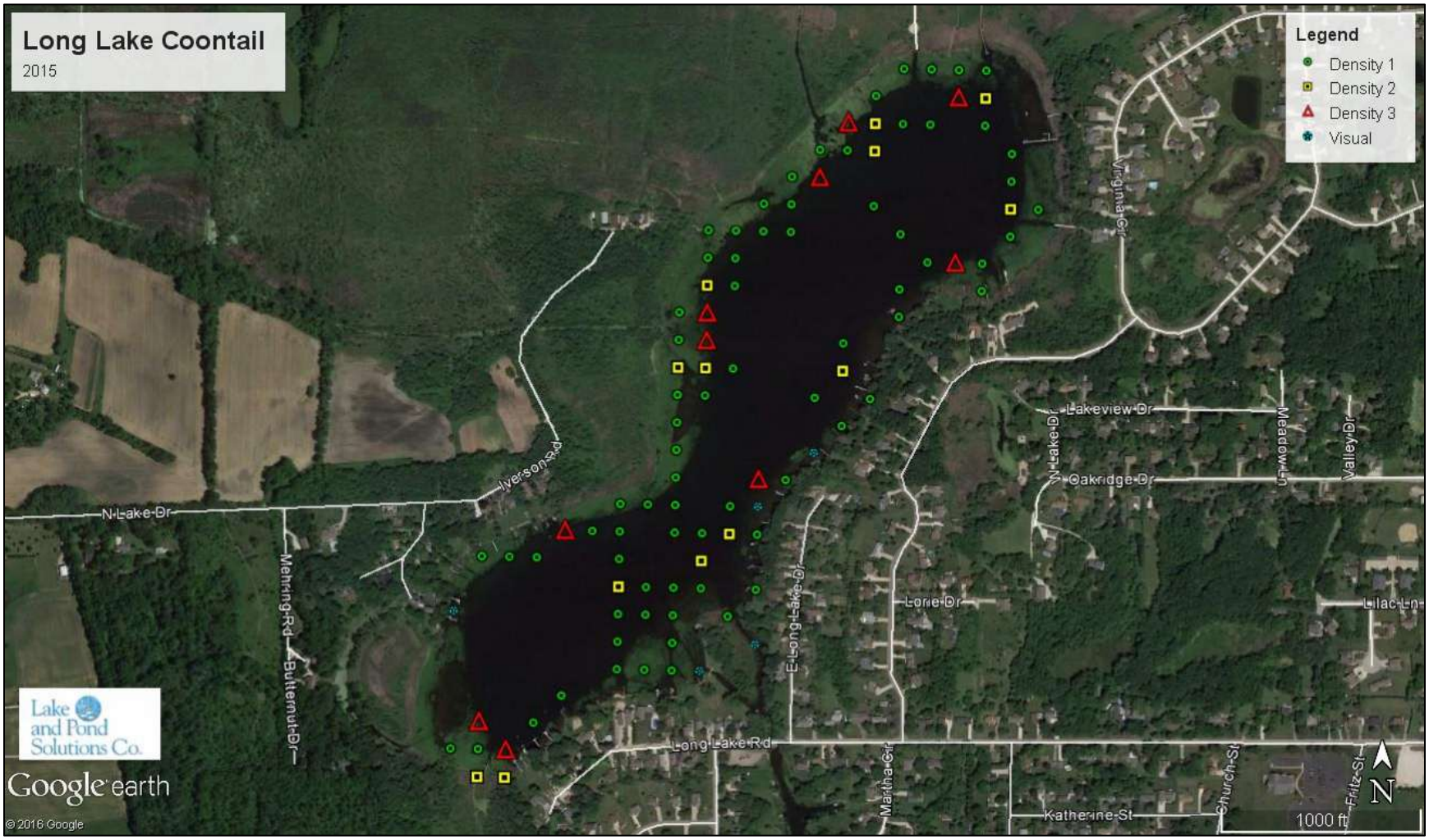
Summary Statistics	2015 Survey (7-20-15)
Total Number of Sites with Vegetation/All Sites Sampled	140/226 (61.9%)
Maximum Depth of Plants	20.0'
Species Richness (Including Visuals)	28
Average Number of All Species per Vegetated Site	2.96
Average Number of Native Species per Vegetated Site	2.82
Simpson Diversity Index	0.87
Average C-Value	5.21
Floristic Quality	22.7

Lake and Pond Solutions Co. (2016)

Overall, the native plant community in Long Lake looks healthy. Figure 4 - Figure 13 shows the distribution and densities of the top seven native species along with the three non-native species found in the Lake in 2015 (arranged from most to least frequent distribution). Two of the top five (common bladderwort and muskgrass) are considered "quality" based on their C-Values.

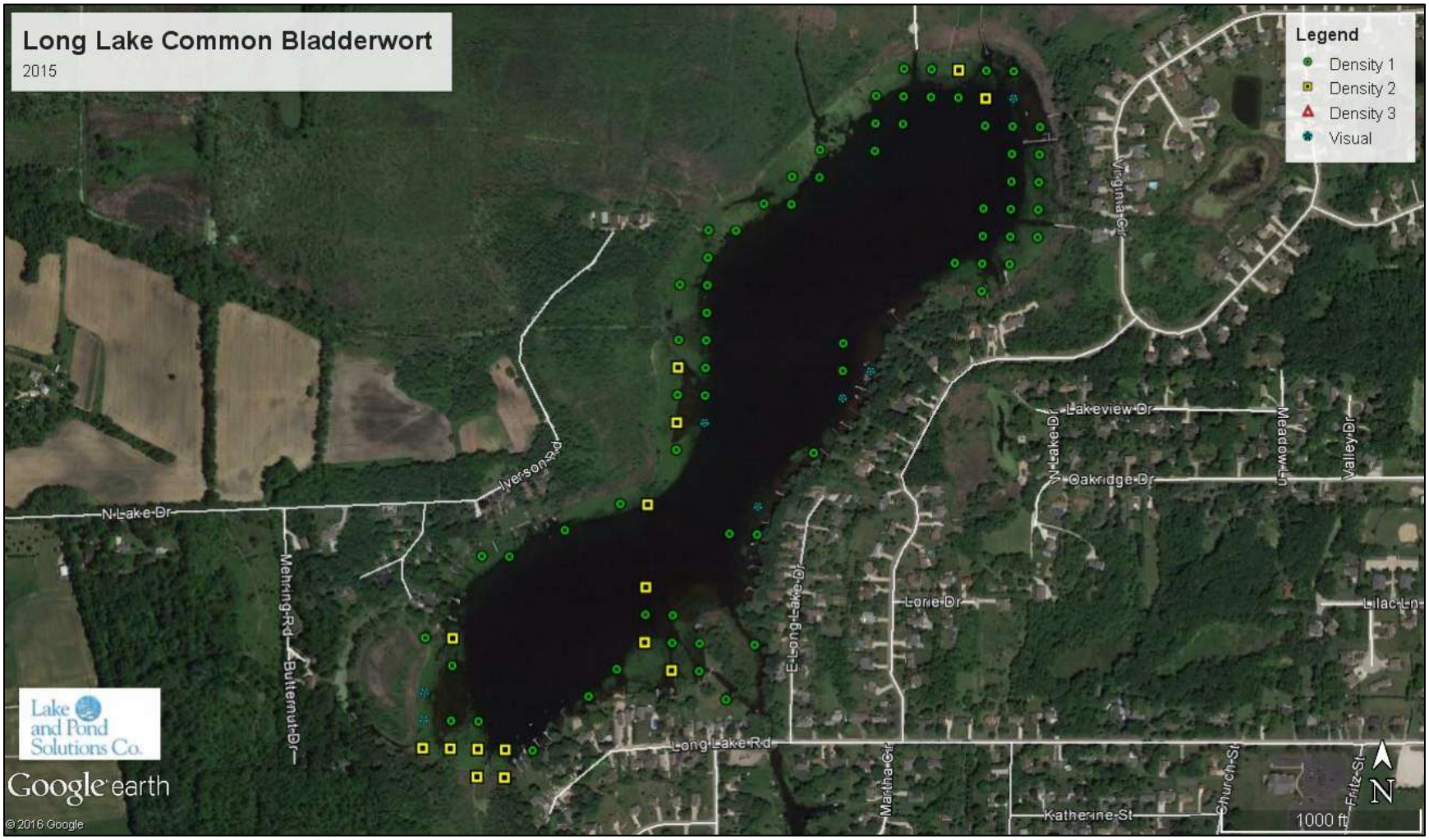
The plant community within Long Lake ranks above the average lake in the Southeastern Till Plain and is higher than the state average for its closeness to what it would be like under undisturbed conditions. Although the lake has Eurasian Water-milfoil and Curly-Leaf Pondweed, the quantity and quality of the native species still remains. With the recent discovery of Starry Stonewort, it is even more important to monitor the lake for changing vegetation patterns.

Figure 4: Long Lake 2015 Coontail Distribution



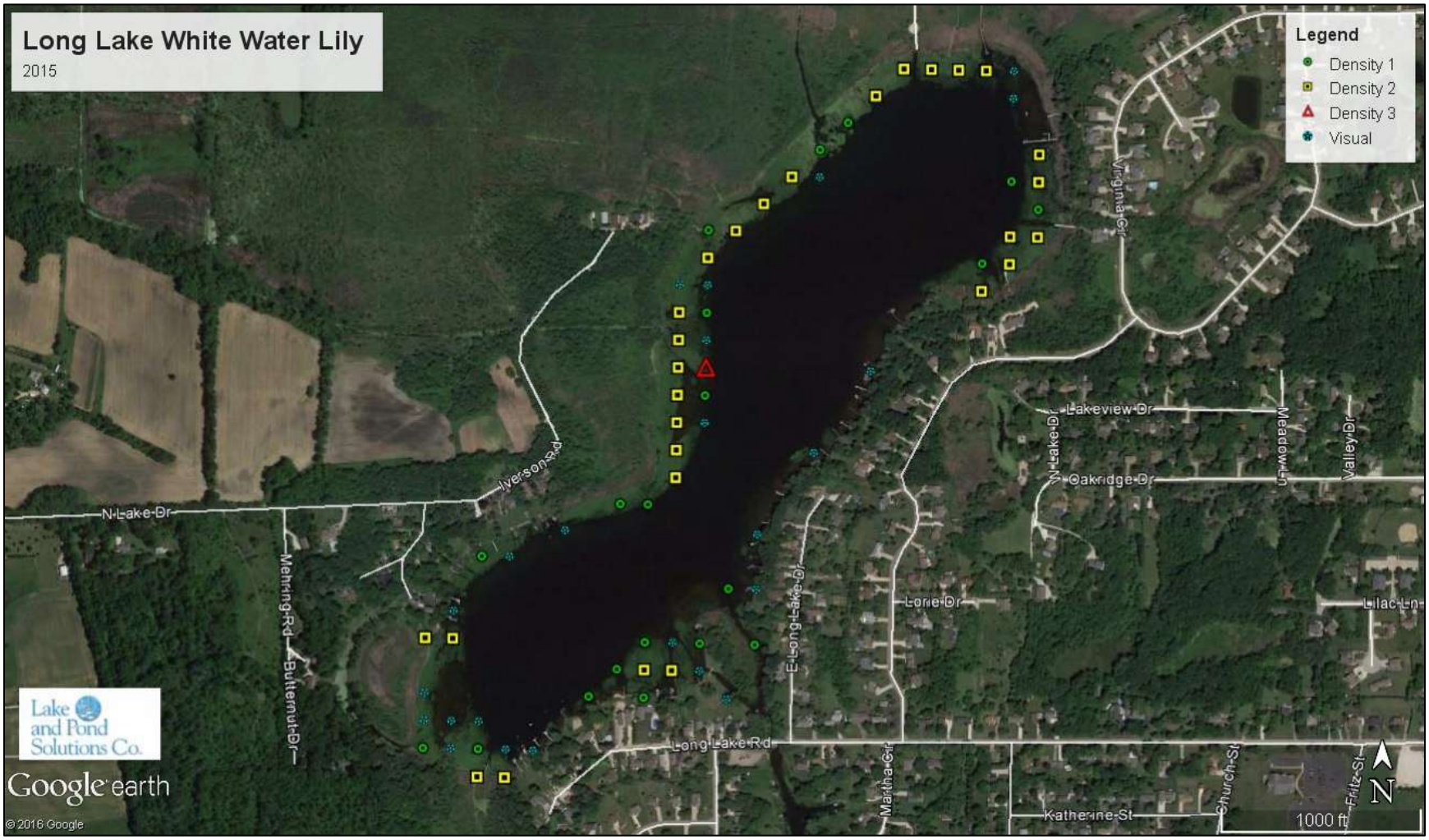
Lake and Pond Solutions Co. (2016)

Figure 5: Long Lake 2015 Common Bladderwort Distribution



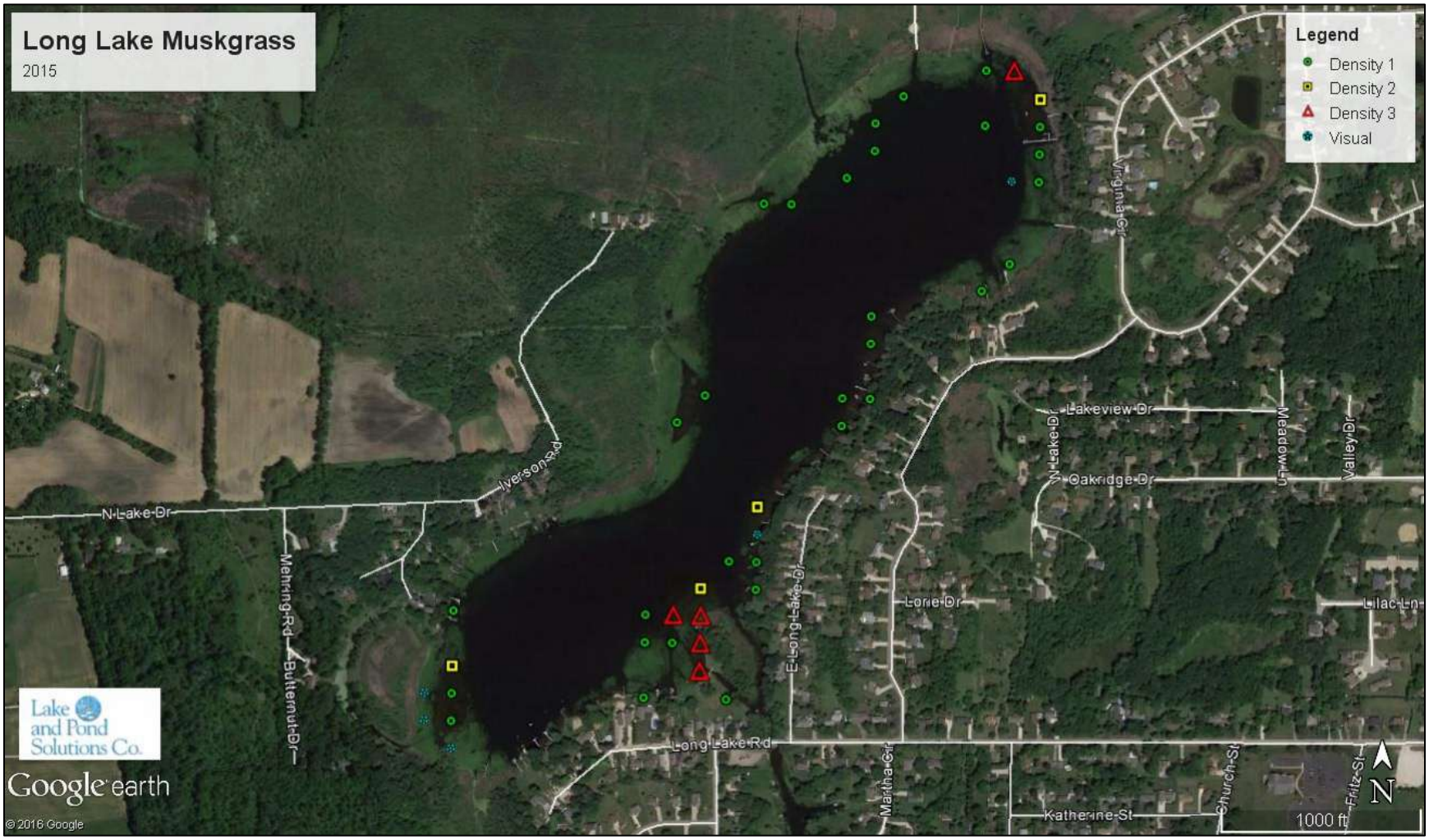
Lake and Pond Solutions Co. (2016)

Figure 6: Long Lake 2015 White Water Lily Distribution



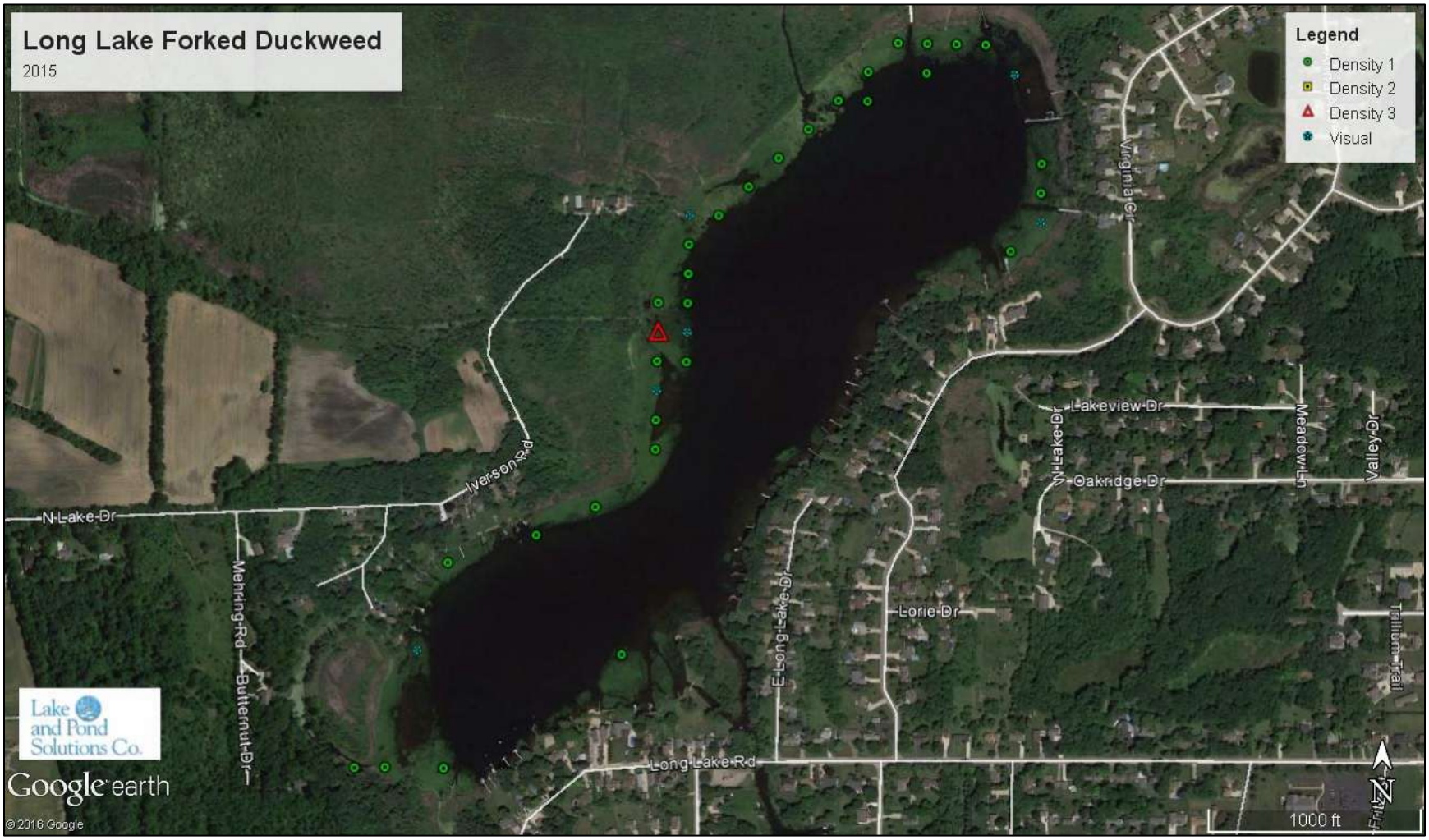
Lake and Pond Solutions Co. (2016)

Figure 7: Long Lake 2015 Muskgrass Distribution



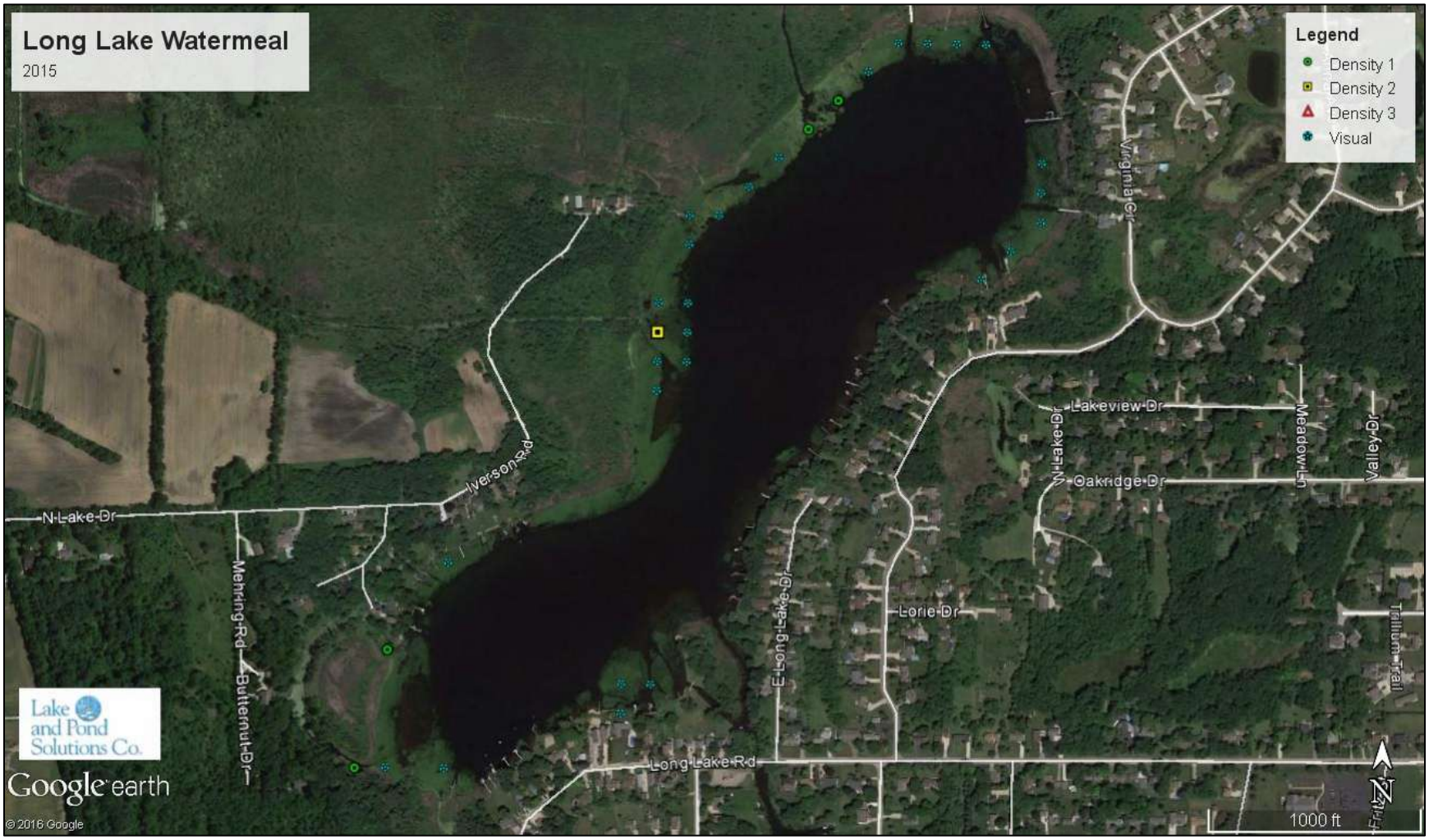
Lake and Pond Solutions Co. (2016)

Figure 8: Long Lake 2015 Forked Duckweed Distribution



Lake and Pond Solutions Co. (2016)

Figure 9: Long Lake 2015 Watermeal Distribution



Lake and Pond Solutions Co. (2016)

Figure 10: Long Lake 2015 Bushy Pondweed Distribution

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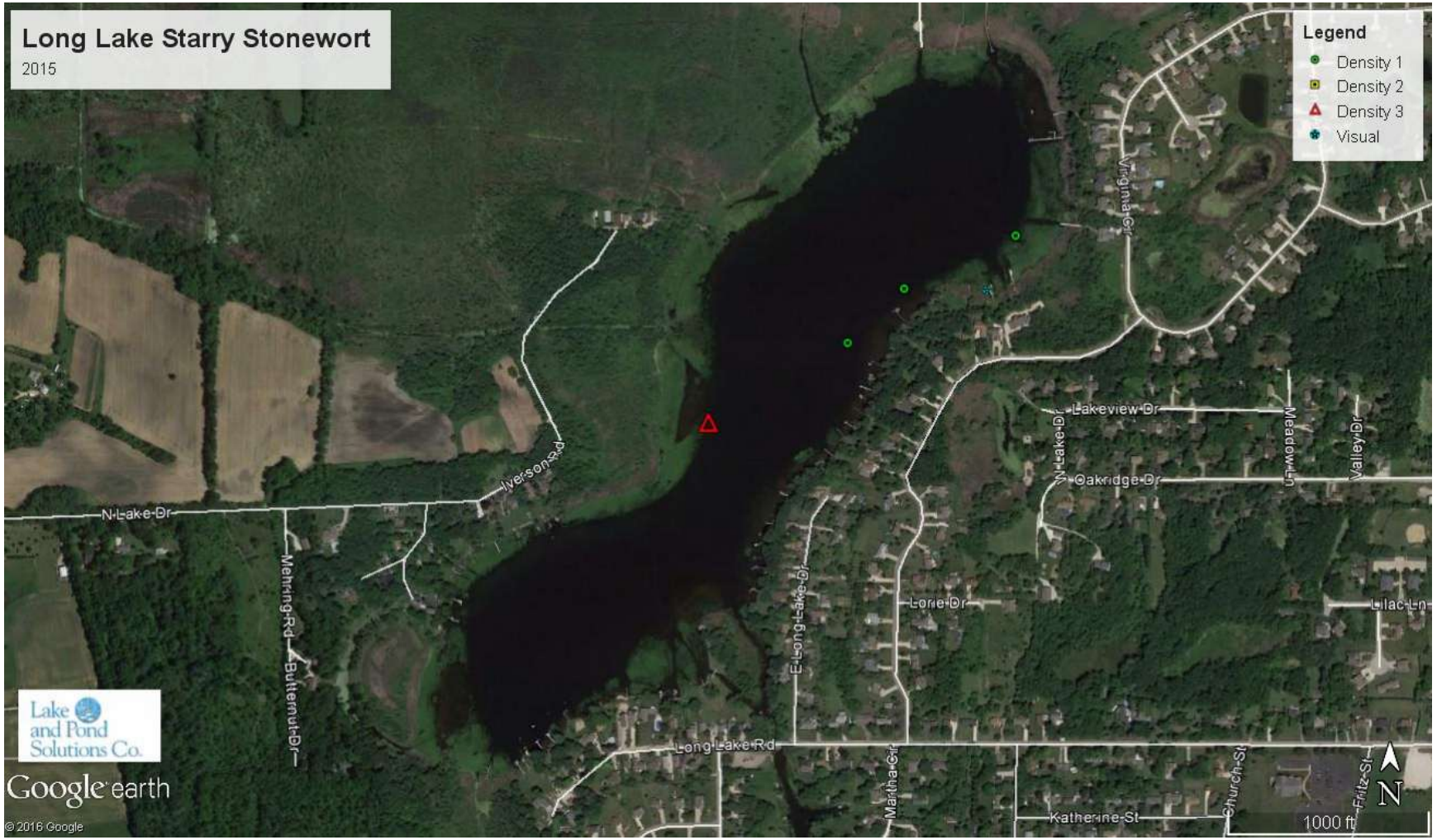
Figure 11: Long Lake 2015 Eurasian Water-Milfoil Distribution

Lake and Pond Solutions Co. (2016)

Figure 12: Long Lake 2015 Curly-Leaf Pondweed Distribution

Lake and Pond Solutions Co. (2016)

Figure 13: Long Lake 2015 Starry Stonewort Distribution



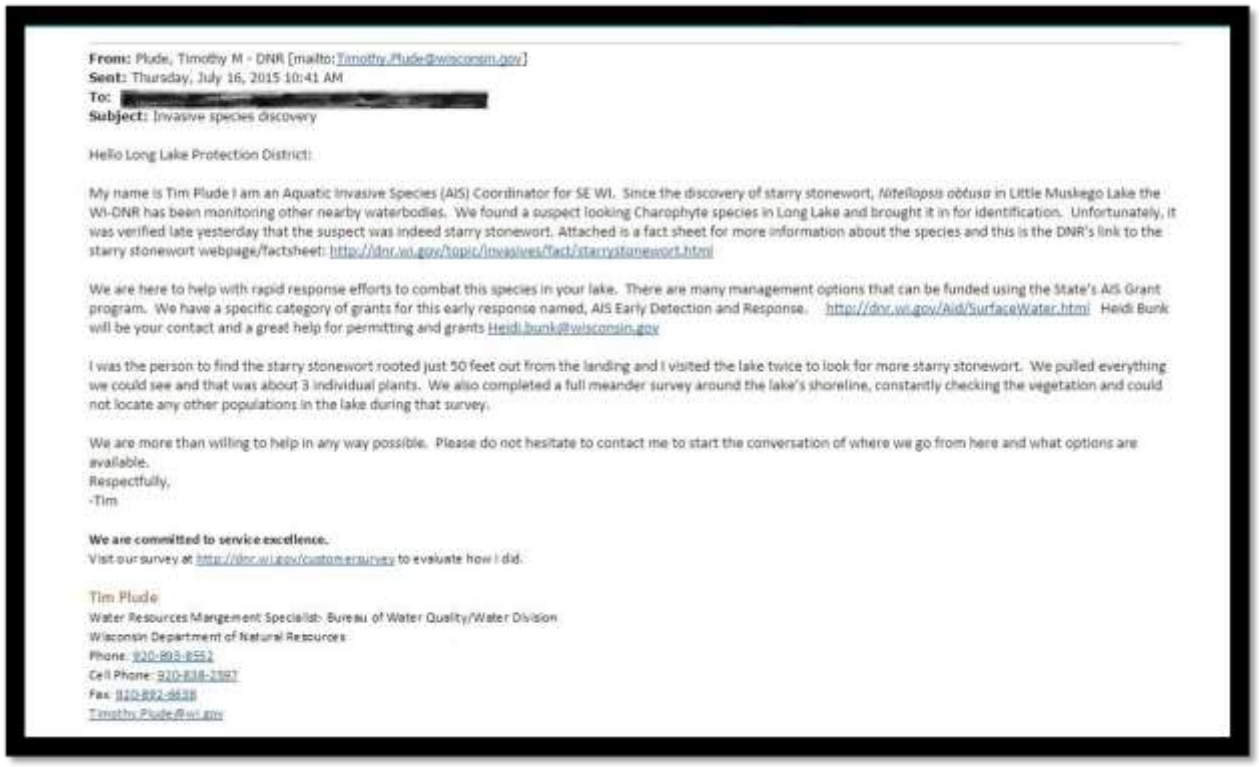
Lake and Pond Solutions Co. (2016)

*This map is not representative of the actual starry stonewort population. Point-intercept surveys have limitations and actual beds of starry stonewort were defined in more detail with other survey methods (see Page 15).

STARRY STONEWORT SPECIFIC SURVEYS

The identification of Starry Stonewort by a Wisconsin Department of Natural Resources (WDNR) staff member (Figure 14) resulted in immediate action and the submission of the rapid response grant. LLPD was granted authorization from the WDNR for the start of control and containment activities per NR 198.32(2) on July 17th, 2015.

Figure 14: WDNR Starry Stonewort Announcement



From: Plude, Timothy M - DNR [mailto:Timothy.Plude@wisconsin.gov]
Sent: Thursday, July 16, 2015 10:41 AM
To: [redacted]
Subject: Invasive species discovery

Hello Long Lake Protection District:

My name is Tim Plude I am an Aquatic Invasive Species (AIS) Coordinator for SE WI. Since the discovery of starry stonewort, *Nitellopsis obtusa* in Little Muskego Lake the WI-DNR has been monitoring other nearby waterbodies. We found a suspect looking Charophyte species in Long Lake and brought it in for identification. Unfortunately, it was verified late yesterday that the suspect was indeed starry stonewort. Attached is a fact sheet for more information about the species and this is the DNR's link to the starry stonewort webpage/factsheet: http://dnr.wi.gov/topic/invasives/fact/starrystonewort.html

We are here to help with rapid response efforts to combat this species in your lake. There are many management options that can be funded using the State's AIS Grant program. We have a specific category of grants for this early response named, AIS Early Detection and Response. http://dnr.wi.gov/Aid/SurfaceWater.html Heidi Bunk will be your contact and a great help for permitting and grants Heidi.bunk@wisconsin.gov

I was the person to find the starry stonewort rooted just 50 feet out from the landing and I visited the lake twice to look for more starry stonewort. We pulled everything we could see and that was about 3 individual plants. We also completed a full meander survey around the lake's shoreline, constantly checking the vegetation and could not locate any other populations in the lake during that survey.

We are more than willing to help in any way possible. Please do not hesitate to contact me to start the conversation of where we go from here and what options are available.
Respectfully,
-Tim

We are committed to service excellence.
Visit our survey at http://dnr.wi.gov/customersurvey to evaluate how I did.

Tim Plude
Water Resources Mangement Specialist- Bureau of Water Quality/Water Division
Wisconsin Department of Natural Resources
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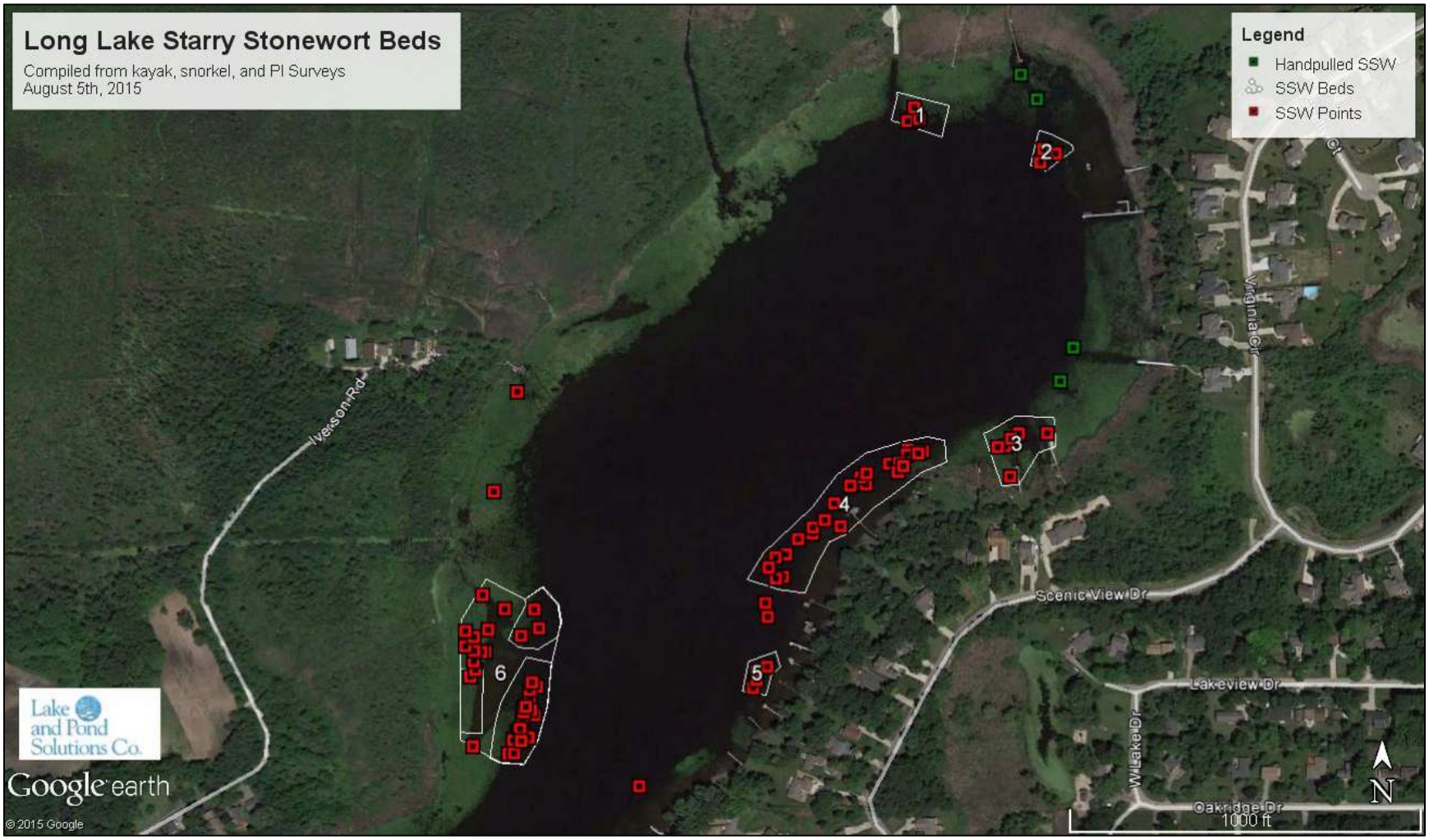
Lake and Pond Solutions Co. began conducting a point-intercept (PI) survey to determine the species composition within the lake at the time of outbreak. Concurrently, an intensive survey focusing solely on Starry Stonewort was conducted. It incorporated small motorized boats, kayaks and a snorkel team along with GPS units to locate and define beds. Figure 15 shows all the points with starry stonewort around Long Lake based on the 2015 survey. A separate survey was conducted to define SSW beds (denoted by polygons). The in-depth 2015 survey resulted in 5.89 acres of SSW being located. There were a few isolated patches of SSW that seemed to be in the early stages of settlement, so they were removed by hand during the snorkel portion of the survey (denoted in green and discussed in further detail on Page 18).

The 2016 survey built on previous data by adding new points and expanding bed configuration based on current growth. Figure 16 shows the most recent populations from August of 2016. There are now approximately 6.08 acres of SSW.

Figure 15: 2015 Starry Stonewort Survey Results



Lake and Pond Solutions Co. (2016)

Figure 16: 2016 Starry Stonewort Survey Results

Lake and Pond Solutions Co. (2016)

STARRY STONEWORT MANAGEMENT

This detailed section is provided to highlight Starry Stonewort management from 2015 – 2016. It includes information on hand removal, treatments, and public outreach.

Hand Removal

Hand removal of SSW was performed during the intensive survey work in 2015. Any individual stands less than 5' x 5' were removed by snorkeling crews (Figure 17).

Figure 17: Long Lake 2015 Hand Removal Sites

Lake and Pond Solutions Co. (2016)

By 2016, the two north hand removal sites had not returned and a new hand removal site was added to the south (Figure 18). However, the other two hand removal sites expanded significantly. Point 1 was now a 20' x 20' patch while Point 2 was a 30' x 30' patch.

Figure 18: Long Lake 2016 Hand Removal Sites

Lake and Pond Solutions Co. (2016)

Due to the varied responses of hand removal sites, it is difficult to truly assess the effectiveness. It is our theory that in the failed hand removal areas, bulbils left behind in the sediment served to repopulate in the subsequent year. In the successful sites, young populations may not have produced a significant amount of bulbils to support reproduction. To be a truly viable option, hand removal should only occur in new and small infestations and soft sediment should also be removed.

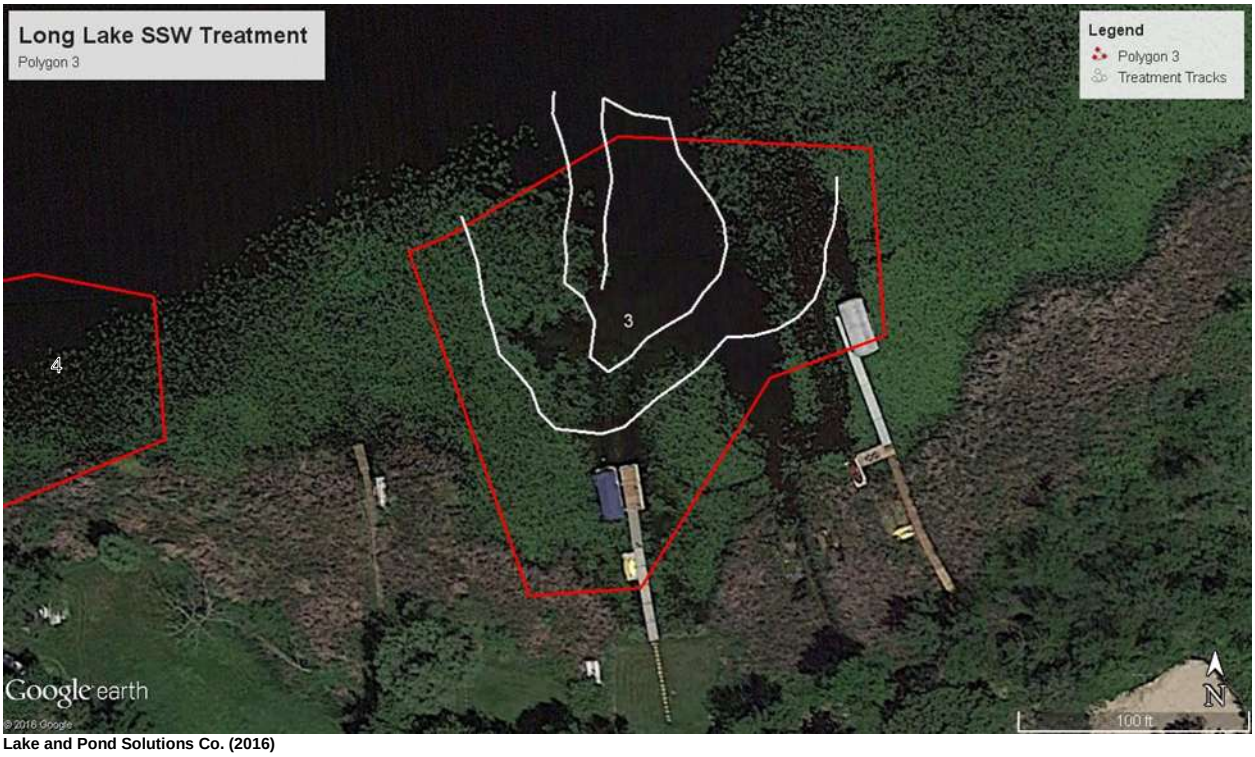
Treatments

The ability to detect and control Starry Stonewort while in its early stages is a major factor in regards to the continued health of Long Lake.

September 17th, 2015

With that in mind, Polygon 3 on the northeastern section of Long Lake was selected for the initial treatment site in the fall of 2015. A 0.61 acre treatment was performed by Lake and Pond Solutions Co. on September 17th, 2015 with a mix of Captain XTR (0.78 ppm), Clipper (154.8 ppb), and Triton AE Pro enzyme. Figure 19 depicts the area and exact path of this treatment.

Figure 19: Long Lake SSW Treatment – September 17th, 2015



Lake and Pond Solutions Co. (2016)

Lake and Pond Solutions Co. in coordination with the WDNR conducted pre and post treatment monitoring in Polygon 3 along with a control site in Polygon 4. The intent was to observe control and impacts to the native plant community.

Figure 20 shows results from the surveys conducted on 9/16/15 (pre-treatment), 9/30/15 (post treatment), and 10/23/15 (post treatment). It was determined that SSW showed significant

reductions compared to the control site but was not eliminated completely. Other reductions included Illinois pondweed and white water lily but only in the treatment area. Surprisingly, another macroalgae, chara, showed significant increases in the treatment area. It was theorized that the chara had hardwater deposits which helped to insulate it from treatment effects. SSW did regrow in this treatment area during 2016 but was delayed from other areas, mainly corresponding to warming temps and what was theorized as bulbil regrowth.

Figure 20: Long Lake 2015 Pre/Post Treatment Plant Survey

	9/16/2016 Poly 3 Estimated % Cover	9/30/2016 Poly 3 Estimated % Cover	10/23/2016 Poly 3 Estimated % Cover	9/16/2016 Poly 4 Estimated % Cover	9/30/2016 Poly 4 Estimated % Cover	10/23/2016 Poly 4 Estimated % Cover
Algae	0.00	75.00	19.17	0.00	10.00	10.00
Bladderwort	0.00	5.00	5.00	V	15.00	5.00
Bushy Pondweed	0.00	0.00	0.00	10.00	10.00	0.00
Chara	15.63	44.38	31.25	15.50	11.00	17.50
CLP	5.00	0.00	0.00	V	0.00	0.00
Coontail	7.00	11.67	7.86	12.14	26.67	12.50
EWM	6.00	V	5.00	21.25	26.67	23.75
Illinois Pondweed	9.00	0.00	0.00	30.00	40.00	10.00
Nitella	0.00	5.00	0.00	0.00	0.00	0.00
Sago Pondweed	5.00	5.00	0.00	26.67	11.67	0.00
Starry Stonewort	60.00	13.00	22.50	74.38	86.43	85.45
Variable Pondweed	0.00	0.00	0.00	5.00	0.00	0.00
Water Stargrass	0.00	0.00	0.00	V	0.00	0.00
White Water Lily	9.00	1.00	0.00	1.00	0.00	0.00
Wild Celery	0.00	0.00	0.00	37.50	10.00	30.00

Lake and Pond Solutions Co. (2016)

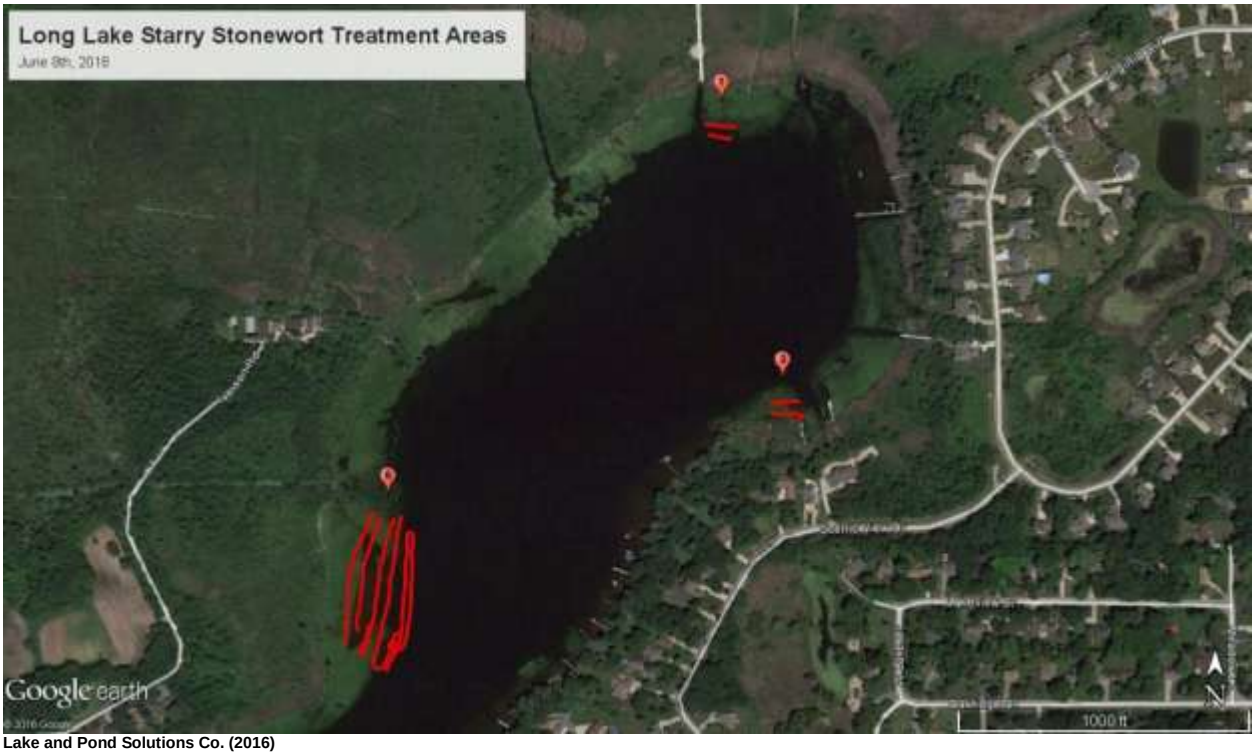
Additional plant height survey work continued throughout the winter of 2015 and into 2016. By May of 2016, it was determined that SSW was again actively growing (including Polygon 3). Trial treatments occurred on 6/8/16, 6/16/16, and 6/29/16 along with DNR coordinated sampling.

June 8th, 2016

The treatment on 6/8/16 occurred in Polygons 1, 3, and 6 using Captain XTR (Figure 21). Polygon 1 (0.30 acres) and 3 (0.30 acres) were injected with 0.94 ppm Cu while Polygon 6 (2.73 acres) was sprayed and injected with 0.80 ppm Cu and a tracer dye. Unfortunately, general surveys on 6/24/16 showed that SSW was unaffected in all three polygons. Native plants were also unaffected except in Polygon 6 where chara was reduced in shallow water. These natives included white water lily, Illinois pondweed, small pondweed, elodea, bladderwort, algae, chara,

small pondweed, spadderdock, coontail, and flat-stem pondweed. It is unclear why the failures occurred but SSW heights (biomass) had swelled from 0.20 feet tall when treatment was requested on 5/24/16 to 1.80 feet tall when treatment was performed. Also, algae was more prevalent at the time of treatment which could have affected the uptake of copper by SSW.

Figure 21: Long Lake SSW Treatment – June 8th, 2016



Lake and Pond Solutions Co. (2016)

June 16th, 2016

The 1.02 acre injection treatment on 6-16-16 occurred in Polygon 4 using Captain XTR (0.825 ppm), Clipper (150.5 ppb), Triton AE Pro enzyme, and a dye tracer (Figure 22). The WDNR requested that the treatment be separated from the 6-8-16 treatments due to different treatment products being used. A post treatment survey on 6/24/16 showed that SSW heights had been cut in half from 2.15 feet to 1.10 feet. Another informal survey was completed on 7/15/16 which showed SSW height was at 0.55 feet but starting to recover.

Native plants were sparse at the outset with coontail, chara, and elodea making up a majority of the biomass. Elodea was negatively impacted; however, coontail and chara remained viable. It is important to point out that SSW heights had increased from 0.25 feet tall when treatment was requested to 2.1 feet tall during treatment. Unlike the previous treatment, taller growth did not impact this mixture adversely.

Figure 22: Long Lake SSW Treatment – June 16th, 2016

Lake and Pond Solutions Co. (2016)

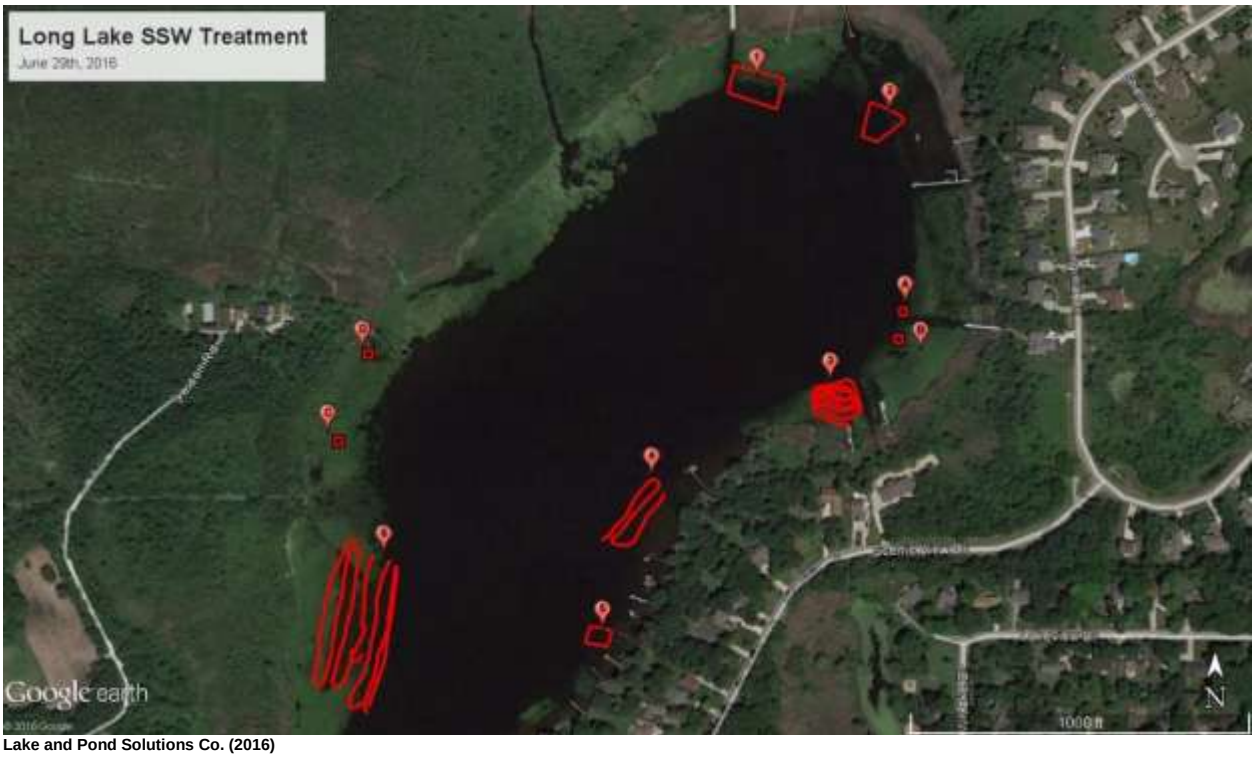
June 29th, 2016

The treatment on 6/29/16 focused on treating all known beds of SSW with a mixture of different products (Figure 23). SSW heights ranged from 0.5 feet to 2.25 feet tall. Polygons 1, 2, and 5 along with all individual points were treated with Komeen Crystal at 0.98 ppm. Polygon 6 was sprayed with Komeen liquid at 0.8 ppm and Hydrothol at 0.29 ppm. Finally, Polygons 3 and 4S were injected with Komeen liquid at 0.86 ppm and Reward at 0.35 – 0.5 ppm (differences based on depth).

Komeen crystal treatments were successful on Polygons 1 (0.30 acres), 2 (0.19 acres), and 5 (0.07 acres) with no impacts to native plants. These natives included Illinois pondweed, elodea, coontail, watermeal, duckweed, bladderwort, white water lily, small pondweed, water celery, and chara. Unfortunately, Komeen crystals were not successful in treating individual points containing smaller beds (all 0.02 acres in size). Although this looks to be a viable treatment option, the smallest treatment area should be at least 0.10 acres in size.

The treatment on Polygon 6 (2.73 acres) with Komeen liquid and Hydrothol was unsuccessful with SWW showing heights expanding to 2.30 feet from 2.05 feet. There were no documented impacts to natives which included white water lily, small pondweed, bladderwort, algae, elodea, chara, and variable pondweed. The SSW bed in this area was the most dominant on the lake with thick monotypic growth in many areas. Interestingly, this area also saw a failed treatment back on 6/8/16. It is unclear if the mixes of products, thick growth, or other external factors are influencing treatment success.

Figure 23: Long Lake SSW Treatment – June 29th, 2016



Lake and Pond Solutions Co. (2016)

Lastly, polygons 3 (0.60 acres) and 4S (0.74 acres) were injected with Komeen liquid at 0.86 ppm and Reward at 0.50 ppm and 0.35 ppm, respectively. The treatment on Polygon 3 was successful but impacts were observed for all native plants except water lilies (due to injection). These natives included chara, small pondweed, algae, elodea, and Illinois pondweed (limited impact). The polygon 4S treatment failed completely with no impacts to SSW or any natives (coontail, Illinois pondweed, small pondweed, and water celery). This site was generally much deeper and product may have been diluted by moving off site.

Treatment Summary

Figure 24 below shows the different treatment regimens and subsequent results. Two treatment methods looked to be the most promising: Komeen crystal and the combination of Captain XTR, Clipper, and enzyme. It is important to point out that even the most successful treatments did not eliminate SSW completely.

Figure 24: 2016 Treatment Regimes and Results

TREATMENT DATE	REGIME	POLYGON	RESULT	CONTROL LENGTH (weeks)	IMPACT TO NATIVES?
June 8th, 2016	Captain XTR (0.95ppm) sprayed	1	Negative	0	N
	Captain XTR (0.8ppm) sprayed/injected	6	Negative	0	N
June 16th, 2016	Captain XTR (0.83ppm), Clipper (150ppb), AE PRO injected	4N	Positive	5	Y-limited
June 29th, 2016	Komeen Crystal (0.98ppm)	1,2, 5	Positive	3 - ?	N
	Komeen Crystal (0.98ppm)	Single Points	Negative	0	N
	Komeen (0.86ppm), Reward (0.5ppm) injected	3	Positive	3	Y - not lillies
	Komeen (0.8ppm), Reward (0.35ppm) injected	4S	Negative	0	N
	Komeen (0.8ppm), Hydrothol (0.29ppm) sprayed	6	Negative	0	N

Lake and Pond Solutions Co. (2016)

After follow up surveys on 7/15/16 and 8/3/16, it was determined that SSW growth had become too aggressive to successfully continue treatments. Additionally, many new smaller "satellite" populations were discovered which had become increasingly difficult to manage.

SSW Height Measurements

Starting in September of 2015 and continuing into October of 2016, SSW height measurements were taken at least once per month. This data was used to track the overall plant height in feet and the percent of water column occupied (Figure 25). Polygon numbers reference the map in Figure 16 while the columns labeled "single points" and "new points" reference the individual points. SSW height measurements were used to track the active expansion of each bed as well as the effectiveness of treatment. Boxes highlighted in red or green respectively show a negative or positive result following a treatment (bold).

Figure 25: Long Lake Starry Stonewort 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 Single Points	% of Water Column Single Points	Avg Plant Height New Points	% of Water Column New 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		
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		
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		
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		
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		
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		
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		
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		
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		
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		
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%**	**1.75**	**67.30%**		
7/15/2016	1.34	40.50%	0.75	25.00%	0.25	6.67%	0.5	20.00%	0.55	18.30%	2.25	39.13%	0.00	0.00%	2.30	60.72%	1.88	70.90%		
8/3/2016	2.29	66.44%	1.75	58.33%	0.00	0.00%	1.5	60.00%	1.95	57.04%	3.50	70.00%	0.00	0.00%	3.35	84.81%	2.56	91.18%		
8/25/2016	1.79	56.98%	0.75	33.33%	0.00	0.00%	2	72.73%	1.45	44.02%	2.75	57.89%	0.00	0.00%	2.71	81.40%	2.06	79.95%	1.71	52.94%
10/11/2016	1.19	38.15%	0.50	20.00%	0.00	0.00%	2.25	90.00%	1.15	41.29%	2.50	52.63%	0.00	0.00%	1.85	58.00%	1.00	47.50%	0.96	20.39%

Lake and Pond Solutions Co. (2016)

Generally, SSW seems to inhabit 40 – 70% of the water column from late May to mid-November. It remains at low densities though the winter months and re-growth in the spring starts initially from old growth. This is followed by bulbil sprouting when water temperatures hit 60 degrees F which typically corresponds to the traditional biomass explosion of SSW. Peak biomass looks to occur by August and slowly diminishes through the fall.

Public Outreach

Public outreach for the project came in a number of different forms. The first was the installation of a starry stonewort specific sign at the boat launch on August 5th, 2015 (Figure 26). This was followed with the installation of a flyer box filled with maps showing known locations of SSW along with a chain stretched across the launch. Although the Town of Norway refused to close the launch, the chain ensured lake users would read the new sign.

Figure 26: Long Lake Starry Stonewort Boat Launch Sign

Lake and Pond Solutions Co. (2016)

Countless encounters with boaters and lake residents afforded us the opportunity to educate users of the lake about identification and the detriment of SSW. Presentations at annual meetings in 2015 and 2016 were vital in presenting valuable information to the district board and other interested residents.

SUMMARY

The overall plant community on Long Lake remains diverse. A total of 28 species were found and there were nearly three native plant species at each site. Unfortunately, the discovery of starry stonewort (SSW) in 2015 threatens that diversity.

In Long Lake, SSW inhabits 40% - 70% of the water column from late May to mid-November. It does remain at low densities throughout the winter months with regeneration initially occurring from old growth. This is followed by aggressive re-growth from bulbils once temperatures reach the 60 degree F threshold. In-lake spreading is aggressive with multiple new plant beds found in 2016 (including some at the ends of boat lifts). SSW was observed completely overtaking native plan beds, resulting in thick, monotypic stands.

Management, and more specifically eradication, has proven to be a difficult task. Handpulling 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. 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. The majority of the "successful" treatments only dropped SSW heights to 0.25 – 0.75 feet. Komeen Crystals at 0.94 ppm showed reductions in SSW with no native impacts but only 3 weeks of control. Captain XTR at 0.8 ppm with Clipper at 150 ppb and an enzyme showed the longest control (5 weeks). There were native plant impacts with this herbicide/algaecide combination, including decreases in Illinois pondweed, elodea, and white water lily (if product was not injected).

SSW seems to be sustained through bulbil production despite current management efforts. Over the course of this grant, field notes highlighted that bulbils became more numerous and robust later in the growing season. To limit the reoccurrence of SSW, it is crucial to find a way to manage the "bulbil" bank.

Recommendations for 2017 would include an aggressive treatment regime with the two relatively successful treatments (Komeen Crystal and Captain XTR/Clipper). It is imperative that these treatments take place just as growth becomes active and heights are minimal, therefore, general surveys will be necessary. Continued treatments every 2 – 4 weeks will keep growth minimized thus reducing bulbil production. A pre and post season bulbil count could help confirm this concept. Since in-lake transport 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".