Starry Stonewort in Lake Koronis, July 19, 2016

Lake Koronis Starry Stonewort Management Project, 2016

Starry Stonewort Surveys Conducted on:
July 19, 26, September 13, October 7 and 28, 2016

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Lake Koronis Starry Stonewort Management Project, 2016

Summary

Starry stonewort (SSW) is an invasive type of macro-algae that is in the same family as the native macro-algae, chara. Starry stonewort was first observed in Minnesota in 2015 in Lake Koronis. In 2016, the Lake Koronis Association spearheaded a starry stonewort control program.

Two types of control approaches were conducted in a delineated treatment area in Lake Koronis that totaled 6.6 acres. In the first approach, 2 algaecide treatments occurred within a month and in the second approach an area was mechanically harvested and then 2 algaecide treatments were applied. Results of the impact on SSW were evaluated using 3 types of abundance measurements: a density rating (MnDNR scale of 1 to 4), the SSW biomass (dry weight), and thickness of the starry stonewort mat.

Mechanical harvesting/pulling of SSW resulted in a reduction in biomass of 69%, whereas the biomass in an adjacent unharvested area increased 75% and the biomass in a reference area increased 25%.

Next, Cutrine Plus (liquid) was applied to both an area that was harvested and an unharvested area. After the first algaecide treatment in an area that was previously harvested, SSW biomass was reduced by 99% compared to the pre-treatment biomass. In the adjacent area, which was not previously harvested, the algaecide treatment also resulted in a 99% decrease in biomass as well. In the untreated reference area, SSW biomass decreased by 45%. After the second algaecide treatment using Cutrine Plus (granular), the SSW biomass in the treatment areas remained at 99% decrease compared to the pre-treatment biomass. The biomass in the untreated reference area declined by 78%. The SSW density and bed depth followed the same patterns.

Mechanical harvesting, or the use of algaecides, or combining the 2 methods all controlled SSW. Mechanical harvesting/pulling in the treatment area was able to reduce SSW to below nuisance levels and the first application of the copper produce (Cutrine Plus - liquid) also reduced SSW to below nuisance conditions. The combination of mechanical harvesting combined with the copper-based treatment also reduced SSW below nuisance levels.

The long-term SSW control by mechanical harvesting, the use of algaecides, or a combination of the 2 is currently under study in Lake Koronis.

Planning for the day of sampling on Lake Koronis. Lake Koronis volunteers assisted in all phases.

Lake Koronis Starry Stonewort Management Project, 2016

Introduction

Starry stonewort (SSW) is an invasive type of algae, referred to as a macro-algae that is in the same family as chara, which is a native macro-algae. SSW was first observed in Minnesota in 2015 in Lake Koronis. In 2016, the Lake Koronis Association spearheaded a SSW control program.

Two types of control approaches were conducted in a delineated treatment area that totaled 6.6 acres. In one trial, 2 algaecide treatments occurred within a month and in another trial an area was mechanically harvested and then 2 algaecide treatments were applied. Results were evaluated using 3 types of abundance measurements: a density rating (MnDNR scale of 1 to 4), the SSW biomass (dry weight), and thickness of the starry stonewort mat.

Methods

Lake Koronis SSW density and dry weights were collected to evaluate the impacts of harvesting and copper algaecide applications in 2016. Initially, 5 areas were surveyed for SSW distribution and abundance (Figure 1) and the middle and mideast sites were selected as treatment and reference areas. A buoyed channel was installed to direct boats through the SSW beds and was surveyed on 3 dates (Figure 2).

Figure 1. Locations of study areas in the 2016 Lake Koronis starry stonewort project.

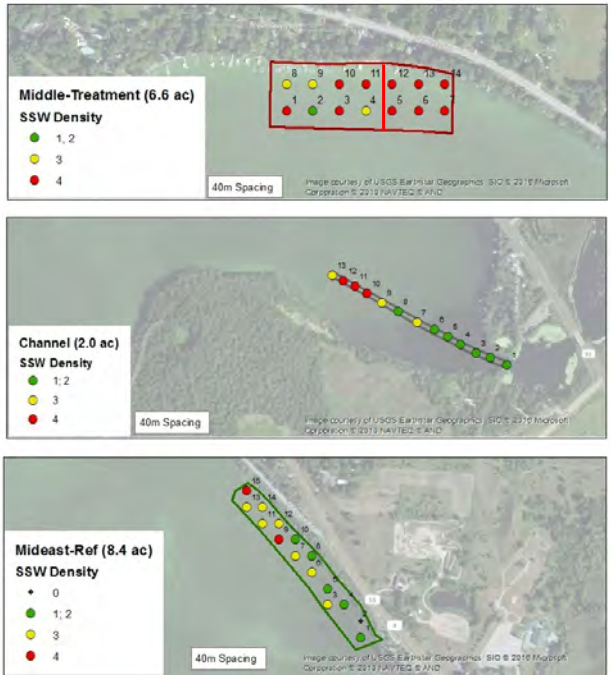

Figure 2. Locations of sample sites within treatment, channel, and reference areas. Spacing between sample sites was 40 m.

Methods - continued

Harvesting: A mechanical harvester/puller (Figure 3) that collected plants worked in the buoyed channel on August 10. The mechanical harvester/puller started in the treatment area (shown in Figures 1 and 2) on August 11 and worked on and off until September 9, 2016. The harvester/puller covered about 57% of the 6.6 acre treatment area or approximately 3.8 acres. Within the treatment area, points 5, 6, 7, 12, 13, and 14 were not harvested (Figure 2). Dockside, the contractor, estimated they removed 250,000 pounds (wet weight) of plant material from the 3.8 acres.

Figure 3. The eco-harvester used by Dockside to harvest/pull starry stonewort in Lake Koronis in 2016.

Algaecide Applications: Two algaecide treatments were applied to the entire 6.6 acre treatment area including the 3.8 acres that were previously harvested (Figure 2). The first treatment was on September 21, 2016 and consisted of Cutrine Plus (9% copper and 0.909 lbs-copper/gal) at 2.77 gallons/ac-ft (95 gallons applied to 6.6 acres at an average depth of 5 feet). The approximate water column copper concentration was 0.9 ppm. The second application was on October 11, 2016 and Cutrine Plus Granular (3.7% copper) was applied at 90.91 pounds per acre (600 pounds applied to 6.6 acres with an average depth of 5.19 feet). The approximate water column copper concentration was 0.25 ppm.

Methods - concluded

Density and Dry Weight Determinations: For all 4 SSW surveys, at 14 sites in the treatment area (6.6 ac) and at 15 sites in the reference area (8.4 ac) density and biomass were determined. In the 2.0 acre channel area, 3 surveys were conducted. Sample points were established in a grid pattern with 40 m spacing between points using GIS software (Figure 2). For density determinations, a rakehead with 14 tines and a width of 33 cm attached to a telescoping pole sampled SSW with a short sweep (approximately a 33 cm). SSW densities were estimated on a scale from 1 to 4 with 4 being the densest (MnDNR website). SSW biomass was determined using the approach of Johnson and Newman (2011) but using another rakehead with 7 tines and was 15 cm wide instead of a 14-tine, 33 cm wide rake. The rakehead was attached to a telescoping pole. The rakehead was lowered to the lake sediment and rotated 3 times and then slowly brought straight up to the surface. Biomass samples were dried at room temperature in front of a fan and weighed to the nearest 0.1 gram.

SSW Bulbil Collection: In the course of sampling for SSW biomass using the 15-cm rakehead, it was noticed that bulbils associated primarily with rhizoids were also being sampled. Bulbils from all biomass samples were also counted after SSW was dried.

Figure 4. Rake samplers: the rakehead on the left has 14 tines and 33 cm wide and was used for density determinations. The rakehead on the right has 7 tines and is 15 cm wide and was used for biomass sampling.

Figure 5. Modified Madsen biomass sampler (Madsen et al 2007) is shown on the left. It was modified by adding a bottom cap that would snap into place when a release mechanism was triggered by a weighted messenger, similar to a vertical VanDorn water sampler. On the right, is a rake sampler with an attached sleeve to contain the plant biomass sample within the cylinder made by a rotating rakehead. Both samplers were tested on Lake Koronis, but neither sampler was effective for sampling starry stonewort biomass and they were not used in this study.

Results

Pre-Treatment and Post Treatment SSW Surveys

Within the 6.6 acre treatment area, SSW was controlled below nuisance levels (nuisance levels are defined when SSW would cause a navigational hindrance) for mechanical harvesting, algaecides only, and the combination of mechanical harvesting and algaecides using 3 types of abundance criteria (Figure 6 and Table 1).

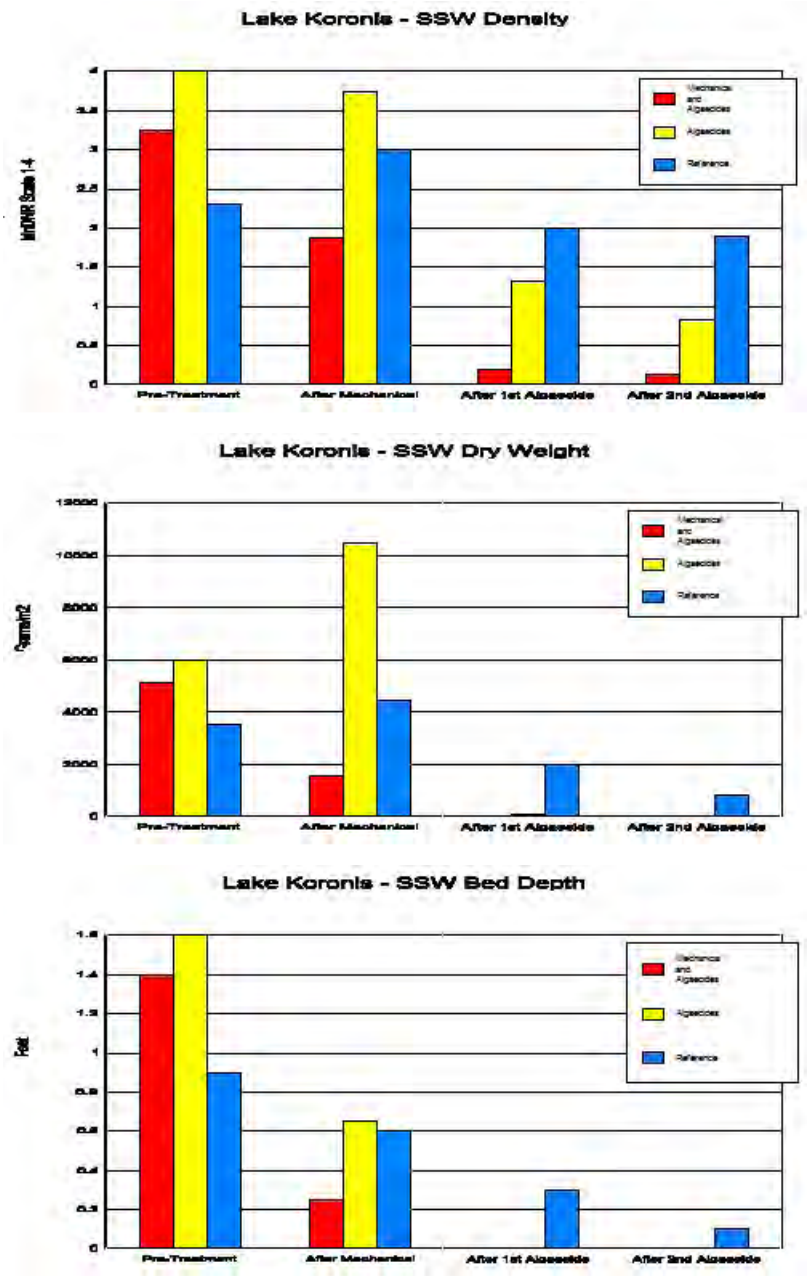

Figure 6. Starry stonewort results for mechanical removal are shown with red bars for the survey conducted after mechanical removal. Results for mechanical removal followed by an algaecide treatment are shown with the red bar after the 1st and 2nd algaecide treatments. Results for just algaecide treatments with no prior harvesting are shown with the yellow bar in the 1st and 2nd algaecide categories.

Table 1. Lake Koronis 2016 starry stonewort densities (using MnDNR criteria), dry weights (g/m^2), and bed depth (ft) for the Treatment Area and Reference Area.

	Treatment Area				Reference Area	
	Mechanical Harvesting and 2 Algaecide Treatments (3.8 acres)		2 Algaecide Treatments (2.8 acres)			
SSW Density (MnDNR scale 1-4)	**Density**	**% Reduction from July 19, 26, 2016**	**Density**	**% Reduction from July 19, 26, 2016**	**Density**	**% Reduction from July 19, 26, 2016**
Pre-Treatment Conditions (July 19 and 26, 2016	3.25	--	4	--	2.3	--
After Mechanical Harvesting/Pulling (Sept 13, 2016)	1.88	- 42%	3.75	- 6%	3.0	+ 30%
After 1st Algaecide Treatment on Sept 21 (Surveyed: Oct 7, 2016)	0.19	- 94%	1.33	- 67%	2	0%
After 2nd Algaecide Treatment on Oct 11 (Surveyed: Oct 28, 2016)	0.13	- 96%	0.83	- 79%	1.9	- 17%
SSW Dry Wt (grams/m^2± stand dev)	**Dry wt (g/m^2)**	**% Reduction from July 19, 26, 2016**	**Dry wt (g/m^2)**	**% Reduction from July 19, 26, 2016**	**Dry wt (g/m^2)**	**% Reduction from July 19, 26, 2016**
Pre-Treatment Conditions (July 19 and 26, 2016	5,159 ± 3,076	--	6,002 ± 3,349	--	3,559 ± 3,554	--
After Mechanical Harvesting/Pulling (Sept 13, 2016)	1,571 ± 2,455	- 69%	10,476 ± 3,770	+ 75%	4,448 ± 4,134	+ 25%
After 1st Algaecide Treatment on Sept 21 (Surveyed: Oct 7, 2016)	2 ± 6	- 99.9%	58 ± 66	- 99.0%	1,957 ± 2,122	- 45%
After 2nd Algaecide Treatment on Oct 11 (Surveyed: Oct 28, 2016)	15 ± 19	- 99.7%	30 ± 24	- 99.5%	792 ± 1,129	- 78%
SSW Bed Depth (feet)	**Bed depth (ft)**	**% Reduction from July 19, 26, 2016**	**Bed depth (ft)**	**% Reduction from July 19, 26, 2016**	**Bed depth (ft)**	**% Reduction from July 19, 26, 2016**
Pre-Treatment Conditions (July 19 and 26, 2016	1.4	--	1.6	--	0.9	--
After Mechanical Harvesting/Pulling (Sept 13, 2016)	0.25	- 82%	0.65	- 59%	0.6	- 33%
After 1st Algaecide Treatment on Sept 21 (Surveyed: Oct 7, 2016)	< 0.1	- 93%	<0.1	- 94%	0.3	- 67%
After 2nd Algaecide Treatment on Oct 11 (Surveyed: Oct 28, 2016)	0	- 100%	0	- 100%	0.1	- 89%

Mechanical harvesting/pulling was conducted in the buoyed channel that guided boats through SSW beds near the public access. No algaecides were applied to the channel in 2016. SSW densities, dry weights, and bed depths decreased compared to pre-harvesting survey on July 19 and 26, 2016 (Table 2).

Table 2. Lake Koronis 2016 starry stonewort densities (using MnDNR criteria), dry weights (g/m^2), and bed depth (ft) for the Channel Area.

	Channel Area (2.0 acres)	
		% Reduction from July 19, 26, 2016
SSW Density (MnDNR rating 1-4)		
July 19 and 26, 2016	2.3	--
Mechanical Harvesting and Pulling Occurred on August 10		
September 13, 2016	1.3	- 43%
October 28, 2016	1.4	- 39%
SSW Dry Weight (g/m^2 ± standard deviation)		
July 19 and 26, 2016	1606 ± 1422	--
Mechanical Harvesting and Pulling Occurred on August 10		
September 13, 2016	437 ± 567	- 73%
October 28, 2016	136 ± 187	- 92%
SSW Bed Depth (feet)		
July 19 and 26, 2016	1.1	--
Mechanical Harvesting and Pulling Occurred on August 10		
September 13, 2016	0.5	- 55%
October 28, 2016	0.04	- 96%

Figure 7. Starry stonewort sampling crew on Lake Koronis, April 26, 2016.

Results

Pre-Treatment Survey July 19 and 26, 2016 (prior to harvesting and algaecide treatments): Starry stonewort densities and biomass had wide variability and some sites had high levels (Figure 8).

Figure 8. Starry stonewort biomass sample (left). Starry stonewort density sample (right).

Post Harvesting Survey September 13, 2016: After mechanical harvesting, SSW biomass and densities were less compared to the pre-harvesting condition.

Figure 9. Starry stonewort biomass sample (left) and a density sample (right).

Results

Survey on October 7, 2016 After 1st Algaecide Treatment on September 21, 2016: Cutrine Plus (a copper based algaecide) was effective in reducing the density of SSW after the first algaecide application (Figure 10).

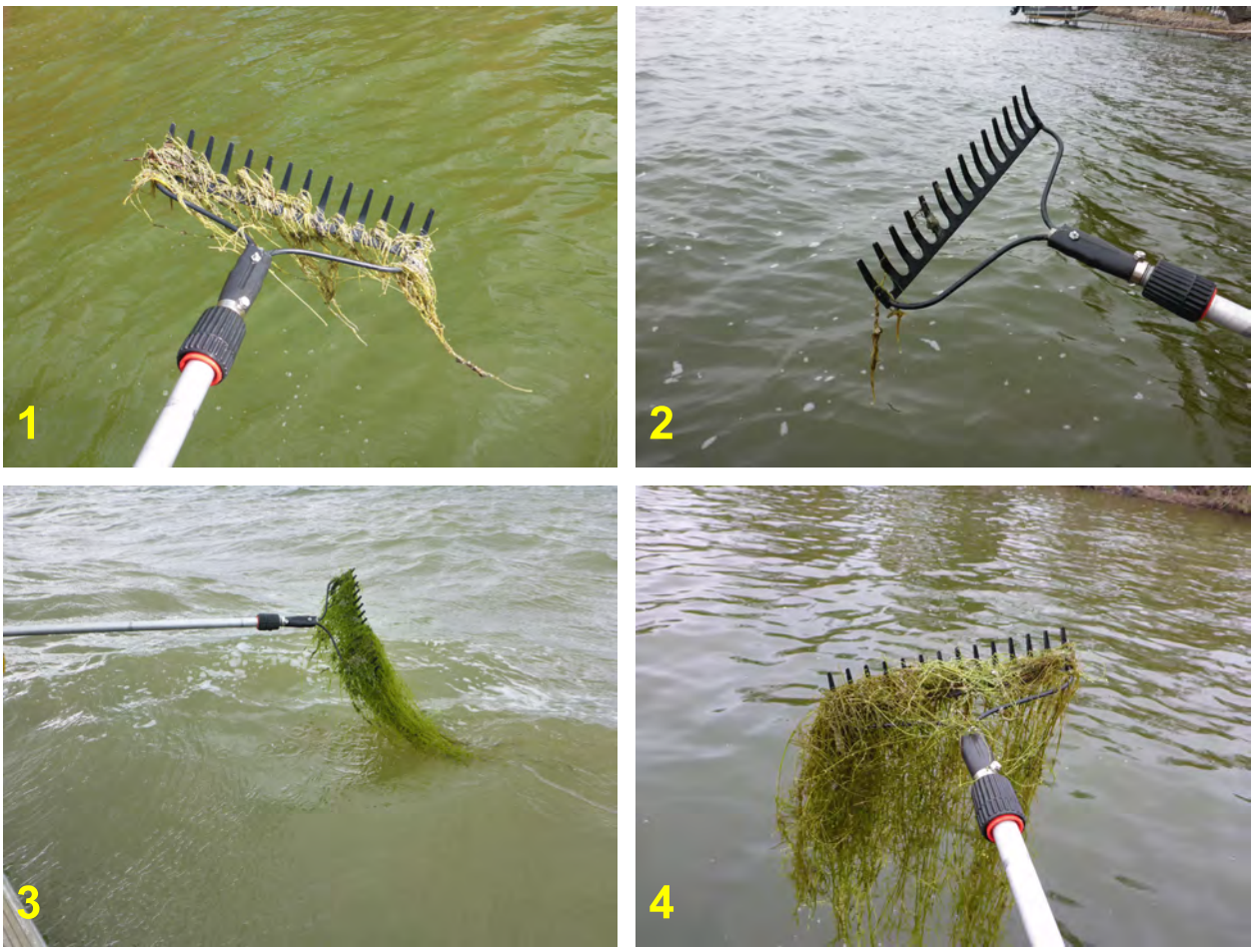

Figure 10. Rake samples from treatment areas are shown in pictures 1 and 2. Rake samples from the reference (untreated) area are shown in pictures 3 and 4.

Results

Survey on October 28, 2015 After 2nd Algaecide Treatment on October 11, 2016: The second copper-based algaecide treatment was sampled on October 28, 2016. The SSW biomass and density were light in the treated area (Figure 11). The SSW density in the reference area was less compared to the July survey but still greater compared to the algaecide treated areas (Figure 13).

Figure 11 . October 28, 2016: Starry stonewort biomass sampler and density sampler in the treated area on the left and SSW density in reference area on the right.

Results

Bulbil Densities: Starry stonewort produces asexual buds called bulbils that grow on colorless rhizoids and can produce new plants. Bulbils are white and star-shaped (Figure 12). Bulbils were collected along with the SSW biomass sample and results are shown in Table 3. The same collection method using the rake was conducted in the treatment and reference areas. More bulbils were found in the treatment area compared to the reference areas. However, the collection method likely does not represent the true status of the benthic bulbil density and more research is needed in this area.

Figure 12. Bulbils October, 28, 2016.

Table 3. White star bulbil densities for two October sample dates. Bulbils are 10 times more abundant in the treatment area compared to the reference area. Collections in both the treatment and reference area used a 6-inch wide rake that was rotated 3 times. The area that was sampled is calculated to be 0.018 m^2. A multiplier of 55.6 produces the number of bulbils/m^2. Therefore in the treatment area we estimate 295 bulbils/m^2 and in the reference area we estimate 26 bulbils/m^2 on October 28, 2016. The locations of the individual sample points are shown in Figure 13. Green shading indicates areas treated with algaecides and no prior mechanical harvesting.

Site	Sampled October 7, 2016 (after 1st Algaecide Treatment)		Sampled October 28, 2016 (after 2nd Algaecide Treatment)	
	Treatment Area (bulbils/0.018 m^2)	Reference Area (bulbils/0.018 m^2	Treatment Area (bulbils/0.018 m^2	Reference Area (bulbils/0.018 m^2
1				
2			4	
3				
4				
8			3	2
9				
10				
11	21		1	3
5			2	
6			22	
7				2
12			23	
13	4		13	
14	5	1	6	
15	--		--	
Ave/site	2.1	0.07	5.3	0.47

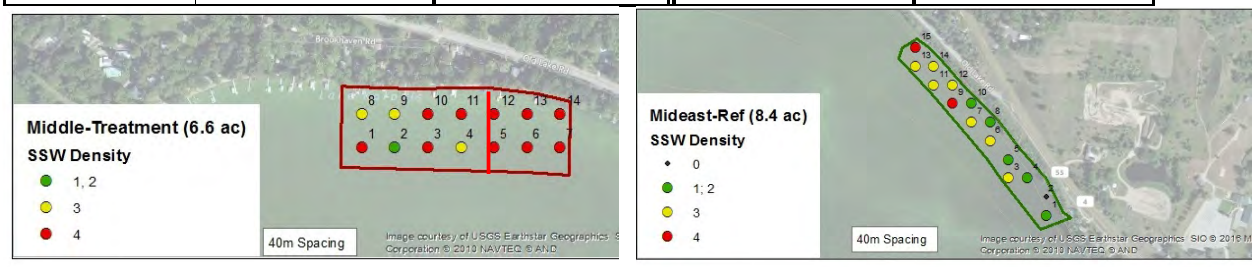

Figure 13. Pre-treatment conditions in the Treatment Areas (left) and in the Reference Area (right).

SSW Observations in Lake Koronis in 2016

Several SSW observations were noted over the project period of July through October:

- All 3 approaches (mechanical harvesting, algaecides, and harvesting plus algaecides) were able to control nuisance SSW growth.
- The 3 measurement methods using the density scale 1-4, biomass as dry weight, and the SSW bed depth were consistent in measuring the abundance of starry stonewort. For example in Figure 6, the relative abundance ranking for harvesting with algaecides, the algaecide only, and the reference area had the same trends for all 3 methods.
- After mechanical harvesting, the survey on September 13 showed SSW biomass was less in the harvested area (red bar) compared to pre-harvesting conditions (Figure 6). In contrast the biomass, measured as dry weight on September 13, in the area where algaecides was not yet been applied and in the reference area increased compared to pre-treatment biomass.
- A single Cutrine Plus (liquid) treatment applied on September 21, 2016 and sampled on October 7 found SSW biomass (measured as dry weight) was significantly reduced. In both treatment areas, harvesting with algaecide, and just the single algaecide application biomass (as dry weight) reductions were 99% or better. Using the MnDNR density scale of 1-4, the mechanical harvesting plus algaecide area had a lower density than just the algaecide treatments but the rake density results indicated there was light SSW growth in both treatment areas (Table 1).
- The second Cutrine Plus (granular) showed SSW biomass (as dry weight) reductions were still greater than 99%, but biomass was already diminished after the first algaecide application.
- Variability within SSW beds was great as shown with the high standard deviations associated with the dry weight results in Table 1.
- High variability was also found over distances just feet apart. Sampling for SSW density using one rake and sampling for biomass using another rake on the other side of the boat, 6 feet apart sometimes found major differences in SSW abundance.
- Sampling for SSW biomass using the rotating rakehead technique was appropriate for Lake Koronis because the same technique was used for all sites in all surveys. However, as the rake sample was taken, surrounding SSW was likely entangled. The SSW biomass samples at sites of heavy growth probably overestimated the actual dry weight biomass within a 0.018 m^2 area that was theoretically sampled with the rake. Biomass as dry weight determined in the Koronis study may not be comparable to SSW biomass determined in other studies where different collection methods were used.
- On the October 28 sample date, bulbil densities were higher in the area that was treated twice with a copper-based algaecide compared to the area that was harvested first and then treated twice with copper. Bulbil densities were also higher in the twice treated area compared to the untreated reference area (Table 3).
- It is unclear why bulbil densities were found in higher densities in the area treated twice with Cutrine. It could be an artifact of sampling or maybe it is related to the greater initial SSW biomass that was treated. It is also possible that the Cutrine Plus treatment enhanced bulbil production. There is some speculation that reduced SSW biomass after a treatment receives more light and light induces bulbil formation. However, after the second Cutrine Plus application the samples collected on October 28 had higher densities in the area treated twice compared to the area that was harvested and then treated twice (Table 3). Sunlight exposure to the reduced SSW biomass was the same in both treatment areas, but there were more bulbils in the area treated twice. The untreated reference area had low bulbil densities.

References

Madsen, J.D., R.M. Wersal, and T.E. Woolf. 2007. A new core sampler for estimating biomass of submersed aquatic macrophytes. J. Aquat. Plant Manage. 45: 31-34.

Johnson, J.A. and R.M. Newman. 2011. A comparison of two methods for sampling biomass of aquatic plants. J. Aquat. Plant Manage. 46: 1-8.

Appendix

Table A. July 19 and 26, 2016 prior to any control activities: The treatment area that had 2 algaecide treatments is shown with shading.

Lake Koronis Area	Site	Water depth (ft)	SSW Depth of bed (ft)	SSW density	SSW lake dry-wt (grams)	Dry weight (g/m^2)	Chara	Chara weight (grams)	Native plant density
Channel ©)	1	9	--	2	trace				Coontail-2
2.0 acres	2	7	--	1	trace				
Treatment	3	6	--	1	0	0			
7/19/2016	4	5	--	1	trace				FA
	5	5	--	1	trace				FA (CT, NWM)
	6	5	--	1	0	0			FA
	7	6	--	3	trace				FA (CT)
	8	6	ND	2	trace				
	9	6	ND	3	5.0	278.0			
	10	7	1	4	50.0	2780.0			
	11	7	1.2	4	70.2	3903.1			
	12	7	1.2	4	39.7	2207.3			
	13	8	1	3	37.3	2073.9			
	Ave (n=13)		1.1	2.3		1606.0			
	Std dev					1422.2			
Middle (M)	1	6	1.5	4	117.1	6512.4			
6.6 acres	2	6	1	1	0.4	23.4	1	114.41	4
Treatment	3	6	2	4	121.9	6777.1			
7/19/2016	4	6	1	3	179.2	9965.7			
	5	6	1.3	4	215.8	11997.9			
	6	6	1.5	4	72.9	4054.9			
	7	6	1.5	4	156.0	8671.4			
	8	5	1	3	82.2	4571.4			
	9	5	1.5	3	15.6	865.7			
	10	5	1.5	4	104.3	5796.3			
	11	5	1.5	4	121.5	6757.1			
	12	5	1.5	4	90.1	5009.6			
	13	5	1.5	4	78.6	4370.2			
	14	5	2	4	34.3	1907.1	1	1.19	1
	Ave (n=14)		1.4	3.5		5520.0			
	Std dev					3222.6			
Mid-East (ME)	1 (32)	6	0	1	9.0	498.7	1	1.79	Stargrass-1
Reference	2 (36)	6	0	0	0	0	1	trace	
7/26/2016	3 (39)	9	1	3	30.5	1697.5			
	4 (40)	7	0.5	2	5.6	308.6	1	0.43	WC-2
	5 (44)	7	0.5	1	0.8	42.8	3	38.88	WC-2
	6 (48)	8	1	3	19.5	1084.8	1	2.39	WC-2
	7 (51)	8	1	3	90.2	5012.9	1	4.41	
	8 (52)	7	--	1	5.2	288.6	3	31.71	WC-2
	9 (55)	7	1.5	4	127.4	7080.7	1	0.62	WC-1
	10 (56)	5	--	1	2.9	162.9	3	54.63	WC-2
	11 (59)	8	1.2	3	161.2	8962.7	2	4.94	
	12 (60)	7	1	3	84.3	4688.2	1	1.89	
	13 (63)	7	1	3	104.5	5807.4			
	14 (64)	6	1	3	191.0	10617.4	1	4.22	
	15 (65)	6	1.5	4	128.3	7132.9			
	Ave (n=15)		0.8	2.2		3559.1			
	Std dev					3553.6			
North (N)	1	9		0	0	0			Coontail-4
5.2 acres	2	18		0	0	0			
7/19/2016	3	34		0	0	0			
	4	34		0	0	0			
	5	20		0	0	0			
	6	8		0	0	0	1	0	4
	7								
	8	8		0	0	0	1		
	9	12					1		4
	10	22		0	0	0			
	11	22		0	0	0			
	12	8	ND	4	145.6	8097.0			
	13	7		1	0.5	25.0			3
	14	10	ND	3	0	0			
	15	9	ND	3	47.5	2641.0			
	Ave (n=15)			0.7		827.9			

Table A. July 19 and 26, 2016 prior to any control activities: The treatment area that had 2 algaecide treatments is shown with shading.

Lake Koronis Area	Site	Water depth (ft)	SSW Depth of bed (ft)	SSW density	SSW lake dry-wt (grams)	Dry weight (g/m^2)	Chara	Chara weight (grams)	Native plant density
	Std dev					2212.3			
South (S)	1	3		0	0	0	2	63.66	2
6.0 acres	2	3		0	0	0	2	10.71	2
7/19/2016	3	7		0	0	0	3	76.95	3
	4	5		0	0	0	2	28.25	2
	5	3		1			2	3.74	2
	6	7		0	0	0	3	78.48	3
	7	7		2	0.13	7.2	2	15.9	2
	8	4		0	0	0	3	48.6	3
	9	8		1-scarce	trace		2	19.82	2
	10	8		2	0.38	21.1	2	44.44	2
	11	6		1	0.83	46.1	2	36.61	2
	12	4		0	0	0	3	90.93	3
?	13	8		0	0	0			Stringy
	14	8		1-scarce	0.39	21.7	3	24.16	3
	15	7		1	0	0	3	101.69	3
	16	4		0	0	0	2	16.37	2
	Ave (n=16)			0.5		6.9			
	Std dev					13.2			
South (S)	7	8		1			2		
Duplicate	7	7		1			2		
samples	7	7		1			2		
7/19/2016	7	8		1			2		
	7	7		0			1		
	7	7		0			1		
	7	7		1			1		

Table B. September 13, 2016 after mechanical control: The treatment area that had 2 algaecide treatments is shown with shading.

Lake Koronis Area	Site	Water depth (ft)	SSW Depth of bed (ft)	SSW density	SSW lake dry-wt (grams)	Dry weight (g/m^2)	Native plant density
Channel	1	7	<0.3	1	4.4	244.64	
9.13.16	2	8	0	0.5	0	0	
	3	6	<0.2	2	2.0	111.2	
	4	5	<0.2	1	0.1	5.56	
	5	4	<0.1	1	0	0	
	6	4	<0.3	2	16.6	922.96	FA=3
	7	4	<0.2	1	16.4	911.8	FA healthy
	8	4	<0.2	1	13.7	761.72	FA present
	9	4	<0.2	0.5	0	0	
	10	5	0.5	1	4.0	222.4	
	11	5	<1.0	1.5	1.0	55.6	
	12	5	<1.0	2.5	7.5	417.0	
	13	6	1	2.5	36.4	2023.8	
	Ave (n=13)		0.3	1.3		436.7	
	Std dev					567.0	
Treatment	1	5	0.2	1	133.1	7400.4	
Middle	2	5	0.4	3	17.5	973.0	
9.13.16	3	5	0.3	3	33.0	1834.8	
	4	5	0.3	2	3.4	189.0	
	5	5	0.3	3	278.4	15479.0	
	6	5	0.5	4	278.6	15490.2	
	7	5	0.5	4	111.0	6171.6	
	8	4	0.2	1	10.6	589.4	
	9	4	0.3	2	0.08	4.4	
	10	4	0.1	1	0.04	2.2	
	11	5	0.2	2			
	12	4	0.5	3.5	188.0	10452.8	
	13	4	1.2	4	129.4	7194.6	
	14	3	1	4	145.1	8067.6	
	Ave (n=14)		0.4	2.6		5680.7	
	Std dev					5432.7	
Reference - R	1	6.5	1	4	84.6	4703.8	
9.13.16	2	5	0.1	1	12.8	711.7	Water celery-2
	3	7	0.8	2	84.5	4698.2	FA-2
	4	6	0.6	3	15.9	884.0	Water celery-1
	5	6	0.4	3	11.2	622.7	Water celery-1
	6	6	0.5	3	61.5	3419.4	
	7	7	1	4	101.2	5626.7	
	8	5	0.8	4	11.1	617.2	Water celery-1
	9	6	0.2	2	60.4	3358.2	
	10	5	0.3	2	27.3	1517.9	
	11	6	0.5	3	7.5	417.0	
	12	5	0.8	4	123.3	6855.5	
	13	6	1	3.5	244.5	13594.2	
	14	5	0.8	4	239.4	13310.6	
	15	5	0.5	3	114.7	6377.3	
	Ave (n=15)		0.6	3.0		4447.6	
	Std dev					4133.5	

Table C. October 7, 2016 after the 1st algaecide treatment: The treatment area that had 2 algaecide treatments is shown with shading.

Lake Koronis Area	Site	Water depth (ft)	SSW Depth of bed (ft)	SSW density	SSW lake dry-wt (grams)	Dry weight (g/m^2)	Bulbils
Treatment	1	7	0	0	0	0	
Middle	2	7	0	0	0	0	
10.7.16	3	7	Trace	0	0	0	
	4	7	0	0	0	0	
	5	6	<0.08	1	3.6	200.2	
	6	6	Trace	0.5	0	0	
	7	6	1	1	1.0	55.6	
	8	6	0	0	0	0	
	9	6	Trace	0.5	0	0	
	10	5	Trace	0.5	0	0	
	11	5	Trace	0.5	0.3	16.7	21
	12	5	0	1.5	0.8	44.5	
	13	5	0.08	2	0.3	16.7	4
	14	5	0.08	2	0.6	33.4	5
	Ave (n=14)		0.2	0.7		26.2	
	Std dev					51.53684	
Reference - R	1	7		1			
10.7.16	2	7		1	8.6	478.2	
	3	8	0.3	3	24.9	1384.4	
	4	8		3	41.7	2318.5	
	5	8	0.3	3	26.8	1490.1	
	6	8	0.3	3	27.5	1529.0	
	7	8	0.3	2	77.3	4297.9	
	8	7	Trace	0.5	0.1	3.9	
	9	8	0.1	2	0.8	44.5	
	10	7	0.3	2	22.1	1228.8	
	11	7	0.1	1	4.4	244.6	
	12	7	0.5	4	8.1	450.4	
	13	7	0.1	1	32.4	1801.4	
	14	7	0.5	4	74.1	4120.0	1
	15	7	0.5	4	144.0	8006.4	
	Ave (n=15)		0.275	2.3		1957.0	
	Std dev					2121.81	

Table D. October 28, 2016 after the 2nd algaecide treatment: The treatment area that had 2 algaecide treatments is shown with shading.

Lake Koronis Area	Site	Water depth (ft)	SSW Depth of bed (ft)	SSW density	SSW lake dry-wt (grams)	Dry weight (g/m^2)	Chara	Native plant density	Bulbils
Channel	1	8	0	3	4.1	222			
10.28.16	2	6	0	1	0.0	0			
	3	5	0	0	0.0	0			
	4	5	0	1.5	2.3	128			
	5	5	0	T	10.7	595			
	6	5	0	0	0.0	0			
	7	6		1	0.1	5.6			
	8	6		1	0.7	38.9			
	9	6		1	0.0	0			
	10	6		1.5	1.1	61.2			
	11	7		1.5	4.5	250			
	12	7	0.3	3	0.2	11.1			
	13	8	0.3	2.5	8.2	456			44-green
	Ave (n=13)		0.08	1.4		136.0			
	Std dev					187.1			
Treatment	1	6	0	T	0.0	0.0			
Middle	2	6	0	T	0.0	0.0			4
10.28.16	3	6	0	T	0.2	11.1			
	4	6	0	T	1.1	61.2			
	5	6	0	1	1.4	77.8			2
	6	6	0	1	0.7	38.9			22
	7	6	0	T	0.1	5.6			
	8	5	0	T	0.3	16.7			3
	9	5	0	1	0.4	22.2			
	10	5	0	0	0.0	0.0			
	11	4	0	T	0.2	11.1			1
	12	4	0	1	0.4	22.2			23
	13	4	0	1	0.3	16.7			13
	14	4	0	1	0.3	16.7			6
	Ave (n=14)		0.0	0.9		21.4			
	Std dev					22.3			
Reference - R	1	5	0.08	1.5	24.5	1362	1		
10.28.16	2	6	0	1	0.0	0			
	3	8	0.2	2.5	46.8	2602			
	4	8	0.2	2	2.7	150			
	5	7	0.08	2.5	0.6	33.4	1		
	6	7	0.2	2.5	17.5	973			
	7	7	0	T	0.1	5.6			2
	8	7	0	1	18.8	1045	2	NWM-1	2
	9	7	0.04	1	9.1	506			
	10	6	0.04	1	9.7	539	1.5		
	11	7	0.04	1	0.1	5.6			3
	12	7	0.04	2	6.7	373			
	13	7	0.3	3	2.5	139			
	14	7	0.3	3	0.3	16.7			
	15	6	0.3	3	74.5	4142			
	Ave (n=15)		0.12	1.9		792.8			
	Std dev					1129.0			