Assessment of Lake Gaston Hydrilla Management Efforts in 2006

A Final Report to the Lake Gaston Weed Control Council

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Introduction

Lake Gaston is a 20,300-acre reservoir on the Roanoke River located on the Virginia-North Carolina border. Hydrilla has spread rapidly in Lake Gaston since its introduction in the early 1980's, with little decline in its spread (Madsen and Owens 2000). Madsen and others (2000) estimated that hydrilla was found in 24% of the lake, or 4,900 acres. If hydrilla colonized a maximum depth of 10 feet, the total potential acreage would have been 5,000 acres. Since 2000, hydrilla has colonized waters as deep as 15 feet, which would include 40% of the lake or a potential total acreage of 8,120 acres.

Regular assessment of management effectiveness is a significant component of successful long-term maintenance management programs. I was asked by the Lake Gaston Weed Control Council (LGWCC) to evaluate the success of fluridone (SONAR®) treatments to control monoecious hydrilla in Lake Gaston during 2006, and compare these treatments to those in 2005. Professional Lake Management of Littleton, NC, was the contractor selected by the LGWCC as the licensed applicator for all fluridone treatments.

I specifically looked for effectiveness of cove treatments in the year of treatment, and attempted to apply simple metrics for evaluation.

Methods

A total of twenty sites were evaluated during 6-8 November 2006 (Figure 1), and are listed in Table 1. Eighteen of the twenty sites were treated in 2006.

Marginal shoreline (Table 2) and submersed plant species (Table 3) were noted for each site. I also noted any evidence of grass carp feeding, which was usually evidenced by golf ball sized pockmarks in the bottom in shallow water (Table 4). A species list with scientific and common names is given in Table 5.

At each site, twenty regularly spaced points were sampled. At each point, one to two rake tosses were performed to check for the presence of submersed species, and each species present was recorded, based on a previously developed method (Madsen 1999). In addition, the depth at each point was recorded. The presence of hydrilla at the surface was recorded at each point. An efficacy or nuisance rating of 1 to 4 was also used at each point, using the following ranking:

Rating	Description
1	Poor control, extensive nuisance problem with hydrilla at the surface
2	Fair control, abundant hydrilla but not to the surface
3	Good control, hydrilla present but sparse
4	Excellent control, only sprigs of hydrilla observed, or no hydrilla

Point observations were averaged for each site, and presented as a mean and standard error for species found, depth, average number of species and native species per point, hydrilla growing to the surface, and treatment ratings (Table 6).

All fluridone-treated sites had treatments computed following a similar protocol, as performed by Professional Lake Management. Initial treatments were made during the week of June 20 to 27, 2006, with four treatments total over four-week intervals. Fluridone treatments were made with a proprietary combination of SONAR SRP, PR and Q formulation, but only the total weight of SONAR is presented (Table 10). No contact treatments were made unless specified in the description below, based on communications from the applicator to me; with the exception that dry hydrants were treated with Komeen.

Finally, the treatments for 2006 will be compared quantitatively to the treatments performed in 2005, using the assessment data collected in 2005 (Madsen 2005).

Comparisons of untreated and treated sites were made using a T-test on the rating, frequency of topped-out hydrilla, frequency of hydrilla occurrence, average number of species per point, and average number of native species per point. Comparisons of treated sites between 2005 and 2006 were performed on the same parameters using a T-test. For all statistical tests, the p=0.05 level was considered a stignificant difference, but all p-values have been reported.

Results and Discussion

Site-by-Site Description. A brief description of each site surveyed in 2006 follows (Table 1).

Great Creek (Site 1, Figure 2). The treatment site was 100 acres (Table 1). Marginal vegetation included water willow, bulrush, burreed, cattail, and southern cutgrass (Table 2). Hydrilla was the only submersed species observed, and was seen at only one point. The treatment resulted in excellent control.

Six Pound Creek (Site 2, Figure 3). The treatment site was 30 acres. Marginal vegetation included waterwillow, bulrush, burreed, cattail, and southern cutgrass. No submersed plants were observed, including a complete absence of hydrilla. The treatment resulted in excellent control.

Jordan Creek (Site 3, Figure 3). The treatment site was 16 acres. No marginal vegetation was observed at this small site. In addition to hydrilla, muskgrass and southern naiad were also observed. The treatment resulted in excellent control.

Big Stonehouse Creek (Site 4, Figure 4). The treatment site was 108 acres. No marginal vegetation was observed at this site, and no submersed species were recorded at the points. The treatment resulted in excellent control.

Little Stonehouse Creek (Site 5, Figure 4). The treatment site was 80 acres. Marginal vegetation observed included waterwillow, bulrush, and cattail. Hydrilla was the only submersed species observed, and this was observed at 32% of the points. The area around the narrows (Figure 4) was treated with Komeen due to high water exchange at this location. Contact herbicide treatments reduced plant abundance, but did not eliminate the growth of the weed. The areas at which less than excellent control was achieved tended to be deeper or otherwise have higher water exchange rates with areas outside the treated shore.

Pretty Creek (Site 6, Figure 5). The treatment site was 60 acres. Waterwillow was observed as marginal vegetation. Hydrilla, muskgrass, and lyngbya were the submersed plants observed. The treatment resulted in excellent control.

Woodlandhurst (Site 7, Figure 6). The treatment site was 18 acres. Marginal vegetation observed was waterwillow. Muskgrass, hydrilla (45%), lyngbya, and southern naiad were observed at the points. Grass carp feeding activity was also observed (Table 4). Spot treatments with Komeen were performed. The fluridone treatment resulted in good control.

Sledge Creek (Site 8, Figure 6). The treatment site was 18 acres. No marginal vegetation was observed. Submersed species observed were muskgrass, hydrilla, and southern naiad. Spot treatments with Komeen were performed. The fluridone treatment resulted in good control.

Hamline Creek (Site 9, Figure 6). This is one of two untreated reference sites. Waterwillow was the only marginal vegetation observed. Aquatic plant species at the points included coontail, hydrilla (85%), waterwillow, and lyngbya. Grass carp feeding was observed at this point. A rating of 2.25 indicates an extensive nuisance problem; and 85% of points had hydrilla present, and 40% of those points with the weed growing to the surface.

Lees Creek (Site 10, Figure 6). The treatment site was 66 acres. Waterwillow was the only marginal species. Vegetation at the points included coontail, muskgrass, hydrilla, and lyngbya. The treatment resulted in excellent control.

Jimmies Creek (Site 11, Figure 6). The treatment site was 100 acres. Marginal vegetation included waterwillow and arrowhead. Plants observed at the points included muskgrass, hydrilla, and lyngbya. The treatment resulted in excellent control.

Pea Hill D (Site 12, Figure 7). The treatment site was 32 acres. Notes on marginal species were not made due to heavy rain. Muskgrass was observed at 56% of points; no hydrilla was observed. The treatment resulted in excellent control.

Pea Hill C (Site 13, Figure 7). The treatment site was 18 acres. Notes on marginal species were not made due to heavy rain. Muskgrass was observed, but no hydrilla. The treatment resulted in excellent control.

Pea Hill A (Site 14, Figure 7). The treatment site was 142 acres. Waterwillow and cattail were observed as marginal plant species. Species at points included watershield, muskgrass, hydrilla, and bladderwort. Some spot treatments with Komeen were made. The fluridone treatment resulted in excellent control.

Pea Hill B (Site 15, Figure 7). The treatment site was 30 acres. Marginal vegetation included watershield, waterwillow, arrowhead, and bulrush. Only muskgrass (45%) was observed at the points. The treatment resulted in excellent control.

Pea Hill E (Site 16, Figure 7). The treatment site was 12 acres. No notes on marginal vegetation were made due to heavy rain. Muskgrass (33%) was observed at the points. The treatment resulted in excellent control.

Lakeview (Site 17, Figure 5). This site is the other untreated reference site. Waterwillow and cattail were observed as marginal vegetation. All points had hydrilla (100%); in addition, waterwillow and lyngbya were observed at the points. Topped-out vegetation was found at 70% of points, and the rating averaged 1.55.

Mill Creek (Site 18, Figure 8). The treated area was 30 acres. No marginal vegetation was observed. Watershield and hydrilla were observed at the points. Grass carp feeding was evident at this site (Table 4). The treatment resulted in excellent control.

Songbird Creek (Site 19, Figure 8). The treated area was 35 acres. Bulrush was observed along the site margins. Watershield, muskgrass, and hydrilla were observed at the points. The treatment resulted in excellent control.

Pigeonroost Creek (Site 20, Figure 8). The treated area was 68 acres. Marginal vegetation included waterwillow, bulrush, burreed, and cattail. Muskgrass and hydrilla were observed at the points. The treatment resulted in excellent control.

Analysis

The efficacy of hydrilla treatments was evaluated using three parameters: the control rating, the frequency of topped-out hydrilla, and the frequency of hydrilla occurrence. In addition, the average number of species and native species per point evaluates the diversity of aquatic plants at each site.

Control Rating (Figure 9). The average rating of the two reference sites was from 1.55 to 2.25, while that of the treated sites ranged from good to excellent (3.4 to 4.0). The rating of the treated sites (3.84) was significantly higher than that of reference sites (1.90), and averaged well into the excellent range (Table 7).

Topped-out hydrilla (Figure 10). Hydrilla causes a nuisance because it can grow to the surface, forming a dense mat. The number of sites with topped-out hydrilla is a measure of this nuisance-forming growth. The untreated sites ranged from 40% to 70% topped out, while all treated sites had less than 5% topped out – and most had no topped-out hydrilla. Treated sites had significantly less topped-out hydrilla than untreated sites (Table 7).

Frequency of Hydrilla (Figure 11). The untreated sites had a range of 85% to 100% hydrilla, but the treated sites ranged from 0% to 45% hydrilla. Most had much less than 10%. The untreated sites averaged 92.5% hydrilla, while treated sites averaged 12.1% points with hydrilla, which was significantly less (Table 7). A single year of treatment is unlikely to completely eradicate hydrilla from a site.

Average Number of Species per Point (see Table 7). The average number of species per point is one measure of species diversity. The untreated sites (1.15) averaged significantly higher than treated sites (0.328), but these averages include the presence of hydrilla (Table 7).

Average Number of Native Species per Point (Figure 12). No discernable pattern is observed for this measure of diversity of native species (rooted plant species other than hydrilla and lyngbya). Untreated sites averaged 0.225 native species per point, while treated sites averaged 0.207. Statistically, there is no difference between these averages (Table 7). The fluridone treatments do not appear to have had any more effect on diversity than the growth of hydrilla.

Comparison to 2005

The ten sites treated with fluridone in 2005 were compared to the eighteen sites treated in 2006. Data were collected on these ten 2005 sites using the same methods as those used in 2006. Information on the 2005 treatments was reported previously (Madsen 2005). In that year, two of the sites (Gaston Heights and Stillhouse Branch) were treated too late for full fluridone effect, so I will make the comparisons first based on all sites, and then without these two sites.

All Sites Comparison (Table 8). The 2005 rating (3.74) was not significantly less than that of 2006 (3.84) if the p=0.05 level is used for the T-test. The frequency of topped-out hydrilla was significantly higher in 2005 (0.113) than in 2006 (0.009). The frequency of hydrilla was likewise significantly higher in 2005 (0.294) than in 2006 (0.121). The average number of native species per point was significantly higher in 2005 (0.387) than in 2006 (0.207).

Effective Sites Comparison (Table 9). In this set of comparisons, the two sites (Gaston Heights and Stillhouse Branch) that were treated later than the other sites were excluded from the comparison. In this analysis, the 2005 average (3.97) was significantly higher than for 2006 (3.84). The frequency of topped-out hydrilla in 2005 (0.006) was not significantly different than for 2006 (0.009). Likewise, the frequency of hydrilla in 2005 (0.136) was not significantly different than for 2006 (0.121). The average number of species per point was significantly higher in 2005 (0.513) than in 2006 (0.328), and the average number of native species in 2005 (0.344) was significantly higher than in 2006 (0.207). While statistically these minor differences can be noted, they are not significant ecologically. Likewise, a given site can vary slightly from one year to the next in terms of the distribution and abundance of plants, without any herbicide treatment. The significant point is that the efficacy of the treatments was comparable both in terms of the efficacy of hydrilla control, and similary in effect on other species.

Herbicide Application Rates (Table 10). Aquatic herbicide applications are very site-specific, and must consider the depth and area to be treated, as well as the water exchange characteristics of the site. In this respect, comparisons of different sites can be misleading. The ten sites treated in 2005 ranged from 6.67 lbs./acre to 37.50 lbs./acre, with an average of 21.49 lbs./acre. These rates are well within the label limits for fluridone. The eighteen sites treated in 2006 ranged from 15.65 lbs./acre to 32.41 lbs./acre, with an average of 20.47 lbs./acre. Given the differences between sites, application rates were comparable. In both years, FasTEST results were used to ensure that adequate fluridone was used to maintain concentration and duration of exposure for effective control.

Conclusions

1. The fluridone treatments in 2006 resulted in good to excellent control of hydrilla, with most sites scoring excellent control. Only 12.1% of points in treated areas had hydrilla, compared to 92.5% of untreated points. Treated areas had less than 1% of the points with topped out hydrilla, while untreated points had 55% of points with topped-out hydrilla.

2. While treated sites had the same average number of native species per point than untreated points, this average was quite low (0.207 to 0.225 per point).

3. While minor differences can be noted between the treatments in 2005 and 2006, treatments both years resulted in excellent control in most sites, which were achieved with comparable amounts of fluridone.

Recommendations

Management

1. Treatments were made in late June, which may allow plants to form tubers or turions before dying. To achieve long-term control, the formation of tubers and turions must be

prevented. Treatments may need to be completed earlier to prevent tuber and turion formation.

2. If hydrilla is regrowing from tubers, treatments may be needed in consecutive years to prevent the rapid reintroduction or reestablishment of hydrilla in these sites. These may be either large-scale fluridone treatments, or spot treatments with contact herbicides.

3. While increased herbicide resistance of hydrilla to fluridone is unlikely to be an immediate concern for Lake Gaston, it will be a long-term concern. As new systemic herbicides are approved for aquatic use, they should be rotated with fluridone for product stewardship.

Programmatic

4. If fluridone treatments are performed earlier in the year, evaluations performed in early fall as opposed to late fall may detect additional species of native plants.

5. If site conditions are appropriate, lakeshore residents should be encouraged to coordinate dock treatments and replace contact herbicide use with systemic herbicide use.

6. In order to perform treatments earlier in the year, contracting should be decided as early as possible to allow for treatments as early as late April or early May.

Research and Monitoring

7. The phenology of monoecious hydrilla in Lake Gaston is poorly understood. The timing of tuber and turion formation and sprouting is not well documented, and should be modeled to better predict when treatments can be made earlier in the year to prevent tuber and turion formation.

8. Monitoring of tuber and turion banks will provide a better understanding of how many consecutive treatments or years of control will be required to eliminate the tuber and turion banks.

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Table 1. Sites evaluated in the 2006 assessment.

Site Name	Site Number	Treatment	Acres Treated
Great Creek	1	Fluridone	100
Six Pound	2	Fluridone	30
Jordan	3	Fluridone	16
Big Stonehouse	4	Fluridone	108
Little Stonehouse	5	Fluridone	80
Pretty Creek	6	Fluridone	60
Woodlandhurst	7	Fluridone	40
Sledge	8	Fluridone	18
Hamline Creek	9	Untreated	0
Lees Creek	10	Fluridone	66
Jimmies Creek	11	Fluridone	100
Pea Hill D	12	Fluridone	32
Pea Hill C	13	Fluridone	18
Pea Hill A	14	Fluridone	142
Pea Hill B	15	Fluridone	30
Pea Hill E	16	Fluridone	12
Lakeview	17	Untreated	0
Mill Creek	18	Fluridone	30
Songbird Creek	19	Fluridone	35
Pigeonroost Creek	20	Fluridone	68
TOTAL			985

Table 2. Marginal vegetation observed at Lake Gaston survey sites. Notes on marginal species were not taken at locations with the notation of "RAIN." At these sites, heavy rain was encountered, so field observation notes were not taken.

Site Name	Site Number	*Justicia americana*	*Sagittaria americana*	*Scirpus* sp.	*Sparganium* sp.	*Typha latifolia*	*Zizaniopsis miliacea*
Great Creek	1	X		X	X	X	X
Six Pound	2	X		X	X		X
Jordan	3						
Big Stonehouse	4						
Little Stonehouse	5	X		X		X	
Pretty Creek	6	X					
Woodlandhurst	7	X					
Sledge	8						
Hamline Creek	9	X					
Lees Creek	10	X					
Jimmies Creek	11	X	X				
Pea Hill D	12	RAIN					
Pea Hill C	13	RAIN					
Pea Hill A	14	X				X	
Pea Hill B	15	X	X	X			
Pea Hill E	16	RAIN					
Lakeview	17	X				X	
Mill Creek	18						
Songbird Creek	19			X			
Pigeonroost Creek	20	X		X	X	X	

Table 3. Species observed at points in the survey sites. Number represents the proportion of points (between 0 to 1) at which these species were observed. Multiply the number by 100 to get a percentage.

Site Name	Site Number	*Brasenia schreberi*	*Ceratophyllum demersum*	*Chara sp.*	*Hydrilla verticillata*	*Justicia americana*	*Lyngbya sp.*	*Najas guadalupensis*	*Utricularia vulgaris*
Great Creek	1	0	0	0	0.05	0	0	0	0
Six Pound	2	0	0	0	0	0	0	0	0
Jordan	3	0	0	0.1	0.25	0	0	0.05	0
Big Stonehouse	4	0	0	0	0	0	0	0	0
Little Stonehouse	5	0	0	0	0.316	0	0	0	0
Pretty Creek	6	0	0	0.05	0.05	0	0.15	0	0
Woodlandhurst	7	0	0	0.2	0.45	0	0.05	0.05	0
Sledge	8	0	0	0.1	0.25	0	0	0.05	0
Hamline Creek (Untreated)	9	0	0.05	0	0.85	0.05	0.1	0	0
Lees Creek	10	0	0.05	0.1	0.2	0	0.15	0	0
Jimmies Creek	11	0	0	0.15	0.15	0	0.1	0	0
Pea Hill D	12	0	0	0.556	0	0	0	0	0
Pea Hill C	13	0	0	0.125	0	0	0	0	0
Pea Hill A	14	0.1	0	0.25	0.05	0	0	0	0.05
Pea Hill B	15	0	0	0.45	0	0	0	0	0
Pea Hill E	16	0	0	0.333	0	0	0	0	0
Lakeview (Untreated)	17	0	0	0	1	0.2	0.05	0	0
Mill Creek	18	0.1	0	0	0.1	0	0	0	0
Songbird Creek	19	0.05	0	0.2	0.15	0	0	0	0
Pigeonroost Creek	20	0	0	0.2	0.1	0	0	0	0

Table 4. Sites with evidence of grass carp feeding.

Site Name	Site Number	Evidence of Grass Carp Feeding
Great Creek	1	
Six Pound	2	
Jordan	3	
Big Stonehouse	4	
Little Stonehouse	5	
Pretty Creek	6	
Woodlandhurst	7	X
Sledge	8	
Hamline Creek	9	X
Lees Creek	10	
Jimmies Creek	11	
Pea Hill D	12	
Pea Hill C	13	
Pea Hill A	14	
Pea Hill B	15	
Pea Hill E	16	
Lakeview	17	
Mill Creek	18	X
Songbird Creek	19	
Pigeonroost Creek	20	

Table 5. List of scientific and common names of aquatic plants observed in this study.

Scientific Name	**Common Name**	**Form**
Brasenia schreberi	Water shield	Floating
Ceratophyllum demersum	Coontail	Submersed
Chara sp.	Muskgrass	Submersed (macroalgae)
Hydrilla verticillata	Hydrilla	Submersed
Justicia americana	Water willow	Emergent
Lyngbya sp.	Lyngbya	Filamentous algae
Najas guadalupensis	Southern naiad	Submersed
Sagittaria americana	Arrowhead	Emergent
Scirpus sp.	Bulrush	Emergent
Sparganium sp.	Burreed	Emergent
Typha latifolia	Cattail	Emergent
Utricularia vulgaris	Bladderwort	Submersed
Zizaniopsis miliacea	Southern cutgrass	Emergent

Table 6. Summary of point observations for sites surveyed in 2006. The control rating, frequency of topped-out hydrilla, average number of species per point, and average number of native species per point are computed. For each variable, the mean and SE (standard error of the mean) are presented.

		Rating		Topped-Out Hydrilla		Hydrilla		Avg Num of Spp per Point		Avg Num of Native Spp per Point	
Site Name	Site Num	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Great Creek	1	3.950	0.050	0.000	0.000	0.050	0.050	0.050	0.050	0.000	0.000
Six Pound	2	3.900	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jordan	3	3.650	0.167	0.050	0.050	0.250	0.099	0.400	0.152	0.150	0.082
Big Stonehouse	4	4.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Little Stonehouse	5	3.632	0.137	0.000	0.000	0.316	0.110	0.316	0.110	0.000	0.000
Pretty Creek	6	3.950	0.050	0.000	0.000	0.050	0.050	0.250	0.123	0.200	0.117
Woodlandhurst	7	3.450	0.154	0.050	0.050	0.450	0.114	0.750	0.143	0.300	0.105
Sledge	8	3.650	0.167	0.050	0.050	0.250	0.099	0.400	0.152	0.150	0.082
Hamline Creek (Untreated)	9	2.250	0.260	0.400	0.112	0.850	0.082	1.050	0.114	0.200	0.092
Lees Creek	10	3.800	0.092	0.000	0.000	0.200	0.092	0.500	0.115	0.300	0.105
Jimmies Creek	11	3.850	0.082	0.000	0.000	0.150	0.082	0.400	0.152	0.250	0.099
Pea Hill D	12	4.000	0.000	0.000	0.000	0.000	0.000	0.556	0.121	0.556	0.121
Pea Hill C	13	4.000	0.000	0.000	0.000	0.000	0.000	0.125	0.085	0.125	0.085
Pea Hill A	14	3.900	0.100	0.000	0.000	0.050	0.050	0.450	0.170	0.400	0.169
Pea Hill B	15	4.000	0.000	0.000	0.000	0.000	0.000	0.450	0.114	0.450	0.114
Pea Hill E	16	4.000	0.000	0.000	0.000	0.000	0.000	0.333	0.126	0.333	0.126
Lakeview (Untreated)	17	1.550	0.185	0.700	0.105	1.000	0.000	1.250	0.123	0.250	0.123
Mill Creek	18	3.900	0.069	0.000	0.000	0.100	0.069	0.200	0.092	0.100	0.069
Songbird Creek	19	3.850	0.082	0.000	0.000	0.150	0.082	0.400	0.112	0.250	0.099
Pigeonroost Creek	20	3.800	0.138	0.000	0.000	0.100	0.069	0.300	0.105	0.200	0.092

Table 7. Comparison of untreated (0) and treated (1) sites, for average rating, frequency of topped-out hydrilla, frequency of hydrilla, average number of species per point, and average number of native species per point, for sites surveyed in 2006. For each variable, the mean and SE (standard error of the mean) are presented. A p-value of less thn 0.05 is typically considered statistically significant.

Parameter	Untreated (N=40)		Treated (N=348)		p-value
	Mean	S.E.	Mean	S.E.	
Rating	1.90	0.167	3.84	0.024	0.0001
Topped-Out Hydrilla Frequency	0.55	0.08	0.0008	0.005	0.0001
Hydrilla Frequency	0.925	0.042	0.121	0.029	0.0001
Average number of species per point	1.15	0.084	0.328	0.026	0.0001
Average number of native species per point	0.225	0.076	0.207	0.023	0.82

Table 8. Comparison of sites treated in 2005 versus those treated in 2006, for average rating, frequency of topped-out hydrilla, frequency of hydrilla, average number of species per point, and average number of native species per point. Includes all sites treated in 2005. For each variable, the mean and SE (standard error of the mean) are presented. A p-value of less thn 0.05 is typically considered statistically significant.

Parameter	2005 Sites (N=194)		2006 Sites (N=348)		T-test
	Mean	S.E.	Mean	S.E.	p-value
Rating	3.74	0.048	3.84	0.024	0.0587
Topped-out Hydrilla Frequency	0.113	0.023	0.009	0.005	0.0001
Hydrilla Frequency	0.294	0.033	0.121	0.018	0.0001
Average Number of species per point	0.717	0.057	0.328	0.029	0.0001
Average Number of Native species per point	0.387	0.037	0.207	0.023	0.0001

Table 9. Comparison of sites treated in 2005 versus those treated in 2006, for average rating, frequency of topped-out hydrilla, frequency of hydrilla, average number of species per point, and average number of native species per point. Excludes Gaston Heights and Stillhouse Branch sites that were treated too late in 2005. For each variable, the mean and SE (standard error of the mean) are presented. A p-value of less thn 0.05 is typically considered statistically significant.

Parameter	2005 Sites (N=194)		2006 Sites (N=348)		T-test
	Mean	S.E.	Mean	S.E.	p-value
Rating	3.97	0.023	3.84	0.024	0.003
Topped-out Hydrilla Frequency	0.006	0.006	0.009	0.005	0.795
Hydrilla Frequency	0.136	0.028	0.121	0.018	0.633
Average Number of species per point	0.513	0.056	0.328	0.029	0.0033
Average Number of Native species per point	0.344	0.041	0.207	0.023	0.004

Table 10. Hydrilla fluridone treatments performed in 2005 and 2006 by site, acreage, and total amount of SONAR (all formulations combined).

Site	Acres Treated	SONAR (lbs)	Sonar Rate (lbs/acre)
Treatments in 2005			
Lizard Creek	165	3730	22.61
Dogwood Branch	133	2789	20.97
Speckle Cove	60	1261	21.02
Poe Creek	42	1065	25.36
Lyons Creek	115	2560	22.26
West I85 Beechwood	114	2540	22.28
Northpoint Cove	37	970	26.22
Hawtree Creek	78	520	6.67
Gaston Heights	20	750	37.50
Stillhouse Branch	38	1052	27.68
Sum	802	17237	21.49
Treatments in 2006			
Big Stonehouse	108	1995	18.47
Little Stonehouse Creek	80	2298	28.73
Pretty Creek	60	1348	22.47
Sledge Creek	18	455	25.28
Woodland Hurst	40	1013	25.33
Lees Creek	66	2139	32.41
Jimmies Creek	100	2375	23.75
Pea Hill A	142	2315	16.30
Pea Hill B	30	535	17.83
Pea Hill C	18	320	17.78
Pea Hill D	32	570	17.81
Pea Hill E	12	215	17.92
Jordan Creek	16	301	18.81
Six pound Creek	30	566	18.87
Great Creek	100	1565	15.65
Songbird Creek	35	565	16.14
Pigeonroost	68	1100	16.18
Mill Creek	30	485	16.17
Sum	985	20160	20.47

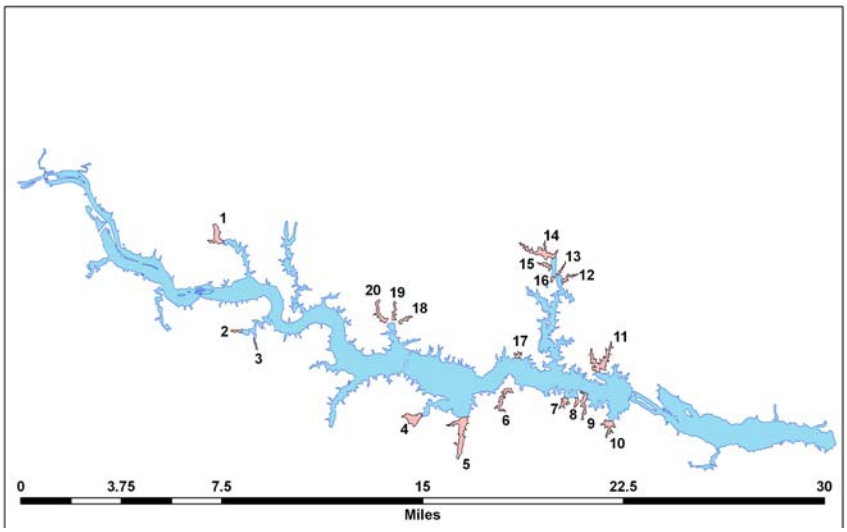

Figure 1. Map of survey sites in Lake Gaston for 2006. Site names are listed in Table 1.

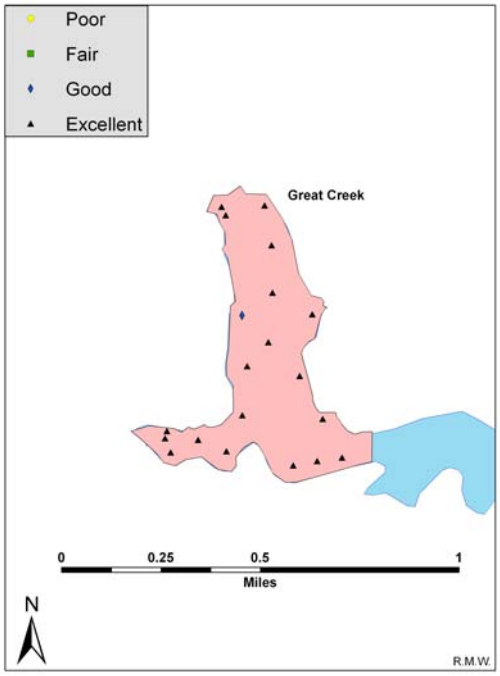

Figure 2. Map of Great Creek sample points. Level of control indicated by the symbol.

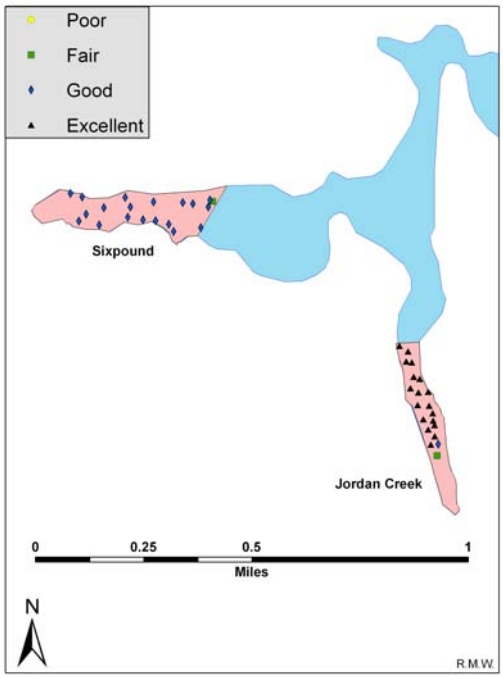

Figure 3. Map of Six Pound and Jordan Creek points. Level of control indicated by the symbol.

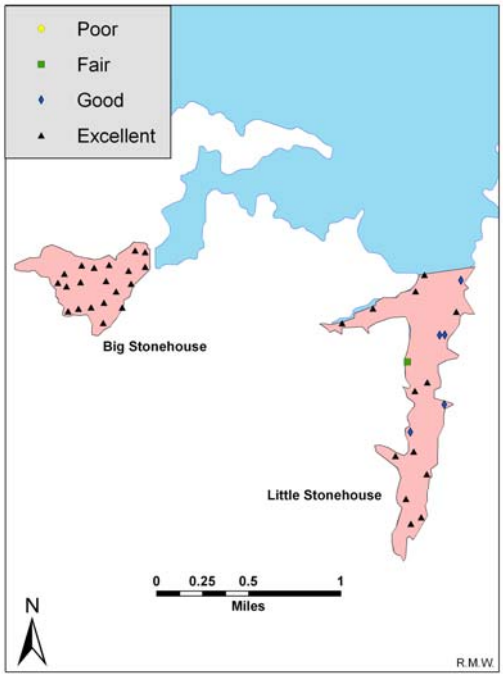

Figure 4. Map of Big Stonehouse and Little Stonehouse Creeks points. Level of control indicated by the symbol.

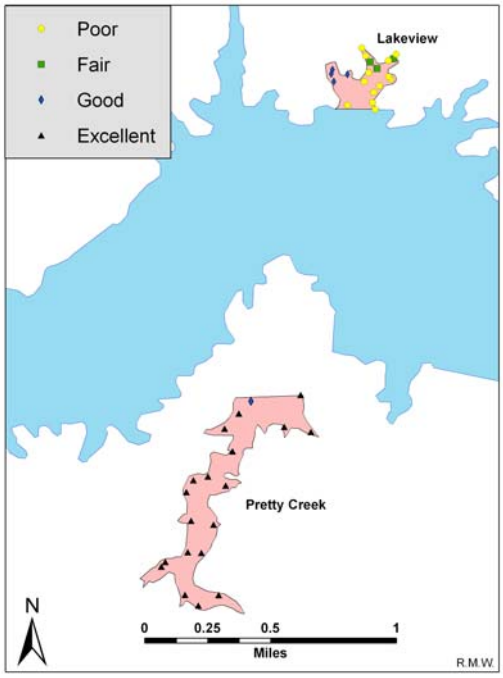

Figure 5. Map of Pretty Creek and Lakeview points. Level of control indicated by the symbol.

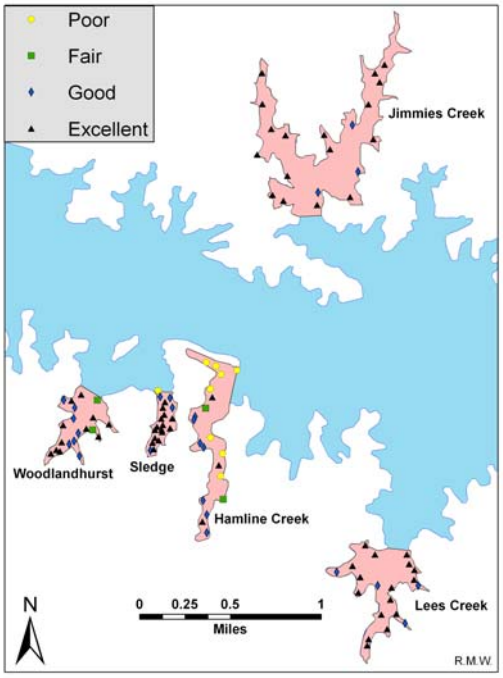

Figure 6. Map of Woodlandhurst, Sledge, Hamline, Lees, and Jimmies Creek points. Level of control indicated by the symbol.

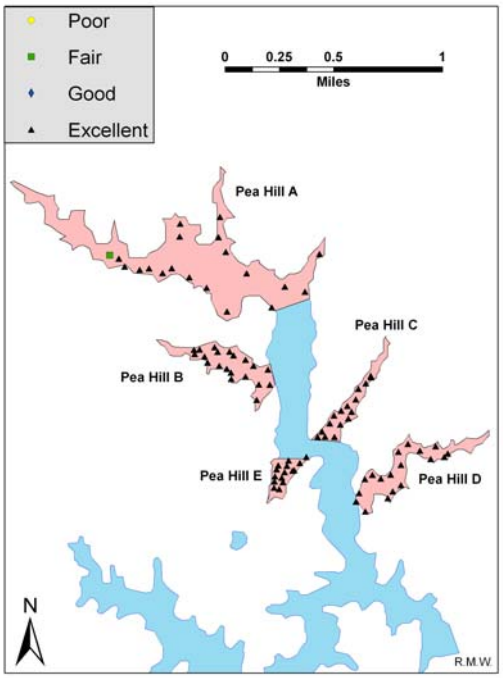

Figure 7. Maps of Pea Hill Cove (A to E) sites points. Level of control indicated by the symbol.

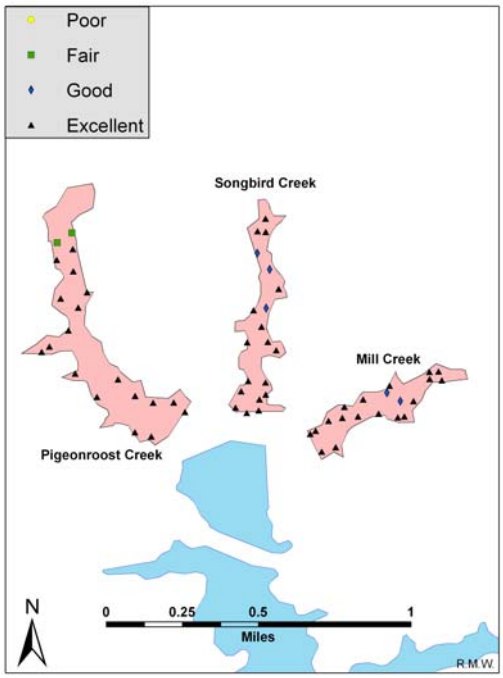

Figure 8. Maps of Pigeonroost, Songbird, and Mill Creek sites. Level of control indicated by the symbol.

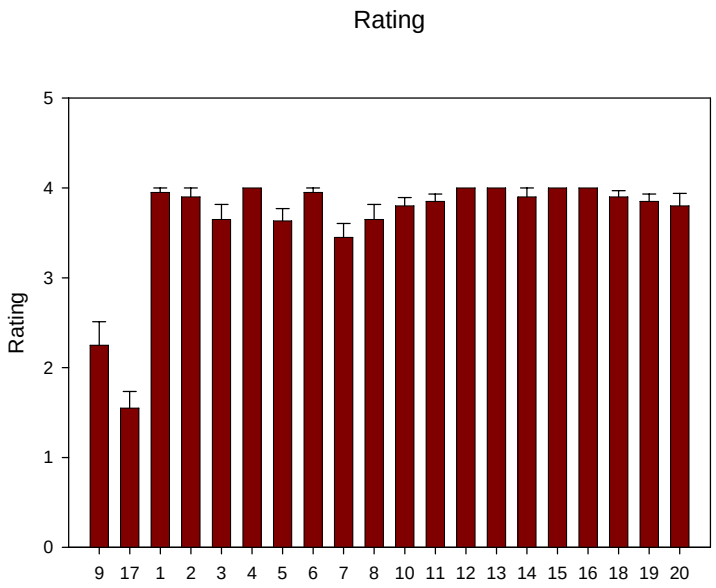

Figure 9. Average rating of twenty points in each of twenty plots, based on a scale described in the methods section. Bar indicates +1 standard error of the mean. Vertical bars without an error bar have a standard error of zero. Sites 9 and 17 are the untreated sites, and have a significantly lower rating than all other sites.

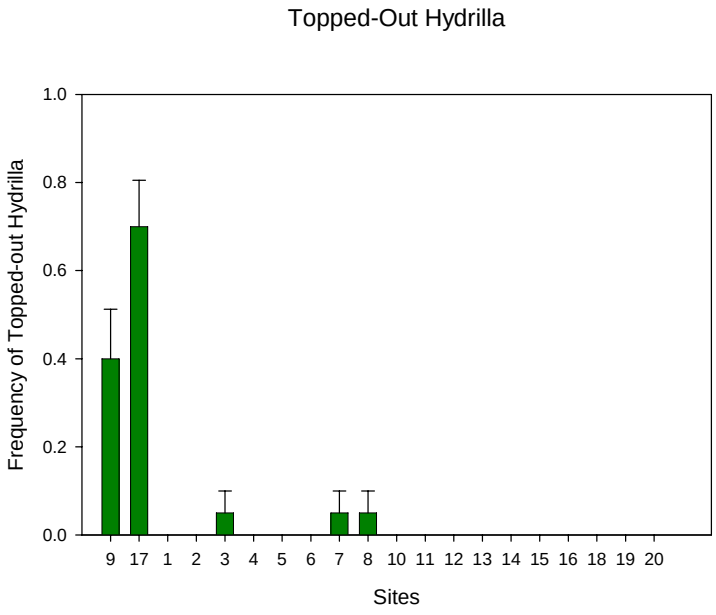

Figure 10. Frequency of topped-out hydrilla at twenty points in each of twenty plots. Bar indicates +1 standard error of the mean. Vertical bars without an error bar have a standard error of zero. Sites 9 and 17 are the untreated sites, and have a significantly higher frequency of topped-out hydrilla than all other sites.

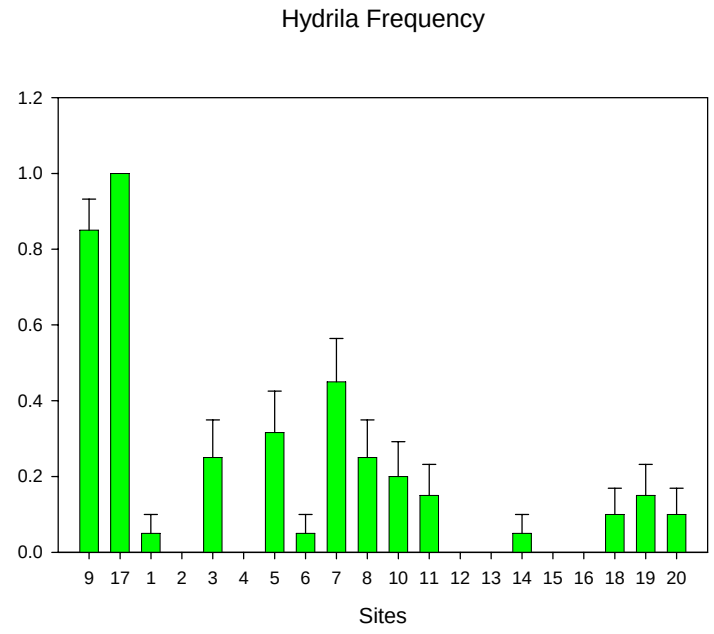

Figure 11. Frequency of hydrilla at twenty points in each of twenty plots. Bar indicates +1 standard error of the mean. Vertical bars without an error bar have a standard error of zero. Sites 9 and 17 are the untreated sites, and have a significantly higher frequency of hydrilla than all other sites.

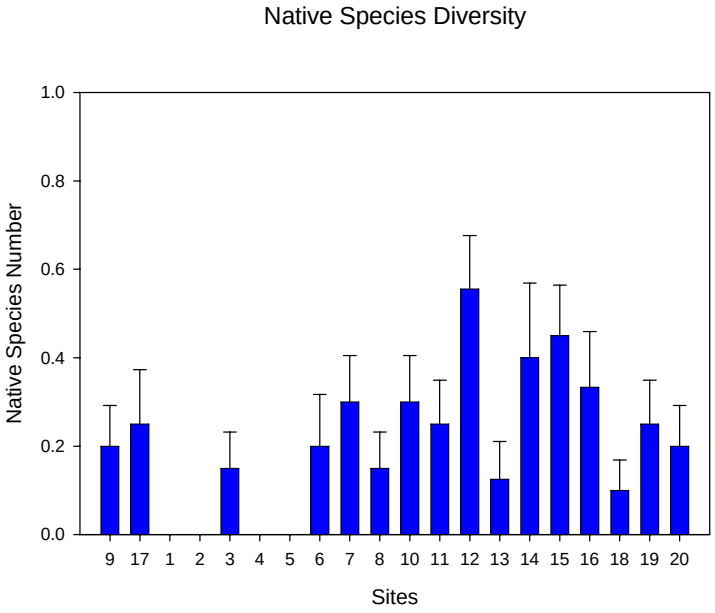

Figure 12. Average number of native species per point at twenty points in each of twenty plots. Bar indicates +1 standard error of the mean. Vertical bars without an error bar have a standard error of zero. Sites 9 and 17 are the untreated sites; which do not have a significantly different number of native species per point than the treated sites.