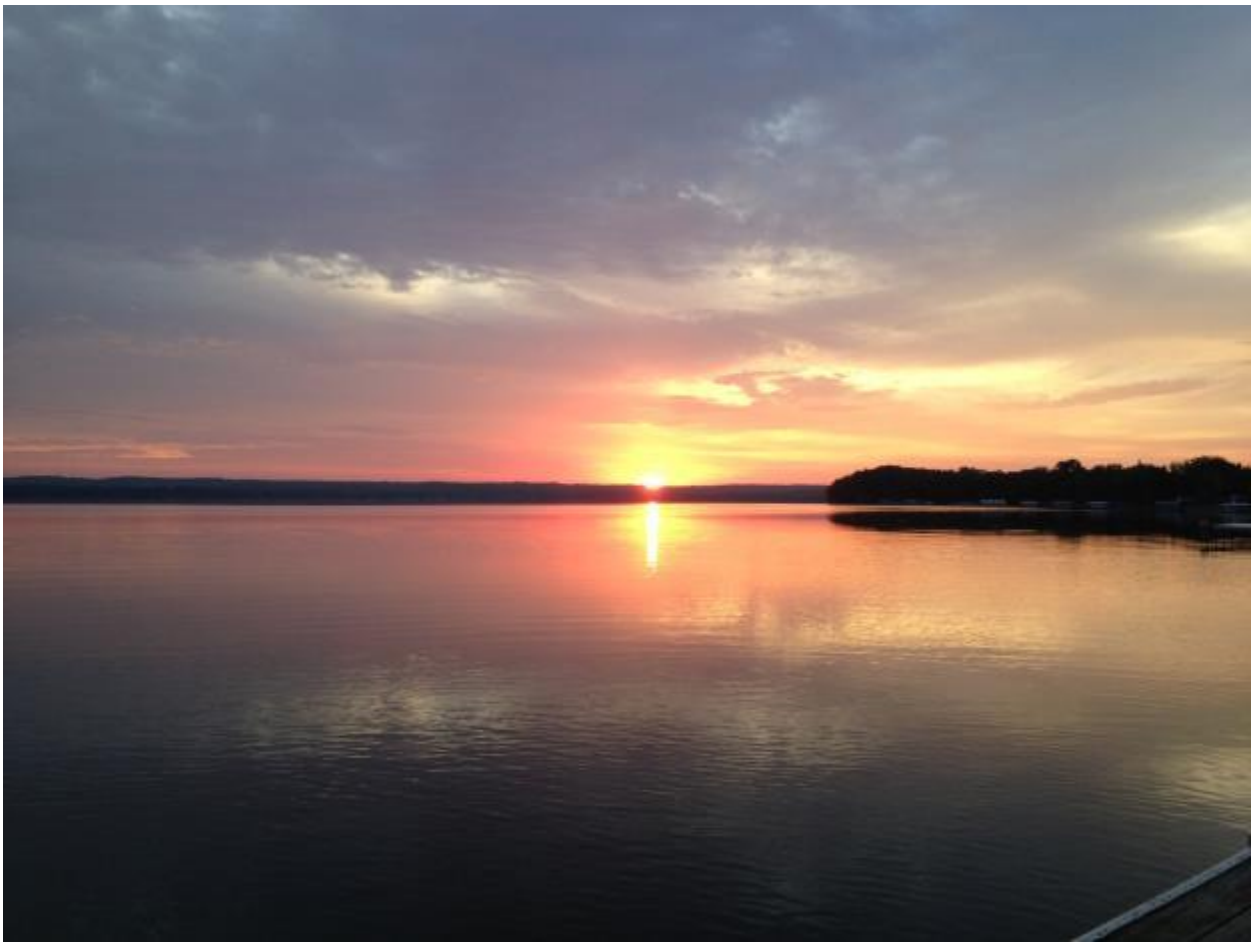
Management of Flowering Rush Using the Contact Herbicide Diquat in Detroit Lakes, Minnesota 2013



A report to the Pelican River Watershed District

John D. Madsen, Gray Turnage and Bradley T. Sartain

Geosystems Research Institute, Mississippi State University, Mississippi State, MS 39762-9627

Geosystems Research Institute Report 5063

May 2014

MISSISSIPPI STATE UNIVERSITY

GRI

Management of Flowering Rush Using the Contact Herbicide Diquat in Detroit Lakes, Minnesota 2013

John D. Madsen, Gray Turnage and Bradley T. Sartain

Geosystems Research Institute, Mississippi State University, Mississippi State, MS 39762-9627

Executive Summary

Conclusions

- Field evaluations of 2013 treatments with the contact herbicide diquat have resulted in a decrease in rhizome bud density of flowering rush.
- Applications of diquat have significantly reduced the nuisance problem and the potential for plants to regrow and spread.
- Diquat treatments do not appear to have a significant effect on species diversity, though some individual species in some plots may have been adversely affected.

Recommendations

- Field evaluations and monitoring of diquat or other herbicides should be continued to determine if reduction in belowground biomass and rhizome bud density is repeatable.
- We recommend that other herbicide active ingredients and use patterns be evaluated under controlled conditions to determine if there are alternatives to diquat treatments, which may be field demonstrated in the future.
- We recommend for ongoing assessment to increase the number of cores taken per plot to thirty to reduce variability, and reduce the number of plots for biomass sampling to six – either four treated and two reference, or three of each; depending on availability of plots.

Cite as:

Madsen, J.D., G. Turnage, and B. T. Sartain. 2014. Management of Flowering Rush Using the Contact Herbicide Diquat in Detroit Lakes, Minnesota 2013. Geosystems Research Institute Report 5063, Geosystems Research Institute, Mississippi State University, Mississippi State, MS. May 2014.

Introduction

Flowering rush (*Butomus umbellatus* L.) is an emergent invasive plant that has invaded the Detroit Lakes area, in particular, Detroit Lake (Big Detroit, Little Detroit, and Curfman Lakes), Lake Sallie, Lake Melissa and Mill Pond (Becker County) since the 1960s. It is native to Europe and Asia and first entered the United States in 1928. Flowering rush has continued to be a problem in the lake for at least three decades.

Although flowering rush has been in North America for over forty years, very little useful information is known about its biology, ecology, and management. Bellaud (2009) reports that it was first observed in North America in St. Lawrence River (Quebec) in 1897. Flowering rush is currently found in all of the southern Canadian provinces except Alberta, and all of the states bordering Canada and the Great Lakes (NRCS 2013). Bellaud (2009) echoes our current state of affairs with flowering rush: "...there is not a wealth of information regarding the management of flowering rush infestations in North America." Bellaud (2009) cites Minnesota Department of Natural Resources research to support the recommendation to use imazapyr on the exposed foliage of flowering rush. Parkinson and others (2010) are also limited in their management recommendations, citing either imazapyr or imazamox foliar applications for management of flowering rush.

The US Army Engineer Research and Development Center (USAERDC) studied the available aquatic herbicides for control of submersed flowering rush plants from Minnesota and Idaho (Poovey et al. 2012). As part of their study, they determined that populations in both Idaho and Minnesota were triploid, as confirmed by ploidy and AFLP (Poovey et al. 2012). Their studies of Minnesota-derived plants used diquat, endothall and flumioxazin at relatively short exposure times. Flumioxazin did not reduce shoot biomass in either treatment. Diquat at the full label rate (0.37 ppm) and at 6 and 12 hours contact time significantly reduced shoot biomass relative to the reference. Endothall treatments at 1.5 and 3 ppm at both 12 and 24 hours exposure time also reduced shoot biomass. No treatments reduced belowground biomass. In contrast, their studies with Idaho-derived plants found flumioxazin at 400ppb and 24 hours exposure time controlled shoot biomass, and endothall at 3 ppm and 24 hour exposure time controlled both aboveground and belowground biomass (Poovey et al. 2012). They also note that repeated treatments with contact herbicides, or integration with systemic herbicides, would be needed to achieve long-term control. However data collected on diquat treatments in the Detroit Lakes in 2012 showed significant reduction in above and belowground biomass as well as rhizome bud density (Madsen et al. 2013). The 2012 diquat protocol was repeated in 2013 on Flowering Rush beds in the Detroit Lakes.

Materials and Methods

Treatments were made to manage flowering rush populations at designated treatment areas (Table 2, Figures 2,3) of submersed or mostly submersed plants with the contact herbicide diquat using drop hoses from a boat, in 4 feet and less of water. From two feet to four feet deep, a rate of two gallons per surface acre were used, and in water depths from shoreline to two feet deep, a rate of one gallon per surface acre were applied; as per the US EPA label (Table 1, 2). The target water column concentration was 0.37 ppm of diquat. Treatments occurred in Big Detroit, Curfman (Figure 2), Sallie (Figure 3), and Melissa Lakes (Figure 3, Tables 1, 2). Diquat formulation used was a 2 lbs. per gallon diquat cation formulation (Tribune, Syngenta Crop Protection, LLC, Greensboro, NC).

Assessment

We assessed the response of flowering rush to herbicide applications using biomass estimates, and assessed the impact of submersed applications on aquatic plant communities using a point intercept method.

Biomass estimates. Assessment of both submersed and emergent treatments in this system were done by sampling biomass collected with a 6" diameter biomass coring device to collect both shoots and rhizomes (Madsen et al. 2007, Figure 4). Twenty cores per plot were collected before each proposed treatment, and at the end of the growing season in September (Table 3). After washing to remove sediment, cores were either shipped to Mississippi State University for processing, or held on ice until returned to campus. Cores were separated into aboveground and belowground biomass. Rhizome buds (Figure 1) were counted, but not separated from the remainder of belowground biomass. Plants were dried for 48 hours at 50C or greater, and weighed for biomass. Successful applications should reduce rhizome weight and rhizome bud number. For the treatments, four treatment plots (Table 3) were sampled for biomass, and three reference plots (Table 3); for a total 140 biomass samples per time. Biomass samples were taken at predetermined points randomly selected from the point intercept points (below) of those plots. For post treatment samples, twenty biomass samples were taken from each plot. Statistical analysis of biomass data was performed using a two-way analysis of variance (ANOVA), with the two factors being treatment (diquat-treated vs. untreated reference) and time of sampling, and the interaction factor being treatment*time. Analysis was done using Statistix (Analytical Software, Tallahassee, FL).

Point Intercept. To assess the community impact of submersed diquat treatments, point intercept sampling (Madsen 1999) was done on all treated plots and reference plots (Table 2). The grid interval was no less than 25 m. There were not an equal number of points per plot. Statistical analysis was performed using a one-way ANOVA, testing for a statistically-significant change in frequency between the three sampling dates. Analysis was done using Statistix (Analytical Software, Tallahassee, FL). Point samples were accidentally omitted for Lake Melissa site 8 (M-

DIQ-8) for the September sampling. Melissa Lake site 6 (M-DIQ-6) was not included in the assessment, as well.

Results and Discussion

Biomass. The measurement of abundance, such as biomass, is the best method to evaluate the effectiveness of control (Madsen 1993, Madsen and Bloomfield 1993). Since the aboveground biomass often causes the nuisance problem, reduction in biomass may measure the reduction in nuisance potential. While reduction of the nuisance potential is important to resource user perception, it is also important to contribute to the long-term management of the invasive plant species. For flowering rush, the two best indicators of reduction in long-term growth potential are rhizome abundance , which may be measured by belowground biomass since rhizomes are the dominant constituent of belowground biomass; and rhizome bud density, since buds appear to be the perennating and regrowth propagule (Marko et al. 2012, Madsen et al. 2012). Rhizomes are the main location to store carbohydrates, essential for overwintering and for regrowth from management. Rhizome buds are the individual growing points from which new ramets or leaves regrow. Reductions in these two constituents indicate long-term control.

Rhizome bud density was significantly reduced in diquat treated plots in 2013, as was observed in 2012 (Figure 5). The two-way ANOVA was significant ($p<0.0001$) for treatment effect. On average, bud density of diquat treated plots was 38% of that in reference plots after two treatments, and 45% less than the diquat treatment plot bud densities before the first treatment.

Biomass plots examined for bud density over time illustrate a general trend for reference site bud density to increase during the growing season, and treatment plot density to decline (Figure 6). The analysis also indicates that several of the plots were treated in 2012 and not continued in 2013.

Point Intercept. While decreasing the nuisance growth and reducing the long-term potential to spread and regrow is important for managing invasive plants, this benefit must be weighed against possible damage to the native plant community. A point intercept study was performed to evaluate the impact on native plant species and the overall community. This sampling did not detect a decrease in the abundance of native plants, but rather if plants survived and continued at the same frequency.

Flowering rush frequency was significantly lower in treated plots than untreated plots by the final assessment in September (Figure 7). In many individual plots, the frequency of flowering rush was dramatically reduced (Tables 7-32). For instance, frequency of flowering rush in CL-DIQ-3 was 66.2% in June, 27.3% after one treatment in July, and 4.8% after two treatments in September (Table 9). In general, diquat treatments resulted in reduced nuisance from flowering rush growth.

Average species richness per point was similar in treated and reference plots in June, but significantly less by July and August (Figure 8). However, a large portion of this reduction is the reduction in flowering rush. As in 2012, we assessed plant frequency for all diquat treated (Table 4) and untreated (Table 5) plots, determining which species had a significant change over time. Diquat-treated plots had one more "increaser" and two more "decreasers" over time than reference plots (Table 6), indicating only minor change in frequency with treatments.

Given that there are 25 individual plots, an analysis of each plot will not be discussed. Readers may examine each plot at their leisure (Tables 7 to 32). One plot, however, is worth more discussion. The "Flats" on Big Detroit Lake is 83 acres (DL-DIQ-8, Table 2) and has been treated for two years. Flowering rush frequency was 36.6% in June. After one treatment, the frequency was 6.9% in July and 4.3% after two treatments, in September (Table 19). The frequency of Chara was over 90% for all three sample times. The frequency of watercelery (*Vallisneria americana*) in July was 50%, and increased to 90.5% in September. Average species richness was 1.68 in June, increasing to 2.05 in July and 2.44 in September. Despite the diquat treatment, the Flats retained a significant coverage of native plants and maintained species diversity.

Diquat treatments do not appear to have a significant effect on species diversity, though some individual species in some plots may have been adversely affected.

Conclusions and Recommendations

Conclusions

- Field evaluations of 2013 treatments with the contact herbicide diquat have resulted in a decrease in rhizome bud density of flowering rush.
- Applications of diquat have significantly reduced the nuisance problem and the potential for plants to regrow and spread.
- Diquat treatments do not appear to have a significant effect on species diversity, though some individual species in some plots may have been adversely affected.

Recommendations

- Field evaluations and monitoring of diquat or other herbicides should be continued to determine if reduction in belowground biomass and rhizome bud density is repeatable.
- We recommend that other herbicide active ingredients and use patterns be evaluated under controlled conditions to determine if there are alternatives to diquat treatments, which may be field demonstrated in the future.
- We recommend for ongoing assessment to increase the number of cores taken per plot to thirty to reduce variability, and reduce the number of plots for biomass sampling to six – either four treated and two reference, or three of each; depending on availability of plots.

Acknowledgements

This research was supported by the Pelican River Watershed District, with additional support from the Minnesota Department of Natural Resources. Professional Lake Management (PLM) performed the herbicide treatments, and provided information on those treatments. Field and laboratory assistance was provided by Christian Carter from Mississippi State University and John Staldine from the Pelican River Watershed.

Literature Cited

Bellaud, M. 2009. Chapter 13.10: Flowering Rush, pp. 141-144. In: Biology and control of aquatic plants: a best management practices handbook (Gettys LA, WT Haller and M Bellaud, eds.). Aquatic Ecosystem Restoration Foundation, Marietta GA. 210 pages.

Madsen, J.D. 1999. Point intercept and line intercept methods for aquatic plant management. US Army Engineer Waterways Experiment Station Aquatic Plant Control Research Program Technical Note CC-02, Vicksburg, MS.

Madsen, J.D. 1993. Biomass techniques for monitoring and assessing control of aquatic vegetation. Lake and Reservoir Management 7:141-154.

Madsen, J.D., B. Sartain, G. Turnage, and M. Marko. 2013. Herbicide Trials for Management of Flowering Rush in Detroit Lakes, Minnesota for 2012. Geosystems Research Institute Report 5059, Geosystems Research Institute, Mississippi State University, Mississippi State, MS. April 2013.

Madsen, J.D., and J.A. Bloomfield. 1993. Aquatic vegetation quantification symposium: An overview. Lake and Reservoir Management 7:137-140.

Madsen, J. D., Wersal, R. M., Marko, M. D., and Skogerboe, J. G. 2012. Ecology and Management of Flowering Rush (*Butomus umbellatus*) in the Detroit Lakes, Minnesota. GRI Report #5054. Mississippi State University: Geosystems Research Institute.

Madsen, J. D., Wersal, R. M., & Woolf, T. E. 2007. A New Core Sampler for Estimating Biomass of Submersed Aquatic Macrophytes. Journal of Aquatic Plant Management. 45, 31-34.

Marko, M., J. Madsen, C. Olsen, and R. Smith. 2012. Ecology of Flowering Rush (*Butomus umbellatus*) in Detroit Lakes, Becker County, Minnesota. Letter report, Concordia College, Moorhead, MN. August 2012.

NRCS 2013. Plants Database, US Department of Agriculture, Natural Resources Conservation Service (NRCS). http://plants.usda.gov. Access March 2013.

Parkinson, H., J. Mangold, V. Dupuis, and P. Rice. 2010. Biology, Ecology, and Management of Flowering Rush (*Butomus umbellatus*). Montana State University Extension, EB0201, December 2010. 7pp.

Poovey, A.G., C.R. Mudge, R.A. Thum, C. James, and K.D. Getsinger. 2012. Evaluations of contact herbicides for controlling two populations of submersed flowering rush. Journal of Aquatic Plant Management 50:48-54.

Figure 1. Rhizome of flowering rush (*Butomus umbellatus*) with two rhizome buds visible. This is the major propagule or growing point of the triploid biotype.

Figure 2. Treatment ("DIQ") and reference ("REF") plots for Detroit Lakes, MN, for 2013. To view treatment plots for 2012, refer to Madsen et al. 2013.

Figure 3. Treatment ("DIQ") and reference ("REF") plots for Lakes Sallie and Melissa, MN, for 2013. To view treatment plots for 2012, refer to Madsen et al. 2013.

Figure 4. The 6” diameter coring device used to collect aboveground and belowground biomass of flowering rush in the Detroit Lakes.

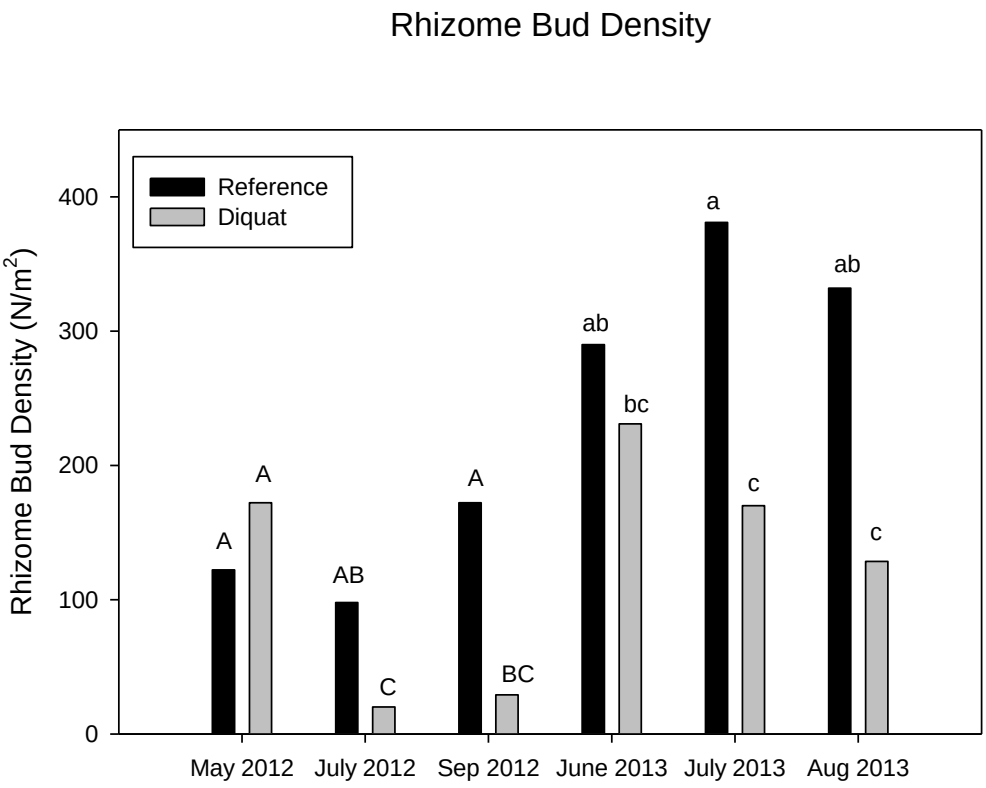


Figure 5. Rhizome bud density (N/m^2) for May, July and September of 2012; and June, July, and August 2013; of reference (untreated) and diquat-treated plots in the Detroit Lake Systems. Means comparison by LSD, p=0.05, comparing means of treatments and months within a year. Therefore, comparisons for 2012 are upper case, and for 2013 are lower case. Plots varied between the two years. Data for 2012 are from Madsen et al. 2013. Diquat plots treated after the June and July sampling.

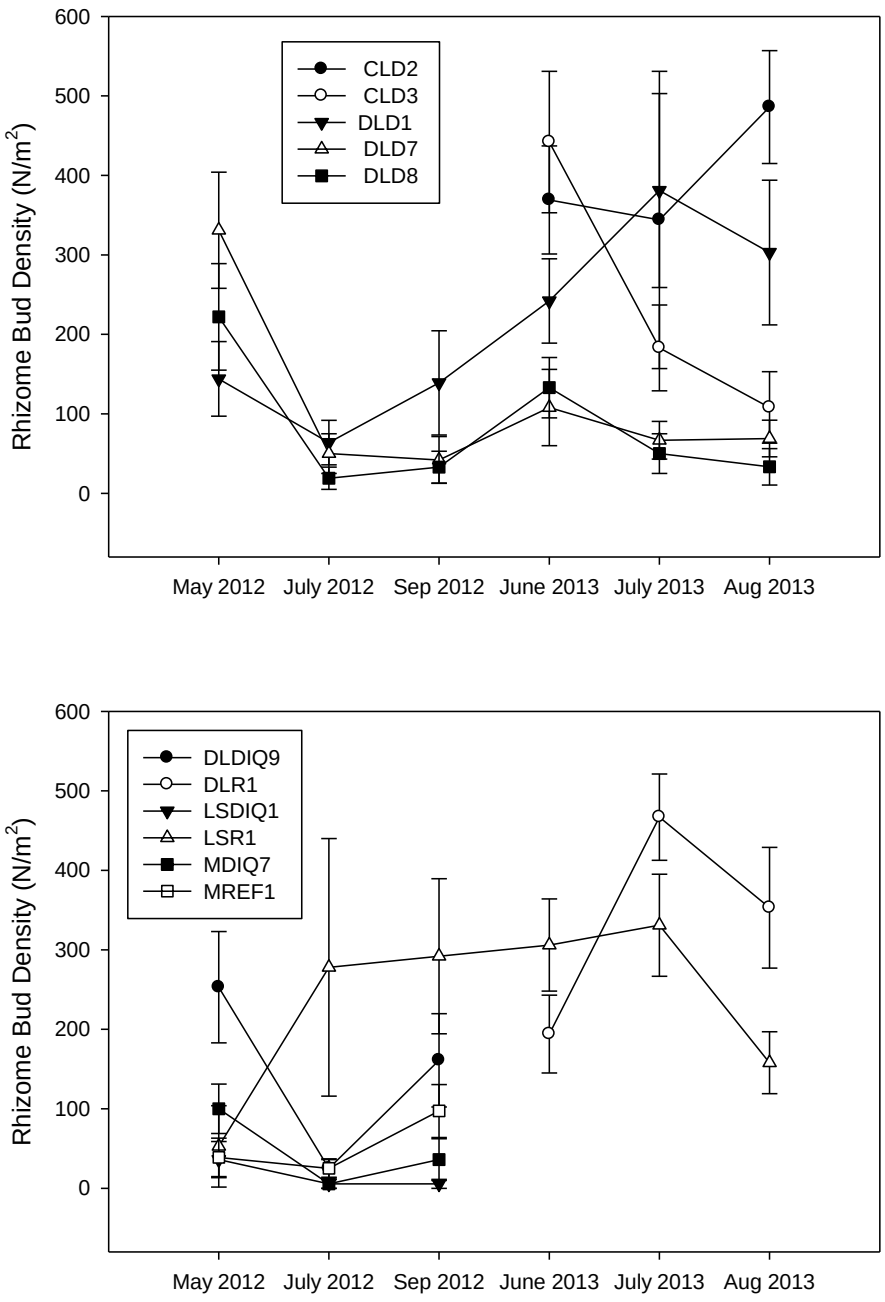


Figure 6. Rhizome bud density (N/m^2) for reference and treatment plots in the Detroit Lakes system from 2012 and 2013. See table 2 for a key to plots and their treatments in respective years. Points are the means for twenty samples per plot per time interval, and the bars indicate one standard error of the mean. Diquat plots treated after the June and July sampling.

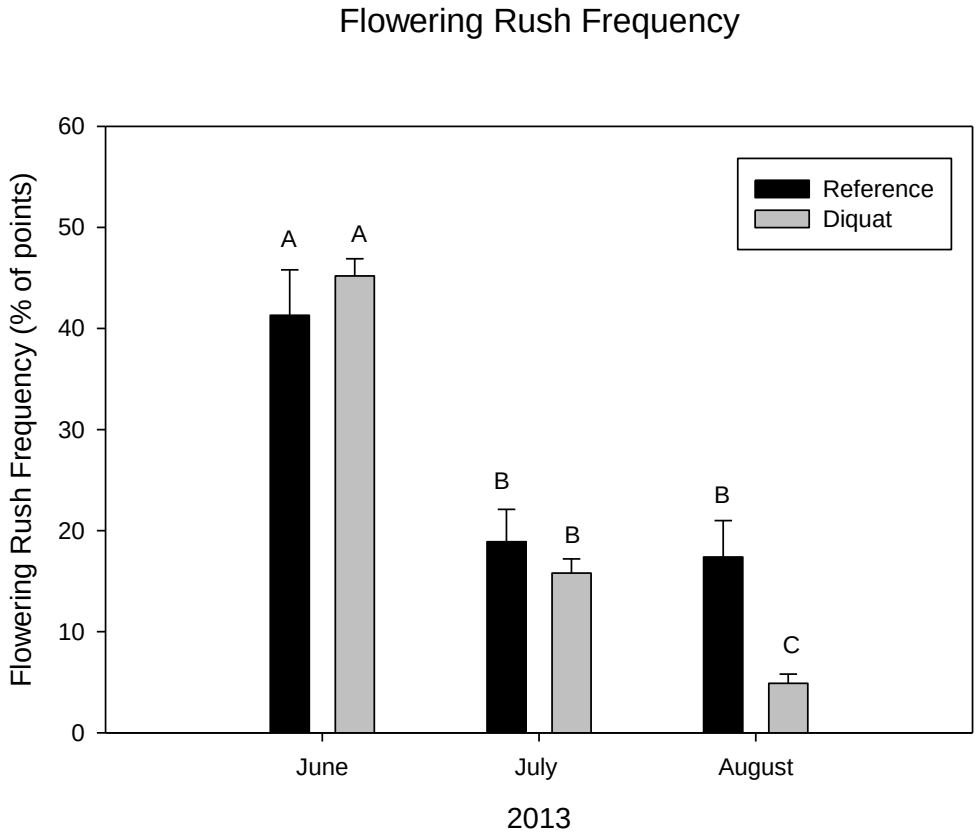


Figure 7. Percent frequency of flowering rush in June, July, and August of 2013 in plots on Detroit Lakes, MN. Different letters indicate that the means are different according to ANOVA at the p-0.05 level. Diquat plots treated after the June and July sampling.

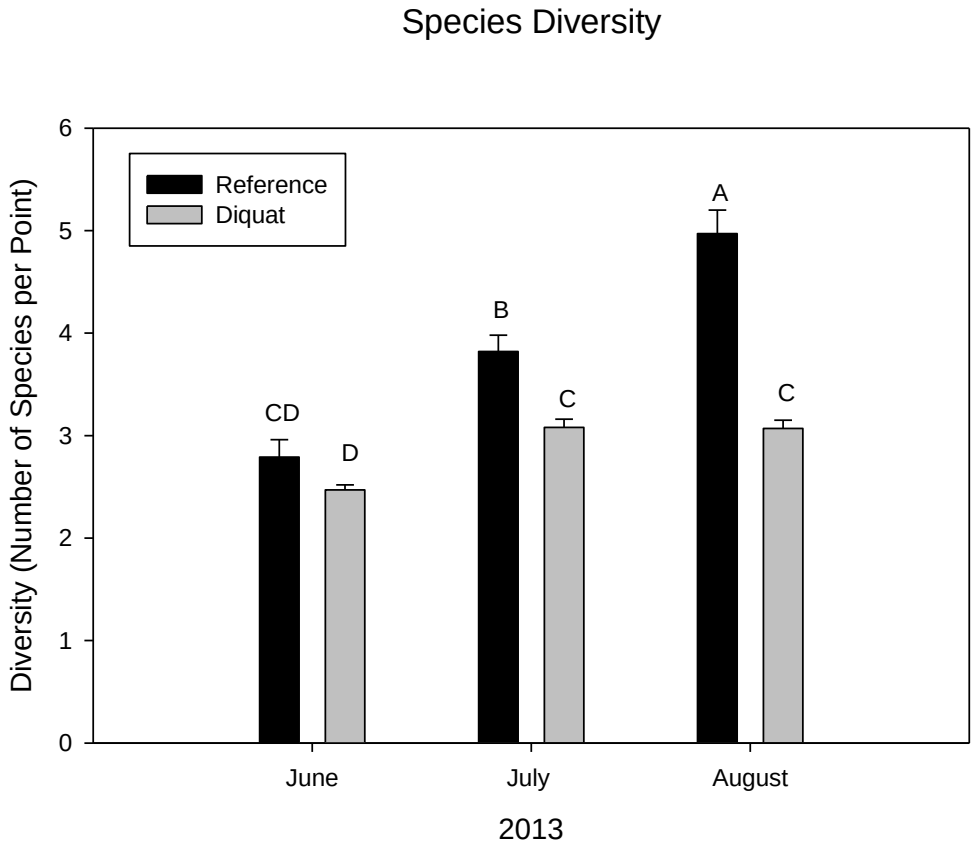


Figure 8. Species diversity (as average number of species per point) in reference and diquat-treated plots in the Detroit Lake system, for months of 2013. Diquat plots treated after the June and July sampling.

Table 1. Diquat[1] treatment dates, areas, and volumes along with application conditions. Weather data from application records (PLM Lake and Land Management Corporation, unpubl. records)

Basins	Area (acres)	Volume of Formulated Herbicide (gallons)	Rate (gal./acre-ft)	Wind Direction (cardinal)	Wind Speed (mph)
First diquat application, June 21, 2013					
Detroit and Little Detroit	172.7	345.4	0.5	SE	3
Curfman	14.2	28.4	0.5	SE	2
Melissa	37.7	75.4	0.5	SE	3-5
Sallie	25	50	0.5	SE	3
Second diquat application, August 1, 2013					
Detroit and Little Detroit	172.7	345.4	0.5	WNW	3-6
Curfman	14.2	28.4	0.5	WNW	3
Melissa	37.7	75.4	0.5	NW	3
Sallie	25	50	0.5	WNW	2

[1]Tribune, Syngenta Crop Protection, Greensboro, NC

Table 2. Treatment and reference plot names for Detroit Lakes basins for 2013, with the plot area, 2012 plot designation, amount of diquat applied per treatment , total treatment amount, and other notes.

Lake	2013 Plot	Area (acres)	2012 Plot Designation	Diquat (gal) per trt time	Total Diquat (gal)	Notes
Curfman	CL_Diq-1	1.37	None	2.7	5.5	
Curfman	CL_Diq-2	2.20	CF-Diq-1	NA	NA	Reference
Curfman	CL_Diq-3	13.27	CF-Diq-2	26.5	53.1	
Little Detroit	DL_Diq-1	4.00	DL-Ref-2	8.0	16.0	
Little Detroit	DL_Diq-2	5.61	None	11.2	22.4	
Little Detroit	DL_Diq-3	9.50	None	19.0	38.0	
Big Detroit	DL_Diq-4	6.92	None	13.8	27.7	
Big Detroit	DL_Diq-5	11.02	None	22.0	44.1	
Big Detroit	DL_Diq-6	19.34	DL-Diq-2	38.7	77.3	
Big Detroit	DL_Diq-7	14.73	DL-Diq-3	29.5	58.9	
Big Detroit	DL_Diq-8	83.40	DL-Diq-1	166.8	333.6	
Big Detroit	DL-Diq-9	31.56	DL-Ref-1	NA	NA	Not Treated
Big Detroit	DL-Diq-10	12.14	None	24.3	48.6	
Big Detroit	DL-Diq-11	6.41	None	NA	NA	Reference
Melissa	LM_Diq-1	7.38	M-Ref-1	14.8	29.5	
Melissa	LM_Diq-2	3.37		6.7	13.5	
Melissa	LM_Diq-3	4.06		8.1	16.2	
Melissa	LM_Diq-4	4.17	M-Diq-4	8.3	16.7	
Melissa	LM_Diq-5	2.74		5.5	10.9	
Melissa	LM_Diq-6	5.36		10.7	21.5	
Melissa	LM_Diq-7	7.85	M-Diq-7	15.7	31.4	
Melissa	LM_Diq-8	20.07		40.1	80.3	
Melissa	LM_Diq-9	3.27		6.5	13.1	
Sallie	LS-Ref-1					Reference
Sallie	LS_Diq-1	16.47	S-Diq-1, S-Diq-2	32.9	65.9	
Sallie	LS_Diq-2	0.75	None	1.5	3.0	
Sallie	LS_Diq-3	7.69	None	15.4	30.7	
TOTAL		304.62		528.9	1057.8	

Table 3. Seven sites at which twenty biomass samples were collected in May, July, and August of 2013.

Lake	2013 Plot	Area (acres)	2012 Plot Designation	Notes
Curfman	CL_Diq-2	2.20	CF-Diq-1	Reference
Curfman	DL_Diq-3	13.3	CF-Diq-2	Treatment
Little Detroit	DL_Diq-1	4.00	DL-Ref-2	Treatment
Big Detroit	DL_Diq-7	14.7	DL-Diq-3	Treatment
Big Detroit	DL_Diq-8	83.4	DL-Diq-1	Treatment
Big Detroit	DL_Ref_1		DL-DIQ-11	Reference
Sallie	LS-Ref-1		S-Ref-1	Reference

Table 4. Point intercept frequency of species in all diquat-treated plots in the Detroit Lakes system, 2013 for three months. P-value is based on a Kruskal-Wallis test, with month as the variable. N= 830, 600, 410; respectively.

Common	**Scientific**	**CODE**	**June**	**July**	**Sep**	**P-value**
Water marigold	*Bidens beckii*	BBEC	0.0	0.0	0.0	M
Flowering rush	*Butomus umbellatus*	BUMB	45.2	15.8	17.4	0.001
Coontail	*Ceratophyllum demersum*	CDEM	7.5	12.2	53.0	0.005
Chara	*Chara*	chara	70.8	82.8	62.6	0.001
Water moss	*Drepanocladus*	DREP	14.3	6.3	4.4	0.001
Elodea	*Elodea canadensis*	ECAN	4.1	1.5	2.6	0.001
Water stargrass	*Heteranthera dubia*	HDUB	1.6	0.3	0.0	0.002
Brownfruit rush	*Juncus pelocarpus*	JPEL	0.6	0.0	0.0	M
Common duckweed	*Lemna minor*	LMIN	0.0	0.0	0.0	M
Star duckweed	*Lemna trisulca*	LTRI	10.0	7.7	30.4	0.19
Northern watermilfoil	*Myriophyllum sibiricum*	MSIB	12.1	16.7	52.2	0.04
Bushy naiad	*Najas flexilis*	NFLEX	1.9	6.2	15.7	0.001
Nitella	*Nitella*	NITEL	0.1	0.2	0.0	M
White waterlily	*Nymphaea odorata*	NODOR	0.0	1.8	13.0	0.001
Yellow pondlily	*Nuphar lutea*	NVARI	2.8	4.8	6.1	0.001
Curlyleaf pondweed	*Potamogeton crispus*	PCRI	7.5	0.2	4.4	0.001
Leafy pondweed	*Potamogeton foliosus*	PFOL	2.5	10.5	2.6	0.001
Variable pondweed	*Potamogeton gramineus*	PGRAM	0.0	3.0	0.0	M
Illinois pondweed	*Potamogeton illinoensis*	PILL	17.0	31.3	37.4	0.001
Floating pondweed	*Potamogeton nataus*	PNAT	0.0	0.0	0.0	M
Whitestem pondweed	*Potamogeton praelongus*	PPRA	7.5	1.2	10.4	0.001
Richardson's pondweed	*Potamogeton richardsonii*	PRICH	17.6	28.5	44.4	0.001
Robbin's pondweed	*Potamogeton robbbinsii*	PROBB	0.1	0.0	0.0	M
Flatstem pondweed	*Potamogeton zosteriformis*	PZOS	6.1	20.8	45.2	0.001
Widgeongrass	*Ruppia cirrhosa*	RCIRR	0.7	0.5	0.9	M
White water buttercup	*Ranunculus longirostris*	RLON	0.7	0.0	0.0	M
Hardstem bulrush	*Schoenoplectus acutus*	SACU	2.8	4.3	17.4	0.25
Arumleaf arrowhead	*Sagittaria cuneata*	SCUN	0.0	0.3	0.0	M
Sago pondweed	*Stuckenia pectinata*	SPEC	9.9	7.2	13.9	0.001
Narrowleaf cattail	*Typha angustifolia*	TANG	0.1	0.5	0.0	M
Broadleaf cattail	*Typha latifolia*	TLAT	0.0	0.0	0.9	M
Common bladderwort	*Utricularia macrorhiza*	UMAC	2.9	7.8	19.1	0.001
Watercelery	*Vallisneria americana*	VAME	0.2	36.0	43.5	0.001
Watermeal	*Wolffia*	WOOLF	0.0	0.0	3.5	M
Total species richness		SPP	2.8	3.8	5.0	0.001
Native species richness		NATSPP	2.4	3.6	4.8	0.001

Table 5. Point intercept frequency of species in all untreated reference plots in the Detroit Lakes system, 2013 for three months. P-value is based on a Kruskal-Wallis test, with month as the variable. N= 148, 121, 115; respectively. A p-value of "M" indicates insufficient presence to compute the statistic.

Common	Scientific	CODE	June	July	Sep	Sig Diff
Water marigold	*Bidens beckii*	BBEC	0.0	0.0	0.0	M
Flowering rush	*Butomus umbellatus*	BUMB	41.3	18.9	17.4	0.001
Coontail	*Ceratophyllum demersum*	CDEM	30.6	32.4	53.0	0.048
Chara	*Chara*	chara	40.5	51.4	62.6	0.004
Water moss	*Drepanocladus*	DREP	10.7	2.7	4.4	0.017
Elodea	*Elodea canadensis*	ECAN	8.3	6.8	2.6	0.17
Water stargrass	*Heteranthera dubia*	HDUB	0.8	0.0	0.0	0.34
Brownfruit rush	*Juncus pelocarpus*	JPEL	0.8	0.0	0.0	M
Common duckweed	*Lemna minor*	LMIN	0.0	0.0	0.0	M
Star duckweed	*Lemna trisulca*	LTRI	22.3	27.0	30.4	0.37
Northern watermilfoil	*Myriophyllum sibiricum*	MSIB	12.4	31.8	52.2	0.001
Bushy naiad	*Najas flexilis*	NFLEX	0.0	8.1	15.7	0.001
Nitella	*Nitella*	NITEL	0.0	0.7	0.0	M
White waterlily	*Nymphaea odorata*	NODOR	0.0	10.8	13.0	0.003
Yellow pondlily	*Nuphar lutea*	NVARI	5.8	3.4	6.1	0.53
Curlyleaf pondweed	*Potamogeton crispus*	PCRI	24.0	0.0	4.4	0.001
Leafy pondweed	*Potamogeton foliosus*	PFOL	0.0	10.1	2.6	0.002
Variable pondweed	*Potamogeton gramineus*	PGRAM	0.0	3.4	0.0	0.017
Illinois pondweed	*Potamogeton illinoensis*	PILL	11.6	23.7	37.4	0.001
Floating pondweed	*Potamogeton natans*	PNAT	0.0	0.7	0.0	M
Whitestem pondweed	*Potamogeton praelongus*	PPRA	12.4	15.5	10.4	0.46
Richardson's pondweed	*Potamogeton richardsonii*	PRICH	15.7	24.3	44.4	0.001
Robbin's pondweed	*Potamogeton robbbinsii*	PROBB	0.0	0.0	0.0	M
Flatstem pondweed	*Potamogeton zosteriformis*	PZOS	8.3	35.1	45.2	0.001
Widgeongrass	*Ruppia cirrhosa*	RCIRR	1.7	0.0	0.9	M
White water buttercup	*Ranunculus longirostris*	RLON	1.7	0.0	0.0	M
Hardstem bulrush	*Schoenoplectus acutus*	SACU	14.9	17.6	17.4	0.82
Arumleaf arrowhead	*Sagittaria cuneata*	SCUN	0.0	0.0	0.0	M
Sago pondweed	*Stuckenia pectinata*	SPEC	5.8	10.1	13.9	0.112
Narrowleaf cattail	*Typha angustifolia*	TANG	0.0	0.7	0.0	M
Broadleaf cattail	*Typha latifolia*	TLAT	0.0	0.0	0.9	M
Common bladderwort	*Utricularia macrorhiza*	UMAC	8.3	18.9	19.1	0.026
Watercelery	*Vallisneria americana*	VAME	0.8	28.4	43.5	0.001
Watermeal	*Wolffia*	WOOLF	0.0	0.0	3.5	0.09
Total species richness		SPP	2.8	3.8	5.0	0.001
Native species richness		NATSPP	2.4	3.6	4.8	0.001

Table 6. Dynamics of species in diquat-treated and untreated reference plots in the Detroit Lake system across three months in 2013; where a "+" indicates species that statistically increased, a "0" indicate species with no significant change, and a "-" indicate species with a significant decrease in frequency at points.

Common	Scientific	CODE	Diquat	Reference
Water marigold	*Bidens beckii*	BBEC	0	0
Flowering rush	*Butomus umbellatus*	BUMB	-	-
Coontail	*Ceratophyllum demersum*	CDEM	+	+
Chara	*Chara*	chara	+	+
Water moss	*Drepanocladus*	DREP	-	-
Elodea	*Elodea canadensis*	ECAN	-	0
Water stargrass	*Heteranthera dubia*	HDUB	-	0
Brownfruit rush	*Juncus pelocarpus*	JPEL	0	0
Common duckweed	*Lemna minor*	LMIN	0	0
Star duckweed	*Lemna trisulca*	LTRI	0	0
Northern watermilfoil	*Myriophyllum sibiricum*	MSIB	+	+
Bushy naiad	*Najas flexilis*	NFLEX	+	+
Nitella	*Nitella*	NITEL	0	0
White waterlily	*Nymphaea odorata*	NODOR	+	+
Yellow pondlily	*Nuphar lutea*	NVARI	+	0
Curlyleaf pondweed	*Potamogeton crispus*	PCRI	-	-
Leafy pondweed	*Potamogeton foliosus*	PFOL	+	+
Variable pondweed	*Potamogeton gramineus*	PGRAM	0	+
Illinois pondweed	*Potamogeton illinoensis*	PILL	+	+
Floating pondweed	*Potamogeton natans*	PNAT	0	0
Whitestem pondweed	*Potamogeton praelongus*	PPRA	+	0
Richardson's pondweed	*Potamogeton richardsonii*	PRICH	+	+
Robbin's pondweed	*Potamogeton robbbinsii*	PROBB	0	+
Flatstem pondweed	*Potamogeton zosteriformis*	PZOS	+	+
Widgeongrass	*Ruppia cirrhosa*	RCIRR	0	0
White water buttercup	*Ranunculus longirostris*	RLON	0	0
Hardstem bulrush	*Schoenoplectus acutus*	SACU	0	0
Arumleaf arrowhead	*Sagittaria cuneata*	SCUN	0	0
Sago pondweed	*Stuckenia pectinata*	SPEC	+	0
Narrowleaf cattail	*Typha angustifolia*	TANG	0	0
Broadleaf cattail	*Typha latifolia*	TLAT	0	0
Common bladderwort	*Utricularia macrorhiza*	UMAC	+	+
Watercelery	*Vallisneria americana*	VAME	+	+
Watermeal	*Wolffia*	WOOLF	0	0
	Increasers		14	13
	No change		15	18
	Decreasers		5	3

Table 7. Species frequencies for 2013 for Curfman Pond site CL-DIQ-1.

Site: CL-DIQ-1 — Location: Curfman Pond, Detroit Lakes, MN

Year	Month	Day	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	June	11	0	100	22.2	77.8	0	0	0	0	0	22.2	33.3	0	0	0	33.3	22.2	0	0	0	0	0	0	0	22.2	0	0	0	0	0	0	0	0	0	0	3.33
2013	July	22	0	16.7	16.7	83.3	0	0	0	0	0	50	16.7	33.3	0	0	83.3	0	0	0	16.7	0	0	16.7	0	33.3	0	0	0	0	0	16.7	0	50.0	66.7	0	5.0
2013	Sep	6	0	12.5	12.5	75.0	0	0	0	0	0	50.0	12.5	25.0	0	0	0	0	0	0	0	0	0	25.0	0	0	0	0	0	0	0	0	0	12.5	100	0	4.0

Table 8. Species occurrence frequencies for CL-DIQ-2, an untreated reference site for Curfman Pond, Detroit Lakes, MN, in 2013.

Site			CL-DIQ-2 (Reference)								Location			Curfman Pond, Detroit Lakes, MN																						
Year	Month	Day	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	June	11	0	69.2	0	53.9	0	0	0	7.7	0	38.5	0	0	0	0	0	15.3	0	0	7.7	0	0	0	0	15.4	0	0	7.7	0	0	0	0	0	7.7	0	2.23
2013	July	22	0	25.0	0	75.	0	0	0	0	0	16.7	8.3	8.3	0	0	8.3	0	0	0	16.7	0	0	8.3	0	8.3	0	0	8.3	0	0	0	0	8.3	58.3	0	2.5
2013	Sep	6	0	0	23.1	76.9	15.4	0	0	0	0	15.4	7.7	30.8	0	0	0	0	0	0	0	0	7.7	0	0	7.7	0	0	7.7	0	0	0	0	23.1	61.5	0	3.0

Table 9. Species occurrence frequencies for CL-DIQ-3, a diquat treated site for Curfman Pond, Detroit Lakes, MN, in 2013.

Site	CL-DIQ-3	Location	Curfman Pond, Detroit Lakes, MN
Year	2013	2013	2013	2013
Month	June	July	Sep	
Day	11	22	6	
Bidens beckii	0	0	0	0
Butomus umbellatus	66.2	27.3	4.8	4.8
Ceratophyllum demersum	15.5	18.3	23.8	23.8
Chara	65.8	72.7	0	0
Drepanocladus	0	0	0	0
Elodea canadensis	0	0	0	0
Heteranthera dubia	0	0	0	0
Juncus pelocarpus	0	0	0	0
Lemna minor	0	0	0	0
Lemna trisulca	29.6	40.9	28.6	28.6
Myriophyllum sibiricum	9.9	13.6	42.9	42.9
Najas flexilis	0	0	4.8	4.8
Nitella	0	0	0	0
Nymphaea odorata	0	0	0	0
Nuphar luteum	14.1	31.8	0	0
Potamogeton crispus	32.4	0	0	0
Potamogeton foliosus	1.4	0	0	0
Potamogeton gramineus	0	0	0	0
Potamogeton illinoensis	11.3	36.4	0	0
Potamogeton natans	0	0	0	0
Potamogeton praelongus	18.3	0	28.6	28.6
Potamogeton richardsonii	11.3	31.8	23.8	23.8
Potamogeton robbinsii	0	0	0	0
Potamogeton zosteriformis	2.8	9.1	0	0
Ruppia cirrhosa	0	0	0	0
Ranunculus longirostris	0	0	0	0
Schoenoplectus acutus	8.5	9.1	4.8	4.8
Sagittaria cuneata	0	0	0	0
Stuckenia pectinata	26.8	0	0	0
Typha angustifolia	0	0	0	0
Typha latifolia	0	0	0	0
Utricularia macrorhiza	12.7	9.1	14.3	14.3
Vallisneria americana	0	50.0	47.6	47.6
Wolffia	0	0	0	0
Average species richness/pt.	3.25	3.5	3.43	

Table 10. Species occurrence frequencies for DL-DIQ-1, a diquat treated site for Little Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-1									Location	Little Detroit Lake, Detroit Lakes, MN																									
Year	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	0	72.0	8	72.0	0	36.0	4.0	0	0	8	64	24	0	0	16	0	48	0	8	0	12	36	0	16	0	0	28	0	0	0	0	0	0	0	4.52
2013	0	69.2	26.9	76.9	0	3.9	0	0	0	3.9	76.9	30.8	0	0	26.9	0	26.9	0	80.8	0	0	61.5	0	76.9	0	0	34.6	0	19.2	0	0	26.9	34.6	0	6.77
2013	0	40.0	12.0	92.0	4.0	0	0	0	0	0	40.0	8.0	0	0	0	0	0	0	84.0	0	24.0	76.0	0	64.0	0	0	36.0	0	0	0	0	20.0	72.0	0	6.24
Month	June	July	Sept																																
Day	12	23	6																																

Table 11. Species occurrence frequencies for DL-DIQ-10, a diquat treated site for Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-10									Location	Big Detroit Lake, Detroit Lakes, MN																													
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep	0	80	33.3	20	20	26.7	6.7	0	0	26.7	33.3	6.7	0	0	0	53.3	0	0	0	13.3	0	33.3	6.7	0	33.3	0	6.7	0	0	6.7	0	0	0	0	0	0	4.27
Day	12	23	6	0	26.7	53.3	13.3	20.0	0	0	0	0	66.7	6.7	6.7	0	0	0	0	0	0	0	13.3	0	13.3	13.3	0	46.7	0	0	0	6.7	0	0	0	26.7	53.3	0	0	3.67
				0	0	30.8	61.5	38.5	0	0	0	0	0	15.4	0	0	0	0	7.7	0	0	0	38.5	0	23.1	23.1	0	30.8	0	0	0	0	7.7	0	0	7.7	61.5	0	0	4.0

Table 12. Species occurrence frequencies for DL-DIQ-11, an untreated reference site for Little Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-11 (untreated reference)										Location	Big Detroit Lake, Detroit Lakes, MN																							
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep																																	
Day	12	23	7																																	
	0	0	0																																	
	30.3	7.9	0																																	
	63.6	68.4	100																																	
	3.0	13.2	30.0																																	
	18.2	7.9	5.0																																	
	18.2	10.5	0																																	
	0	0	0																																	
	0	0	0																																	
	0	0	0																																	
	24.2	68.2	75.0																																	
	9.1	34.2	40.0																																	
	0	0	5.0																																	
	0	2.6	0																																	
	0	0	0																																	
	0	0	0																																	
	69.7	0	10.0																																	
	0	0	0																																	
	0	0	0																																	
	0	5.3	5.0																																	
	15.2	0	0																																	
	0	50.0	40.0																																	
	42.4	0	10.0																																	
	9.1	0	0																																	
	0	0	0																																	
	21.2	73.7	70.0																																	
	0	0	0																																	
	6.1	0	0																																	
	0	0	0																																	
	0	0	0																																	
	12.1	0	5.0																																	
	0	0	0																																	
	0	0	0																																	
	9.1	26.3	30.0																																	
	0	18.4	15.0																																	
	0	0	0																																	
	3.51	3.87	4.50																																	

Table 13. Species occurrence frequencies for DL-DIQ-2, a diquat treated site for Little Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-2								Location	Little Detroit Lake, Detroit Lakes, MN																								
Year	Month	Day	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	June	12	0	31.3	0	78.2	0	9.4	0	0	0	0	50	9.4	0	0	0	0	0	0	9.4	0	37.5	50	0	9.4	0	0	0	0	15.6	0	0	3.1	0	0	3.09
2013	July	23	0	12.5	3.1	84.4	0	0	0	0	0	0	15.6	0	0	0	3.1	0	3.1	0	50.0	0	9.4	53.1	0	21.9	3.1	0	0	0	6.3	0	0	6.3	9.4	0	2.82
2013	Sep	7	0	0	9.1	95.5	0	0	0	0	0	4.6	13.6	4.6	0	0	0	0	0	0	40.9	0	9.1	45.5	0	18.2	0	0	0	0	0	0	0	13.6	18.2	0	0	2.77

Table 14. Species occurrence frequencies for DL-DIQ-3, a diquat treated site for Little Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-3									Location	Little Detroit Lake, Detroit Lakes, MN																									
Year	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013
Month	June	July	Sep																																	
Day	12	23	7																																	
Bidens beckii	0	0	0																																	
Butomus umbellatus	53.1	37.8	5.0																																	
Ceratophyllum demersum	26.5	33.3	20.0																																	
Chara	67.4	64.4	100																																	
Drepanocladus	2.0	0	0																																	
Elodea canadensis	22.5	2.2	0																																	
Heteranthera dubia	0	0	0																																	
Juncus pelocarpus	0	0	0																																	
Lemna minor	0	0	0																																	
Lemna trisulca	2.0	0	0																																	
Myriophyllum sibiricum	30.6	42.2	5.0																																	
Najas flexilis	10.2	0	5.0																																	
Nitella	0	0	0																																	
Nymphaea odorata	0	0	0																																	
Nuphar luteum	0	0	0																																	
Potamogeton crispus	4.1	0	0																																	
Potamogeton foliosus	4.1	13.3	0																																	
Potamogeton gramineus	0	0	0																																	
Potamogeton illinoensis	14.3	42.2	40.0																																	
Potamogeton natans	0	0	0																																	
Potamogeton praelongus	16.3	0	20.0																																	
Potamogeton richardsonii	14.3	37.8	30.0																																	
Potamogeton robbinsii	0	0	0																																	
Potamogeton zosteriformis	8.2	35.6	25.0																																	
Ruppia cirrhosa	0	0	0																																	
Ranunculus longirostris	0	0	0																																	
Schoenoplectus acutus	0	0	0																																	
Sagittaria cuneata	0	0	0																																	
Stuckenia pectinata	2.0	17.8	5.0																																	
Typha angustifolia	0	0	0																																	
Typha latifolia	0	0	0																																	
Utricularia macrorhiza	0	8.9	10.0																																	
Vallisneria americana	0	37.8	55.0																																	
Wolffia	0	0	0																																	
Average species richness/pt.	2.78	3.73	3.20																																	

Table 15. Species occurrence frequencies for DL-DIQ-4, a diquat treated site for Big Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-4	Location	Big Detroit Lake, Detroit Lakes, MN

Year	2013	2013	2013
Month	June	July	Sep
Day	12	23	6
Bidens beckii	0	0	0
Butomus umbellatus	27.3	5.3	0
Ceratophyllum demersum	0	5.3	0
Chara	100	94.7	93.3
Drepanocladus	0	0	0
Elodea canadensis	0	0	0
Heteranthera dubia	0	0	0
Juncus pelocarpus	0	0	0
Lemna minor	0	0	0
Lemna trisulca	0	0	0
Myriophyllum sibiricum	4.6	0	6.7
Najas flexilis	0	0	0
Nitella	0	0	0
Nymphaea odorata	0	0	0
Nuphar luteum	0	0	0
Potamogeton crispus	0	0	0
Potamogeton foliosus	0	0	0
Potamogeton gramineus	0	0	0
Potamogeton illinoensis	9.1	10.5	53.3
Potamogeton natans	0	0	0
Potamogeton praelongus	0	0	0
Potamogeton richardsonii	0	0	20.0
Potamogeton robbinsii	0	0	0
Potamogeton zosteriformis	0	0	0
Ruppia cirrhosa	0	0	0
Ranunculus longirostris	0	0	0
Schoenoplectus acutus	0	0	0
Sagittaria cuneata	0	0	0
Stuckenia pectinata	0	5.3	0
Typha angustifolia	0	0	0
Typha latifolia	0	0	0
Utricularia macrorhiza	13.6	0	6.7
Vallisneria americana	0	5.3	26.7
Wolffia	0	0	0
Average species richness/pt.	1.55	1.26	2.07

Table 16. Species occurrence frequencies for DL-DIQ-5, a diquat treated site for Big Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-5									Location	Big Detroit Lake, Detroit Lakes, MN																									
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep																																		
Day	12	23	6																																		
	0	0	0																																		
	40	13.3	5.6																																		
	26.7	53.3	16.7																																		
	33.3	53.3	50.0																																		
	13.3	20.0	22.2																																		
	20	26.7	0																																		
	20	0	0																																		
	0	0	0																																		
	20	26.7	0																																		
	6.7	40.0	5.6																																		
	0	20.0	33.3																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	20	0	0																																		
	0	13.3	0																																		
	0	0	0																																		
	6.7	20.0	33.3																																		
	0	0	0																																		
	0	20.0	33.3																																		
	0	0	0																																		
	13.3	33.3	5.6																																		
	0	0	0																																		
	13.3	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	6.7	53.3	77.8																																		
	0	0	0																																		
	2.47	3.93	2.83																																		

Table 17. Species occurrence frequencies for DL-DIQ-6, a diquat treated site for Big Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-6	Location	Big Detroit Lake, Detroit Lakes, MN
Year	2013	2013	2013
Month	June	June	Sep
Day	11	22	6
Bidens beckii	0	0	0
Butomus umbellatus	53.6	7.1	0
Ceratophyllum demersum	0	0	0
Chara	95.9	100	100
Drepanocladus	18.6	10.7	0
Elodea canadensis	1.0	0	0
Heteranthera dubia	0	0	0
Juncus pelocarpus	0	0	0
Lemna minor	0	0	0
Lemna trisulca	9.3	0	11.1
Myriophyllum sibiricum	7.2	3.6	3.7
Najas flexilis	0	0	3.7
Nitella	0	0	0
Nymphaea odorata	0	0	0
Nuphar luteum	1.0	3.6	0
Potamogeton crispus	0	0	0
Potamogeton foliosus	0	0	0
Potamogeton gramineus	0	0	0
Potamogeton illinoensis	14.4	28.6	29.6
Potamogeton natans	0	0	0
Potamogeton praelongus	5.2	0	11.1
Potamogeton richardsonii	21.7	21.4	48.2
Potamogeton robbinsii	1.0	0	0
Potamogeton zosteriformis	2.1	3.6	0
Ruppia cirrhosa	0	0	0
Ranunculus longirostris	0	0	0
Schoenoplectus acutus	0	0	0
Sagittaria cuneata	0	0	0
Stuckenia pectinata	12.4	0	0
Typha angustifolia	0	0	0
Typha latifolia	0	0	0
Utricularia macrorhiza	0	3.6	3.7
Vallisneria americana	0	67.9	81.4
Wolffia	0	0	0
Average species richness/pt.	2.43	2.5	2.93

Table 18. Species occurrence frequencies for DL-DIQ-7, a diquat treated site for Big Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-7									Location	Big Detroit Lake, Detroit Lakes, MN																									
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep	0	59.3	8.1	62.8	64.0	0	0	0	0	26.7	1.2	0	1.2	0	3.5	7.0	0	0	0	15.1	0	1.2	4.7	0	4.7	0	0	0	0	2.3	1.1	0	1.2	2.3	0	2.66
Day	11	22	6	0	0	4.0	72.0	48.0	0	4.0	0	0	32.0	8.0	8.0	4.0	0	32.0	0	0	0	0	8.0	0	0	4.0	0	0	0	0	0	0	0	8.0	0	4.0	68.0	0	3.04
			3.7	0	0	96.3	51.9	0	0	0	0	40.7	22.2	7.4	0	7.4	0	0	0	0	0	7.4	0	25.9	7.4	0	3.7	0	0	0	0	0	0	0	88.9	0	4.0

Table 19. Species occurrence frequencies for DL-DIQ-8, a diquat treated site for Big Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-8	Location	Big Detroit Lake, Detroit Lakes, MN

Year	2013	2013	2013	2013
Month	June	July	Sep	
Day	11	22	7	
Bidens beckii	0	0	0	
Butomus umbellatus	36.6	6.9	4.3	
Ceratophyllum demersum	0	0	2.6	
Chara	93.5	99.2	100	
Drepanocladus	15.0	10.8	5.2	
Elodea canadensis	0	0	0	
Heteranthera dubia	0	0	0	
Juncus pelocarpus	0	0	0	
Lemna minor	0	0	0	
Lemna trisulca	2.0	3.1	5.2	
Myriophyllum sibiricum	2.0	0.7	3.5	
Najas flexilis	0	6.9	8.6	
Nitella	0	0	0	
Nymphaea odorata	0	0	0	
Nuphar luteum	0	0	0	
Potamogeton crispus	0	0	0	
Potamogeton foliosus	0	12.3	0	
Potamogeton gramineus	0	0	0	
Potamogeton illinoensis	3.9	3.1	9.5	
Potamogeton natans	0	0	0	
Potamogeton praelongus	3.9	0	1.7	
Potamogeton richardsonii	3.9	8.5	12.1	
Potamogeton robbinsii	0	0	0	
Potamogeton zosteriformis	0	0.8	0.8	
Ruppia cirrhosa	0	0	0	
Ranunculus longirostris	0	0	0	
Schoenoplectus acutus	0	0	0	
Sagittaria cuneata	0	0	0	
Stuckenia pectinata	7.2	1.5	0	
Typha angustifolia	0	0	0	
Typha latifolia	0	0	0	
Utricularia macrorhiza	0	0.7	0	
Vallisneria americana	0	50.0	90.5	
Wolffia	0	0	0	
Average species richness/pt.	1.68	2.05	2.44	

Table 20. Species occurrence frequencies for DL-DIQ-9, a diquat treated site for Big Detroit Lake, Detroit Lakes, MN, in 2013.

Site	DL-DIQ-9									Location	Big Detroit Lake, Detroit Lakes, MN																									
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep																																		
Day	12	22	7																																		
	0	0	0																																		
	11.3	0	2.7																																		
	2.3	4.6	16.2																																		
	88.6	93.2	94.6																																		
	0	2.3	2.7																																		
	2.3	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	9.1	5.4																																		
	4.6	20.5	56.8																																		
	0	11.4	32.4																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	13.6	50.0	64.9																																		
	0	0	0																																		
	2.3	9.1	8.1																																		
	16.0	43.2	70.3																																		
	0	0	0																																		
	2.3	11.4	21.6																																		
	0	0	0																																		
	0	0	0																																		
	4.6	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	9.1	10.8																																		
	0	43.2	83.8																																		
	0	0	0																																		
	1.50	3.07	4.70																																		

Table 21. Species occurrence frequencies for M-DIQ-1, a diquat treated site for Lake Melissa, Detroit Lakes, MN, in 2013.

Site	M-DIQ-1	Location	Lake Melissa, Detroit Lakes, MN
Year	2013	2013	2013
Month	June	July	Sep
Day	13	23	8
Bidens beckii	0	0	0
Butomus umbellatus	23.1	4.8	0
Ceratophyllum demersum	0	9.5	7.7
Chara	62.5	76.2	100
Drepanocladus	0	0	23.1
Elodea canadensis	0	0	0
Heteranthera dubia	0	0	0
Juncus pelocarpus	0	0	0
Lemna minor	0	0	0
Lemna trisulca	0	4.8	0
Myriophyllum sibiricum	0	0	0
Najas flexilis	0	0	23.1
Nitella	0	0	0
Nymphaea odorata	0	0	0
Nuphar luteum	0	0	0
Potamogeton crispus	0	0	0
Potamogeton foliosus	0	4.8	0
Potamogeton gramineus	0	0	0
Potamogeton illinoensis	23.1	42.9	15.4
Potamogeton natans	0	0	0
Potamogeton praelongus	0	0	7.7
Potamogeton richardsonii	0	33.3	0
Potamogeton robbinsii	0	0	0
Potamogeton zosteriformis	0	14.3	0
Ruppia cirrhosa	15.4	9.5	0
Ranunculus longirostris	0	0	0
Schoenoplectus acutus	0	0	0
Sagittaria cuneata	0	0	0
Stuckenia pectinata	7.7	0	0
Typha angustifolia	0	0	0
Typha latifolia	0	0	0
Utricularia macrorhiza	0	19.1	0
Vallisneria americana	0	9.5	15.4
Wolffia	0	0	0
Average species richness/pt.	1.30	2.29	1.92

Table 22. Species occurrence frequencies for M-DIQ-2, a diquat treated site for Lake Melissa, Detroit Lakes, MN, in 2013.

Site	M-DIQ-2									Location	Lake Melissa, Detroit Lakes, MN																									
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep																																		
Day	13	23	8																																		
	0	0	0																																		
	44.4	17.7	0																																		
	0	5.9	0																																		
	0	94.1	88.9																																		
	0	5.9	11.1																																		
	0	0	11.1																																		
	11.1	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	11.1	11.1	0																																		
	22.2	11.1	0																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	11.1	52.9	11.1																																		
	0	0	0																																		
	33.3	41.2	11.1																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	22.2	23.5	0																																		
	0	0	0																																		
	2.56	3.82	3.00																																		

Table 23. Species occurrence frequencies for M-DIQ-3, a diquat treated site for Lake Melissa, Detroit Lakes, MN, in 2013.

Site			M-DIQ-3									Location		Lake Melissa, Detroit Lakes, MN																							
Year	Month	Day	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	June	13	0	18.8	12.5	68.8	6.3	6.3	12.5	0	0	0	6.3	0	0	0	0	0	0	0	6.3	0	0	31.3	0	0	0	6.3	37.5	0	6.3	0	0	6.3	0	0	2.25
2013	July	23	0	3.5	6.9	96.6	0	6.9	0	0	0	0	20.7	3.5	0	0	0	0	13.8	10.3	65.5	0	0	27.6	0	13.8	0	0	48.3	0	13.8	0	0	6.9	13.8	0	3.52
2013	Sep	8	0	0	37.5	93.8	6.3	0	0	0	0	0	12.5	0	0	0	0	0	0	0	68.8	0	0	56.3	0	6.3	0	0	43.8	0	0	0	0	0	12.5	0	3.38

Table 24. Species occurrence frequencies for M-DIQ-4, a diquat treated site for Lake Melissa, Detroit Lakes, MN, in 2013.

Site	M-DIQ-4									Location	Lake Melissa, Detroit Lakes, MN																											
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep																																			
Day	13	23	8																																			
	0	0	0																																			
	7.1	23.1	16.7																																			
	0	30.8	83.3																																			
	0	84.6	91.7																																			
	0	0	0																																			
	0	3.9	0																																			
	14.3	0	0																																			
	0	0	0																																			
	0	0	0																																			
	0	0	8.3																																			
	21.4	50.0	50.0																																			
	0	11.5	16.7																																			
	0	0	0																																			
	0	15.4	0																																			
	0	0	0																																			
	7.1	3.9	0																																			
	0	34.6	16.7																																			
	0	23.1	0																																			
	7.1	34.6	83.3																																			
	0	0	0																																			
	21.4	0	0																																			
	14.3	61.5	66.7																																			
	0	0	0																																			
	7.1	50.0	41.7																																			
	0	0	0																																			
	0	0	0																																			
	0	0	0																																			
	0	11.5	16.7																																			
	0	0	0																																			
	0	0	0																																			
	14.3	7.7	8.3																																			
	0	42.3	50.0																																			
	0	0	0																																			
	1.43	4.88	6.08																																			

Table 25. Species occurrence frequencies for M-DIQ-5, a diquat treated site for Lake Melissa, Detroit Lakes, MN, in 2013.

Site			M-DIQ-5									Location			Lake Melissa, Detroit Lakes, MN																					
Year	Month	Day	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	June	13	0	0	0	28.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42.9	0	0	0	0	0	0	0	0	0	28.6	0	0	0	0	0	1.00
2013	July	23	0	0	6.3	87.5	0	0	0	0	0	0	0	6.3	0	0	0	0	12.5	37.5	25.0	0	0	12.5	0	6.3	0	0	0	6.3	56.3	0	0	6.3	0	0	2.63
2013	Sep	8	0	12.5	37.5	100	0	0	0	0	0	0	12.5	25.0	0	0	0	0	12.5	0	0	0	0	62.5	0	25.0	0	0	0	0	25.0	0	0	0	0	0	3.25

Table 26. Species occurrence frequencies for M-DIQ-7, a diquat treated site for Lake Melissa, Detroit Lakes, MN, in 2013.

Site	M-DIQ-7									Location	Lake Melissa, Detroit Lakes, MN																											
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep	0	0	15.0	55.0	5.0	0	0	0	0	25.0	15.0	5.0	0	5.0	0	0	5.0	0	20.0	0	0	15.0	0	20.0	0	0	0	0	0	0	0	45.0	0	2.35
Day	13	23	8	0	34.4	18.8	50.0	15.6	3.1	6.3	6.3	0	18.8	21.9	0	0	0	6.3	6.3	3.1	0	12.5	0	0	28.1	0	25.0	3.1	0	6.3	0	12.5	0	0	9.4	0	0	2.88
	0	12.5	12.5	70.8	4.2	0	4.2	0	6.3	0	0	12.5	37.5	4.2	0	4.2	0	0	0	0	29.2	0	4.2	54.2	0	45.8	0	0	0	0	0	0	16.7	37.5	0	0	3.50
	0	0	15.0	55.0	5.0	0	0	0	0	0	0	25.0	15.0	5.0	0	0	5.0	0	0	5.0	0	20.0	0	0	15.0	0	20.0	0	0	0	0	5.0	0	0	0	45.0	0	2.35

Table 27. Species occurrence frequencies for M-DIQ-8, a diquat treated site for Lake Melissa, Detroit Lakes, MN, in 2013.

Site	M-DIQ-8										Location			Lake Melissa, Detroit Lakes, MN																								
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Naias flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep																																			
Day	13	23	8																																			
	0	0	0																																			
	2.7	0	0																																			
	2.7	3.3	9.1																																			
	100	100	100																																			
	2.7	3.3	6.1																																			
	2.7	0	0																																			
	0	0	0																																			
	0	0	0																																			
	0	0	0																																			
	0	0	9.1																																			
	10.8	3.3	0																																			
	0	6.7	3.0																																			
	0	0	0																																			
	0	0	0																																			
	0	0	0																																			
	0	0	0																																			
	5.4	3.3	0																																			
	0	3.3	0																																			
	59.5	60.0	21.2																																			
	0	0	0																																			
	0	0	0																																			
	10.8	13.3	15.2																																			
	0	0	0																																			
	2.7	13.3	6.1																																			
	0	0	0																																			
	0	0	0																																			
	0	0	0																																			
	5.4	0	0																																			
	0	0	0																																			
	0	0	0																																			
	0	0	0																																			
	0	0	0																																			
	2.05	2.2	1.76																																			

Table 28. Species occurrence frequencies for M-DIQ-9, a diquat treated site for Lake Melissa, Detroit Lakes, MN, in 2013.

Site			M-DIQ-9									Location			Lake Melissa, Detroit Lakes, MN																						
Year	Month	Day	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	June	13	0	0	0	66.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.67
2013	July	23	0	0		70.0	0	0	0	0	0	0	0	10.0	0	0	0	0	0	10.0	0	0	0	10.0	0	0	0	0	0	0	0	0	0	0	10.0	0	1.1
2013	Sep	8																																			

Table 29. Species occurrence frequencies for S-DIQ-1, a diquat treated site for Sallie Lake, Detroit Lakes, MN, in 2013.

Site	S-DIQ-1									Location	Sallie Lake, Detroit Lakes, MN																									
Year	2013	2013	2013	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
Month	June	July	Sep																																		
Day	13	23	8																																		
	0	0	0																																		
	68.1	34.8	2.1																																		
	6.9	4.4	8.5																																		
	34.7	69.6	78.7																																		
	9.7	0	2.1																																		
	0	0	0																																		
	1.4	0	0																																		
	1.4	0	0																																		
	0	0	0																																		
	9.7	6.5	8.5																																		
	6.9	6.5	31.9																																		
	1.4	6.5	21.3																																		
	0	0	0																																		
	0	13.0	10.6																																		
	0	0	0																																		
	12.5	0	2.1																																		
	0	8.7	2.1																																		
	0	2.2	0																																		
	22.2	26.1	14.9																																		
	0	0	0																																		
	4.2	2.2	4.3																																		
	59.7	56.5	51.1																																		
	0	0	0																																		
	15.3	34.8	36.2																																		
	0	0	0																																		
	0	0	0																																		
	2.8	2.2	4.3																																		
	0	0	0																																		
	12.5	6.5	2.1																																		
	0	0	0																																		
	0	0	0																																		
	2.8	2.2	2.1																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	0	0	0																																		
	2.72	3.24	3.51																																		

Table 30. Species occurrence frequencies for S-DIQ-2, a diquat treated site for Sallie Lake, Detroit Lakes, MN, in 2013.

Site			S-DIQ-2									Location			Sallie Lake, Detroit Lakes, MN																					
Year	Month	Day	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	June	13	0	0	0	100	0	0	0	0	0	50.0	0	0	0	0	0	50.0	0	0	100	0	0	50.0	0	0	0	0	0	0	50.0	0	0	0	0	0	4.00
2013	July	23	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	100	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.0
2013	Sep	8	0	0	0	100	0	0	0	0	0	0	20.0	20.0	0	0	0	0	0	0	0	0	0	20.0	0	0	0	0	0	0	0	0	0	0	0	0	1.6

Table 31. Species occurrence frequencies for S-DIQ-3, a diquat treated site for Sallie Lake, Detroit Lakes, MN, in 2013.

Site			S-DIQ-3									Location			Sallie Lake, Detroit Lakes, MN																							
Year	Month	Day	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	June	13	0	20.8	8.3	45.8	6.3	0	0	0	0	0	8.3	0	0	0	0	10.4	6.3	0	52.1	0	4.2	14.6	0	2.1	6.3	2.1	0	0	0	14.6	0	0	2.1	0	0	2.04
2013	July	23	0	6.3	43.8	81.3	0	0	0	0	0	0	37.5	0	0	0	0	0	37.5	0	37.5	0	0	25.0	0	31.3	0	0	0	0	18.8	0	0	0	50.0	6.3	0	3.75
2013	Sep	8	0	0	12.5	100	0	0	0	0	0	0	18.8	6.3	0	0	0	0	0	0	0	0	6.3	25.0	0	25.0	0	0	0	0	0	0	0	0	50.0	0	0	2.44

Table 32. Species occurrence frequencies for S-Ref-1, an untreated reference site for Sallie Lake, Detroit Lakes, MN, in 2013.

Site			S-REF-1									Location			Sallie Lake, Detroit Lakes, MN																						
Year	Month	Day	Bidens beckii	Butomus umbellatus	Ceratophyllum demersum	Chara	Drepanocladus	Elodea canadensis	Heteranthera dubia	Juncus pelocarpus	Lemna minor	Lemna trisulca	Myriophyllum sibiricum	Najas flexilis	Nitella	Nymphaea odorata	Nuphar luteum	Potamogeton crispus	Potamogeton foliosus	Potamogeton gramineus	Potamogeton illinoensis	Potamogeton natans	Potamogeton praelongus	Potamogeton richardsonii	Potamogeton robbinsii	Potamogeton zosteriformis	Ruppia cirrhosa	Ranunculus longirostris	Schoenoplectus acutus	Sagittaria cuneata	Stuckenia pectinata	Typha angustifolia	Typha latifolia	Utricularia macrorhiza	Vallisneria americana	Wolffia	Average species richness/pt.
2013	June	13	0	83.9	48.4	6.5	22.6	9.7	0	0	0	45.2	32.3	0	0	0	22.6	12.9	0	0	6.5	0	0	29.0	0	0	6.5	0	54.8	0	3.2	0	0	22.6	0	0	4.06
2013	July	23	0	61.3	61.3	6.5	0	12.9	0	0	0	25.8	48.4	16.1	0	32.3	9.7	0	16.1	3.2	9.7	0	0	35.5	0	48.4	0	0	54.8	0	19.4	0	0	29.0	25.8	0	5.16
2013	Sep	8	0	58.1	71.0	25.8	3.2	9.7	0	0	0	51.6	90.3	3.2	0	45.2	0	9.7	6.5	0	32.3	0	0	54.8	0	74.2	3.2	0	54.8	0	22.6	0	0	29.0	22.6	12.9	6.84