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Management of flowering rush in the Detroit Lakes, Minnesota

JOHN D. MADSEN, BRADLEY SARTAIN, GRAY TURNAGE, AND MICHELLE MARKO*

ABSTRACT

Flowering rush (*Butomus umbellatus*) is an invasive aquatic plant introduced to North America from Eurasia in 1897. Flowering rush can grow either submersed or emergent from wet soil habitats to waters that are up to 5 m deep. Flowering rush was first observed in the Detroit Lake system in the 1960s, causing significant impact to shoreline and recreational use. Flowering rush is currently found in five basins of the Detroit Lake system: Big Detroit, Little Detroit, Curfman, Sallie, and Melissa Lakes. Submersed treatments with diquat were used during 2012 on an operational scale to control the nuisance impacts of flowering rush in waters from 0 to 1.3 m deep. We evaluated the response of native plant communities with the use of a point intercept method on 30 or more predetermined points in each of nine treatment plots, with four untreated reference plots. Treatment plots were sampled before treatment (June), and 4 wk after each of the two treatments. We also sampled 20 biomass cores (0.018 m^{-2}) in each of four treatment and four untreated reference plots. Although some species declined after treatment, most native species did not change significantly after treatments compared to untreated reference plots. Treatments with diquat not only significantly reduce flowering rush distribution (60%) and aboveground biomass (99%), but also significantly reduced belowground biomass (82%) and rhizome bud density (83%). As flowering rush is an herbaceous perennial that propagates predominantly by rhizome buds, reductions in rhizome bud density indicate that this approach can be used for long-term reduction in flowering rush populations.

Key words: *Butomus umbellatus* L., chemical control, diquat, efficacy, emergent plant, invasive plant, native plant diversity, selectivity.

INTRODUCTION

Flowering rush (*Butomus umbellatus* L.) is a nonnative emergent plant that has invaded the Detroit Lakes (Minnesota) area; in particular, Detroit Lake (Big Detroit, Little Detroit, and Curfman Lakes), Lake Sallie, Lake Melissa, and Mill Pond (Marko et al. 2015). It is native to Europe and Asia and first entered the United States in 1928 (Bellaud 2009). Flowering rush has continued to be a problem in the lake for at least three decades.

In the Detroit Lakes area, the flowering rush has been determined to be triploid (Kliber and Eckert 2005, Lui et al. 2005, Poovey et al. 2012). This is one of two cytotypes in the species (Hroudova et al. 1996); the other is diploid. The diploid is sexually fertile and self-compatible, whereas the triploid is predominantly sterile and self-incompatible. In the triploid cytotype, the principal means of spread are vegetative growth of the rhizome and production of lateral and terminal buds on the rhizome (Hroudova 1989, Hroudova et al. 1996).

Although flowering rush has been in North America for over 40 yr, little information is known about its 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, and all of the states bordering Canada and the Great Lakes (U.S. Department of Agriculture 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." Parkinson and others (2010) are also limited in their management recommendations, citing either imazapyr or imazamox foliar applications for management of flowering rush.

In aquarium studies, the U.S. Army Engineer Research and Development Center (USAERDC) evaluated 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 mg ai L^{-1}) and at 6 and 12 h contact time significantly reduced shoot biomass relative to the reference. Endothall treatments at 1.5 and 3 ppm at both 12- and 24-h exposure time also reduced shoot biomass. No treatments reduced belowground biomass. In contrast, their studies with Idaho-derived plants found flumioxazin at 400 μg ai L^{-1} and 24-h exposure time controlled shoot biomass, and endothall at 3 mg ai L^{-1} and 24-h exposure time controlled both aboveground and belowground biomass (Poovey et al. 2012). They also note

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that repeated treatments with contact herbicides, or integration with systemic herbicides, would be needed to achieve long-term control.

Under mesocosm conditions, submersed applications of 2,4-D, triclopyr, imazamox, a tank mix of 2,4-D and triclopyr, and a tank mix of 2,4-D and a surfactant did not reduce either shoot or belowground biomass of flowering rush (Wersal et al. 2014). In contrast, foliar treatments (including a surfactant) of 2,4-D, triclopyr, a tank mix of 2,4-D and triclopyr, aminopyralid (not labeled for aquatic use), imazapyr, glyphosate, and a tank mix of imazapyr and glyphosate reduced both shoot and belowground biomass (Wersal et al. 2014). Foliar applications (including a surfactant) of imazamox or a tank mix of imazamox and glyphosate did not control belowground biomass, but did control shoot biomass (Wersal et al. 2014). All of these applications would require repeated treatments for successful control.

Under field conditions in 2011, we treated larger plots to evaluate submersed applications of endothall. We had two 4-ha plots for endothall treatments, two 0.4-ha plots for diquat, and we conducted a rhodamine dye study in conjunction with the herbicide applications (Madsen et al. 2012). Biomass data indicated that endothall treatments did not reduce above- or belowground biomass with the first treatment, but two sequential diquat treatments significantly reduced flowering rush aboveground biomass, but not belowground biomass. Assessment of the species composition of the plots found no reduction in native species diversity after the second treatment of diquat. Dye studies found that the herbicide moved quickly out of the large plots, following shoreline currents (Madsen et al. 2012). Half-life of dye in endothall plots ranged from 3 to 6 h. Although 3 to 6 h is sufficient for control of some species with diquat, it is not sufficient to control plants using endothall (Netherland et al. 1991, Glomski et al. 2005, Skogerboe et al. 2006). Therefore, we recommend submersed plant treatments with diquat, until such time as alternatives can be identified.

For diquat treatments, our goal was to measure efficacy of control of the nuisance impacts of flowering rush and reduction of reproductive ability through reduction of belowground biomass and rhizome bud density through biomass sampling. We also wanted to evaluate the impact of diquat treatments on native plant communities with the use of a point-intercept survey method. In this paper, we present the results of operational-scale treatments in multiple plots across several basins in the Detroit Lakes system in 2012.

MATERIALS AND METHODS

Site description

The Detroit Lake system is a series of five basins connected by streams or narrows, in the vicinity of the City of Detroit Lakes, MN (46.81333°N, 95.844722°W), which is 74 km (46 miles) east of Fargo, ND. Three of the basins (Big Detroit, Little Detroit, and Curfman) are contiguous and separated only by shallows or narrows (Figure 1). The remaining two, Sallie and Melissa Lakes, are downstream of the other three basins connected by a small stream. The lakes are mesotrophic to meso-eutrophic, and are classified as glacial kettle lakes. Approximately 359 ha of flowering rush was delineated in the Detroit Lakes basin in 2011 (Figure 1). In this system, the flowering rush was confirmed by laboratory testing to be triploid (Poovey et al. 2012).

Study design

For this 2012 operational-scale study, we established nine submersed diquat treatment plots (all lakes) and four untreated reference plots (Big Detroit, Little Detroit, Sallie, and Melissa) (Figure 1, Table 1). Though we found flowering rush in depths up to 4.8 m in the Detroit Lakes area (Madsen et al. 2012), the plant causes nuisances principally in shallow water. For this reason, we established plots in which water depths ranged from 0 to 1.3 m deep.

Treatments were not randomly assigned to plots, but were assigned based on the relative abundance of flowering rush to minimize the variability of biomass samples. In some instances, reference plots were selected to avoid treating stands of hardstem bulrush [*Schoenoplectus acutus* (Muhl ex Bigelow) À Löve & D. Löve].

Herbicide treatments

A target rate of 4.2 kg diquat dibromide ha^{-1} was applied for this study, for a target water concentration of 0.38 mg L^{-1} of diquat cation.[1] This was achieved by stratifying application rates by depth. From the shoreline to depths of 0.6 m, a rate of 4 L ha^{-1} was applied of formulated product, and from 0.6 m to 1.3 m deep, a rate of 8 L ha^{-1} was used, as per the U.S. Environmental Protection Agency label (Syngenta Crop Protection 2011). These repeated treatments of the same areas were done twice during the growing season, the first in June, and the second in July (Table 1). Treatments occurred in Big Detroit, Curfman, Sallie, and Melissa Lakes (Figure 1, Table 1).

Biomass assessment

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

Biomass assessment of flowering rush was performed by sampling both above- and belowground biomass with a 15-cm-diameter biomass coring device (0.018 m^2) (Madsen et al. 2007). Four of the nine treatment plots (two in Big Detroit, one each in Sallie and Melissa) were sampled for biomass, as were four untreated reference plots (one each in Big Detroit, Little Detroit, Sallie, and Melissa), for a total 160 biomass samples per sample period. Biomass samples were taken at predetermined randomly selected points from the point-intercept points of those plots. After washing to remove sediment, cores were either shipped to Mississippi State University for processing, or held on ice until being

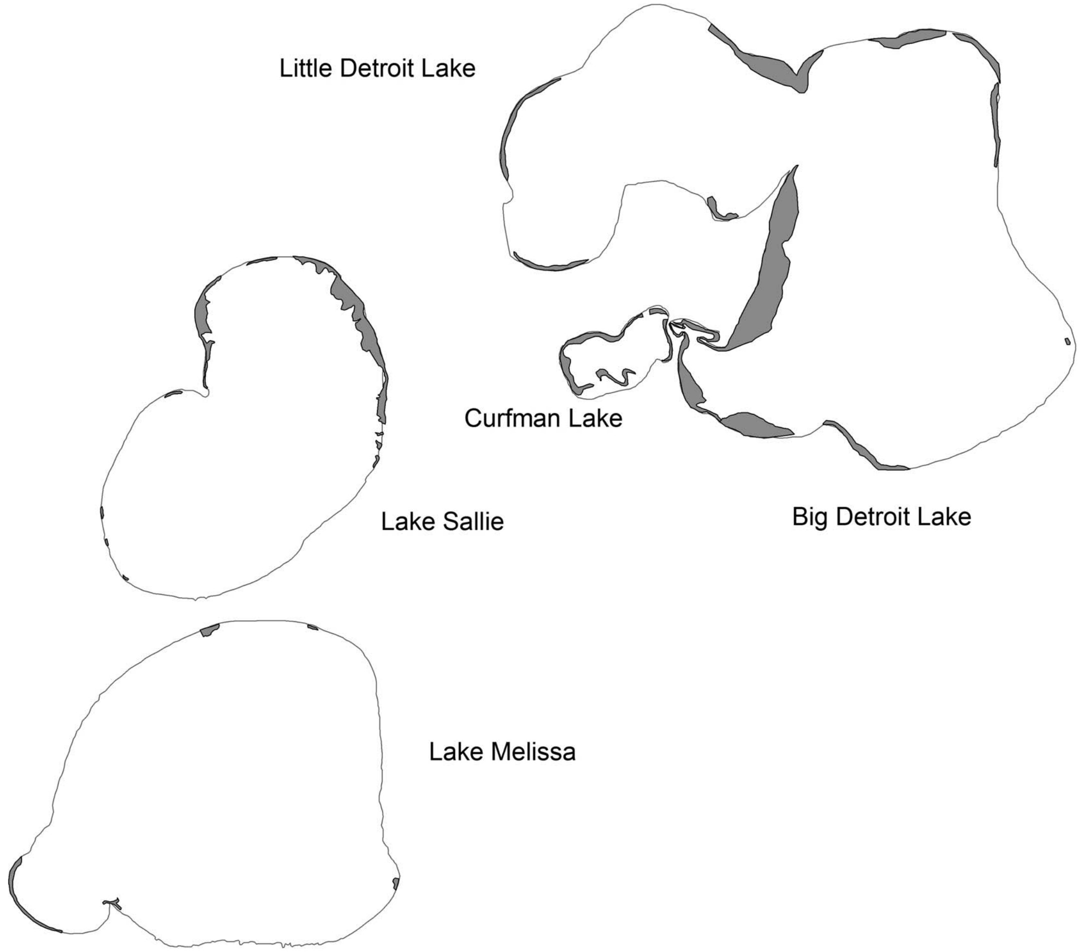

Figure 1. Locations of flowering rush (*Butomus umbellatus*) treated in Big Detroit, Little Detroit, Curfman, Sallie, and Melissa Lakes, MN.

returned to campus. Cores were separated into aboveground and belowground biomass. Ramets and rhizome buds were counted. Plants were dried for 48 h at 70 C or greater, and weighed for biomass. Successful applications should reduce rhizome weight and rhizome bud density. Statistical analysis of biomass data was performed with 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 by time. Analysis was done with Statistix[2] Analytical Software.

Native plant community assessment

To assess the community impact of submersed diquat treatments, point-intercept sampling (Madsen 1999, Wersal

Table 1. Diquat treatment dates, areas, and volumes along with application conditions in the Detroit Lakes, MN during 2012. Weather data from application records (PLM Lake and Land Management Corporation, unpub. records).

Basins	Area (ha [ac])	Volume of herbicide (L [gal])	Rate (L ha^{-1} [gal ac^{-1}])	Wind Direction (Cardinal)	Wind Speed (km h^{-1} [mi h^{-1}])
First diquat application, June 6, 2012					
Detroit	46.8 (117)	805 (212)	2.8 (1.81)	ESE	5 (3)
Curfman	5.1 (12.7)	79.4 (20.9)	2.5 (1.65)	ESE	5–11 (3–7)
Melissa	5.4 (13.6)	103 (27.2)	3.0 (2.0)	ESE	5–8 (3–5)
Sallie	6.9 (17.3)	122 (32.2)	2.8 (1.86)	ESE	5–11 (3–7)
Second diquat application, July 19, 2012					
Detroit	46.8 (117)	805 (212)	2.75 (1.81)	SSE	5–11 (3–7)
Curfman	2.8 (7)	53.2 (14)	3.0 (2.0)	SSE	5–11 (3–7)
Melissa	5.4 (13.6)	110 (29)	3.0 (2.0)	SSE	5–11 (3–7)
Sallie	6.9 (17.3)	116 (30.5)	2.68 (1.76)	SSE	5–11 (3–7)

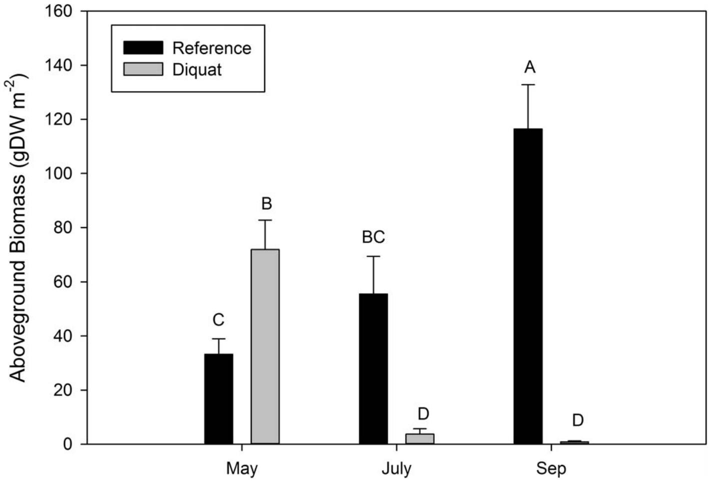

Figure 2. Flowering rush (*Butomus umbellatus*) aboveground biomass (g dry weight [DW] m^{-2}) of untreated reference vs. diquat-treated plots for four treated and four reference plots in the Detroit Lakes, Minnesota in 2012. Means with the same letter are not significantly different at the $P = 0.05$ level. Bars indicate + 1 standard error of the mean.

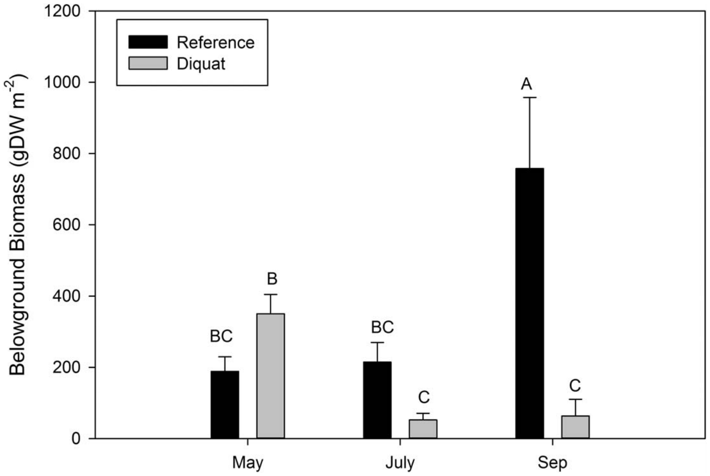

Figure 3. Flowering rush (*Butomus umbellatus*) belowground biomass (g dry weight [DW] m^{-2}) of untreated reference versus diquat-treated plots for four treated and four reference plots in Detroit Lakes, Minnesota in 2012. Means with the same letter are not significantly different at the $P = 0.05$ level. Bars indicate + 1 standard error of the mean.

et al. 2010, Madsen and Wersal 2012) was done on all nine treated plots, and four reference plots. Taxonomic identifications followed Crow and Hellquist (2000a,b). The grid interval was no less than 25 m. The numbers of points varied among the plots, but equal numbers of plots or samples are not required for a McNemar's test. Statistical analysis was performed with the use of a McNemar's test, testing for a statistically significant change in frequency between the current time and the previous time interval (Wersal et al. 2010, Cox et al. 2014). Analysis was performed with SAS.[3]

RESULTS AND DISCUSSION

Biomass assessment

A two-way analysis of variance (ANOVA) found a significant reduction in aboveground biomass from diquat treatments in the four treated plots, from 72 g dry weight (DW) m^{-2} in May to 0.83 g DW m^{-2} in September (Figure 2, Table 2). In contrast, reference plots had a significant increase in aboveground biomass, from 33 g DW m^{-2} in May to 120 g DW m^{-2} in September 2012 (Figure 2, Table 2). The significant interaction (Treatment by Month) term is the result of aboveground biomass in treated plots decreasing in abundance and aboveground biomass in untreated reference plots increasing in abundance.

Table 2. Two-way analysis of variance of aboveground biomass (g dry weight [DW] m^{-2}), belowground biomass (g DW m^{-2}), and rhizome bud density (N/m^{-2}) from four diquat treatment and four reference plots across three basins of Detroit Lakes, MN during 2012. $N = 479$. Treatment $*$ Month is the interaction term.

Source	Degrees of Freedom	F score	P value
Aboveground biomass (g DW m^{-2})			
Treatment	1	26.77	≤ 0.0001
Month	2	4.56	0.0109
Treatment by Month	2	29.18	≤ 0.0001
Belowground biomass (g DW m^{-2})			
Treatment	1	9.65	0.0020
Month	2	4.61	0.0104
Treatment by Month	2	11.21	≤ 0.0001
Rhizome bud density (N m^{-2})			
Treatment	1	6.52	0.0110
Month	2	5.21	0.0058
Treatment by Month	2	6.46	0.0017

The measurement of abundance, such as biomass, is the best method to evaluate the effectiveness of control (Madsen 1993a, Madsen and Bloomfield 1993). Because the aboveground biomass often causes the nuisance problem, reduction in biomass may measure the reduction in nuisance potential. Although 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, because rhizomes are the dominant constituent of belowground biomass, and rhizome bud density, because buds appear to be the perennating and regrowth propagule (Hroudova et al. 1996, Madsen et al. 2012, Marko et al. 2015). Rhizomes are the main location to store carbohydrates, essential for overwintering and for regrowth from management. In our companion studies, we found about 70% of the flowering rush biomass was in the rhizomes, which contained about 10% starch. In the densest part of a flowering rush bed, more than 300 buds m^{-2} were produced (Madsen et al. 2012, Marko et al. 2015). Rhizome buds are the individual growing points from which new ramets or leaves regrow. Reductions in these two constituents indicate long-term control.

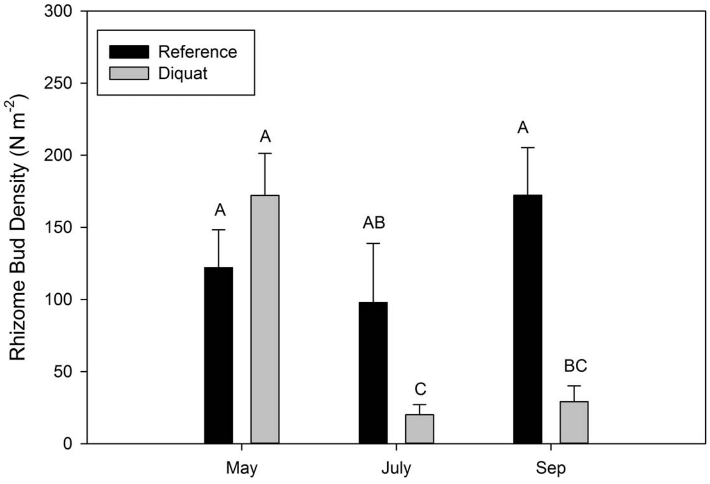

Figure 4. Flowering rush (*Butomus umbellatus*) rhizome bud density (N m^{-2}) of untreated reference versus diquat-treated plots for four treated and four reference plots in Detroit Lakes, MN in 2012. Means with the same letter are not significantly different at the $P = 0.05$ level. Bars indicate + 1 standard error of the mean.

In 2011, we did not observe a reduction in belowground biomass with two diquat treatments, albeit with a much smaller sample size (Madsen et al. 2012). Nevertheless, in the current study, a two-way ANOVA found a significant treatment effect from diquat treatments on belowground biomass (Figure 3, Table 2). Reference plot belowground biomass was constant from May and July and significantly higher in September. Belowground biomass in diquat-treated plots, on the other hand, was highest in May (350 g DW m^{-2}), and declined to 64 g DW m^{-2} in September (Figure 3, Table 2). Belowground biomass samples are notoriously variable, in part because of the difficulty of consistently cleaning sediment and debris from the sample (pers. obs.). The significant interaction (Treatment by Month) term is the result of belowground biomass decreasing in the treated plots over time, and biomass increasing over time in the untreated reference plots. Other studies have likewise not detected a reduction in belowground biomass from most herbicide treatment of flowering rush, including field treatments in Idaho and mesocosm studies in Mississippi (Woolf et al. 2011), and aquarium studies with Minnesota plants (Poovey et al. 2012). Repeating this finding would ensure confidence that treatments are, in fact, reducing belowground biomass, as would controlled experiments under mesocosm conditions.

Rhizome bud density should be a more conservative measure of reduction in the potential for plants to regrow. A two-way ANOVA of rhizome bud density found no statistically different change in bud density across the season for untreated reference plots, but did find a significant decrease in bud density between pretreatment values in May and posttreatment values in July and September of diquat-treated plots (Figure 4, Table 2). In May, bud density averaged 170 N m^{-2}, whereas July averaged 20 N m^{-2} and September averaged 29 N m^{-2}, a decrease of 80 to 90%. The significant interaction (Treatment $*$ Month) term is the result of rhizome bud density decreasing in treated plots over time, and rhizome bud density not changing over time in untreated reference plots.

These findings support a use pattern in which repeated treatments with diquat reduces the nuisance of emergent flowering rush, and actually contributes to long-term control by reducing rhizome bud density. Continued monitoring of rhizome buds should show long-term suppression of rhizome bud density. Using propagule abundance to evaluate the effectiveness of management efforts has been used for curlyleaf pondweed (*Potamogeton crispus* L.) turions (Johnson et al. 2012), hydrilla [*Hydrilla verticillata* (L.f.) Royle] subterranean turions (Richardson 2012), and waterchestnut (*Trapa natans* L.) seeds (Madsen 1993b, Methe et al. 1993). A controlled study in mesocosm tanks would also strengthen the case that this management program has long-term benefit to controlling flowering rush.

Native Plant Community Assessment

Although decreasing the nuisance growth and reducing the long-term potential of spread and regrowth is important for managing invasive plants, this benefit must be weighed against possible damage to the native plant community. For the diquat treated plots, 7 species were found to increase, 8 to decrease, and 17 did not change (Table 3). This compares favorably with the reference plots, in which 7 increased, 5 decreased, and 20 remained the same (Table 4). The species that decreased in the diquat plots that did not decrease in the reference plots were elodea, leafy pondweed, claspingleaf pondweed, sago pondweed, and bladderwort. Claspingleaf had lower numbers in July, but increased again in September. Although some individual plants had evidence of herbicide injury, most species were not affected in frequency by the treatments.

Submersed contact herbicide treatments on large blocks using diquat herbicide exceeded our expectations in three ways. First, the treatments were much more effective at reducing aboveground biomass and nuisance growth than expected. Our expectation was that diquat would only control plants within the area accessible to the treatment boat, and we would have to treat plants in the water depths of 0.3 m or less with a subsequent foliar application. Localized dissipation allowed control of aboveground biomass, including emergent leaves, even in very shallow water. The effectiveness of diquat in controlling flowering rush all but obviated the need for emergent plant treatments, which were only needed in areas in which diquat was not applied. Second, diquat treatments reduced belowground biomass and rhizome bud density, contributing to long-term control. Most people insist that only a systemic herbicide can effectively control belowground biomass or be used for long-term control, but our results indicate that a contact herbicide can control belowground biomass and reduce rhizome bud density. Although it is premature to base new treatment program on a single year's result, this result is an indication that populations of

Table 3. Summary of species percent frequency of occurrence by month for all diquat-treated plots in all lakes for 2012. May is pretreatment data, July and September are 4 wk after the first and second diquat treatment, respectively. Species that did not constitute at least 5% of the points in any month in either treatment were not reported. An asterisk indicates a significant difference from the previous month, as indicated by a McNemar's test.

Common Name	Species	May %	July %	September %
Flowering rush	*Butomus umbellatus* L.	78	33*	31
Coon's tail	*Ceratophyllum demersum* L.	6	20*	27*
Chara	*Chara* spp.	46	73*	69*
Moss	*Drepanocladus* spp.	7	15*	9*
Elodea	*Elodea canadensis* Michx.	13	3*	1
Forked duckweed	*Lemna trisulca* L.	9	11	12
Northern water milfoil	*Myriophyllum sibiricum* Kom.	8	10	16
Slender naiad	*Najas flexilis* (Willd.) Rostk. & Schmidt	0	4*	3
Yellow pond-lily	*Nuphar lutea* (L.) Sm.	3	9*	5
White waterlily	*Nymphaea odorata* Aiton	0.3	0	2
Curly leaf pondweed	*Potamogeton crispus* L.	13	0.6*	0.7
Illinois pondweed	*Potamogeton illinoensis* Morong	22	18	26
White stem pondweed	*Potamogeton praelongus* Wulfen	9	11	9
Claspingleaf pondweed	*Potamogeton richardsonii* (Benn.) Rydb.	36	19*	28*
Flatstem pondweed	*Potamogeton zosteriformis* Fernald	11	20*	26
Spiral ditchgrass	*Ruppia cirrhosa* (Petagna) Grande	2	0.6	0.3
White water crowfoot	*Ranunculus longirostris* Godr.	14	0*	0
Hardstem bulrush	*Schoenoplectus acutus* (Muhl. ex Bigelow) Á. Löve & D. Löve	3	3	3
Sago pondweed	*Stuckenia pectinata* (L.) Börner	22	6*	9
Bladderwort	*Utricularia macrorhiza* Leconte	21	9*	7
Water celery	*Vallisneria americana* Michx.	0	44*	70*

flowering rush could in fact be reduced with this herbicide usage pattern. Third, the adverse effect of diquat treatments on native plant communities was much less than expected. Diquat is often considered the ultimate in broad-spectrum herbicides, and would cause a reduction in all species within the treatment plot. However, a number of submersed species were not reduced by diquat applications. On the other hand, we did not measure abundance of native plant species, and we did note that many species appeared to have some herbicide damage. Further documentation of treatments may indicate if long-term applications will reduce populations.

SOURCES OF MATERIALS

[1] Tribune® Herbicide, Syngenta Crop Protection, Inc., 410 South Swing Rd., Greensboro, NC 27419.

[2] Statistix 10.0, Analytical Software, 2105 Miller Landing Road, Tallahassee, FL 32312.

[3] SAS, SAS Institute Inc., 100 SAS Campus Drive, Cary, NC 27513.

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Table 4. Summary of species percent frequency of occurrence by month for all submersed application reference plots in all lakes for 2012. May is pretreatment data, July and September are 4 wk after the first and second diquat treatment, respectively. Species that did not constitute at least 5% of the points in any month in either treatment were not reported. An asterisk indicates a significant difference from the previous month, as indicated by a McNemar's test.

Common Name	Species	May %	July %	September %
Flowering rush	*Butomus umbellatus* L.	66	40*	43
Coon's tail	*Ceratophyllum demersum* L.	2	10*	23
Chara	*Chara* spp.	55	72*	63
Moss	*Drepanocladus* spp.	2	8*	1
Elodea	*Elodea canadensis* Michx.	15	15	11
Forked duckweed	*Lemna trisulca* L.	2	0.6	8
Northern water milfoil	*Myriophyllum sibiricum* Kom.	28	25	52
Slender naiad	*Najas flexilis* (Willd.) Rostk. & Schmidt	0	11*	10
Yellow pond-lily	*Nuphar lutea* (L.) Sm.	6	11	8
White waterlily	*Nymphaea odorata* Aiton	0	11*	7
Curly leaf pondweed	*Potamogeton crispus* L.	7	1*	0
Illinois pondweed	*Potamogeton illinoensis* Morong	24	28	49
White stem pondweed	*Potamogeton praelongus* Wulfen	8	0*	8
Claspingleaf pondweed	*Potamogeton richardsonii* (Benn.) Rydb.	26	24	37
Flatstem pondweed	*Potamogeton zosteriformis* Fernald	7	22*	15
Spiral ditchgrass	*Ruppia cirrhosa* (Petagna) Grande	6	1*	6
White water crowfoot	*Ranunculus longirostris* Godr.	16	4*	0
Hardstem bulrush	*Schoenoplectus acutus* (Muhl. ex Bigelow) Á. Löve & D. Löve	22	21	17
Sago pondweed	*Stuckenia pectinata* (L.) Börner	11	17	25
Bladderwort	*Utricularia macrorhiza* Leconte	16	19	2
Water celery	*Vallisneria americana* Michx.	0	21*	48

ments, and provided information on those treatments. Field and laboratory assistance was provided by students from Mississippi State University and Concordia College, Moorhead, MN. Reviews before submission were provided by Guy Kyser, Chip Welling, and Dr. Ryan Wersal. Mention of a manufacturer does not constitute a warranty or guarantee of the product by the U.S. Department of Agriculture nor an endorsement over other products not mentioned.

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