RESULTS OF THE POST-APPLICATION VEGETATION SURVEY OF GOOSE BAY, NEW YORK

FINAL REPORT

PREPARED FOR:

GOOSE BAY RECLAMATION CORPORATION

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The milfoil control effort at Goose Bay is the result of the hard work of many people without whom this effort would not be possible. Special thanks are due Bob Lamoureux, President of the Goose Bay Reclamation Corporation (GBRC), as well as to Stewart Davey and other members of GBRC who voluteered their time to organize this effort, obtain funding, and assist with permit applications.

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Goose Bay landowners and members graciously provided shoreline access and labor.

To all, thank you for your assistance with controlling aquatic invasive species and restoring Goose Bay.

NOMENCLATURE

In this report we use the common name Eurasian water-milfoil for *Myriophyllum spicatum* following Weldy et al. (2015) in which water-milfoil is hyphenated. Water-milfoil is also commnly spelled as two words "water milfoil" or as a single word "watermilfoil."

1.0 INTRODUCTION

Goose Bay is an embayment on the St. Lawrence River in the town of Alexandria, Jefferson County, New York. It is largely enclosed and protected from the main body and currents of the St. Lawrence River (Figure 1). Goose Bay is a beautiful area with both year-round residents and summer vacation homes and is an important destination for anglers and visitors (Figure 2). Over approximately the last decade, the invasive aquatic species Eurasian water-milfoil (*Myriophyllum spicatum*) has become established in the Bay. In recent years, it has become so thick as to threaten the integrity and ecology of the bay, reducing native plant cover and recreational opportunities for residents and visitors alike (Figure 3). In an effort to restore the bay, local residents formed the Goose Bay Reclamation Corporation (GBRC).

Over a period of several years, and after volunteer efforts to hand-pull milfoil, GBRC held public meetings to consider additional available options for controlling Eurasian water-milfoil in the bay. The result of these meetings was a proposal to move forward with a pilot project to assess the efficacy of treating a portion of the bay with aquatic herbicide. Further consultations with local residents, scientists, and the New York State Department of Environmental Conservation (NYSDEC) resulted in the selection of the aquatic herbicide Renovate OTF. Prior to approving the use of Renovate OTF, NYSDEC requested a flow study and a pre-application vegetation survey. The flow study demonstrated little to no flow in the proposed treatment area (Parkes Ecological 2014), making Renovate OTF a viable treatment option. The pre-application vegetation survey (Zimmer et al. 2014) provided baseline data which could be used to compare to a post-application vegetation survey.

The appropriate applications were filed and permits obtained from NYSDEC to proceed with the application of the herbicide to a maximum of 40 acres in the vicinity of Little Goose Bay at the upwind end of the bay where milfoil was known to be extensive (Figures 3 and 4). Riveredge performed a pre-application bathymetric survey to determine the amount of herbicide to use, and on June 6, 2015, 3.24 tons of Renovate OTF was applied to 39 acres of Little Goose Bay using two boats (one airboat and one outboard-powered boat) (Figure 5).

In order to assess the efficacy of the treatment, a post-application vegetation survey was conducted on July 30, 2015. This report details the findings of this post-application vegetation survey.

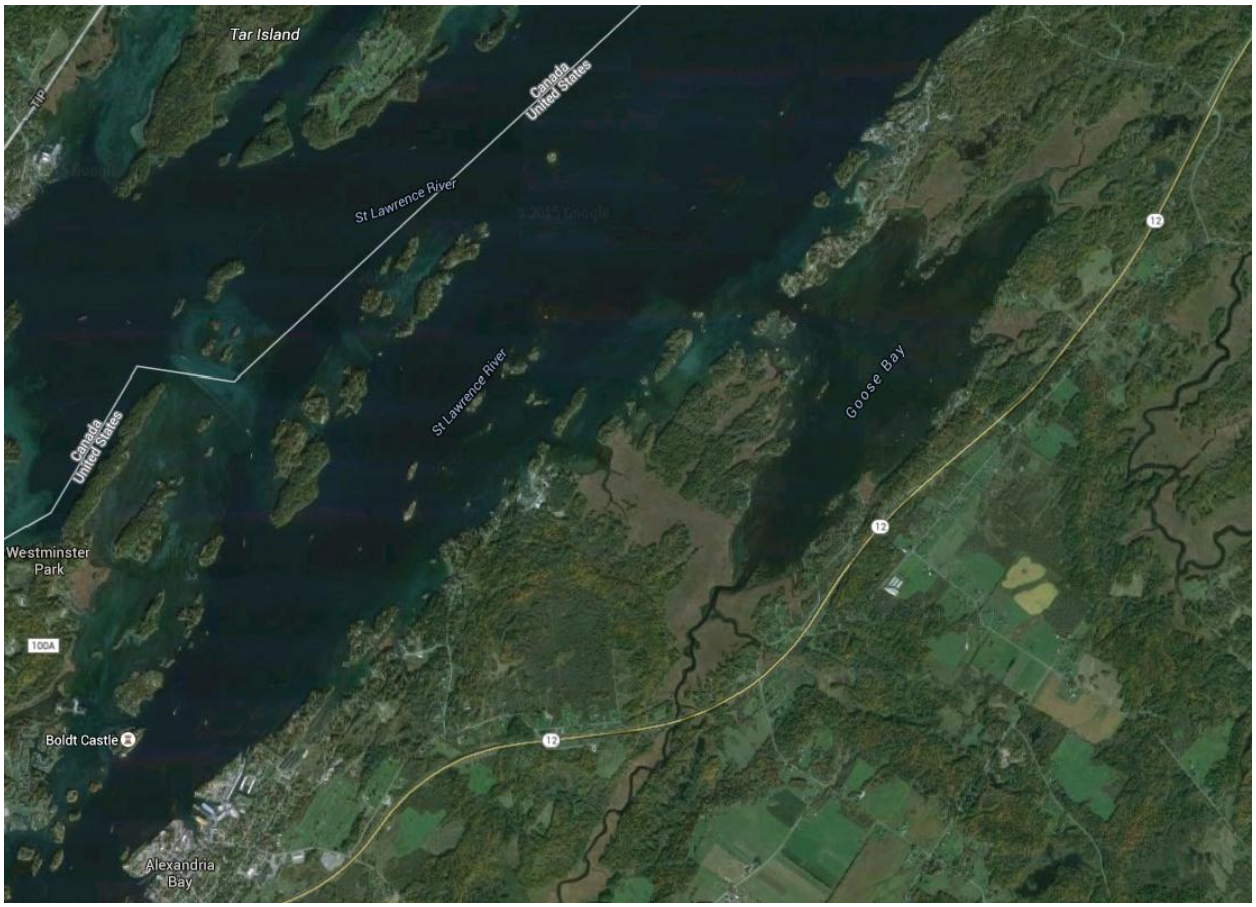

FIGURE 1. LOCATION OF GOOSE BAY, ST. LAWRENCE RIVER, NEW YORK.

FIGURE 2. GOOSE BAY, FALL 2005 .

(photos courtesy of GBRC, http://savegoosebay.weebly.com)

FIGURE 3. EURASIAN WATER-MILFOIL AT GOOSE BAY.

(photos courtesy of GBRC, http://savegoosebay.weebly.com)

FIGURE 4. LITTLE GOOSE BAY.

FIGURE 5. APPLICATION OF RENOVATE OTF TO LITTLE GOOSE BAY.

2.0 METHODS

Riveredge biologists Anne Johnson and Anna Butler conducted the post-application vegetation survey by boat on July 30-31, 2015. Percent cover for each plant species encountered was recorded within one meter square plots located along 150 meter transects (three plots per transect). The transects were established perpendicular to the shoreline within the treatment area (n=10 transects, 30 plots) and the control area (n=5 transects, 15 plots). An additional five transects and 15 plots were established in the treatment area where native broadleaved submersed aquatic vegetation was located to examine post-application response within a more varied stand of native vegetation (Figure 6). Temperature and dissolved oxygen were also recorded at each plot. After assessing percent cover, plant samples were taken and identified to genus and/or species (Figure 7).

Transects and plots were located at approximately the same locations as the pre-application vegetation survey conducted by Zimmer et al. (2014) although the GPS points of their survey were not available and the PVC stakes they installed could not be located in the field.

As in the pre-treatment report (Zimmer et el. 2014), we compared the average percent cover of each species present among the three groups. This was done by averaging the percent cover of each species in all the treatment plots (n=30), control plots (n=15), and reference plots (n=15) and creating a stacked column chart showing the percent abundance (scaled to 100%) of all species present in each of the transect areas.

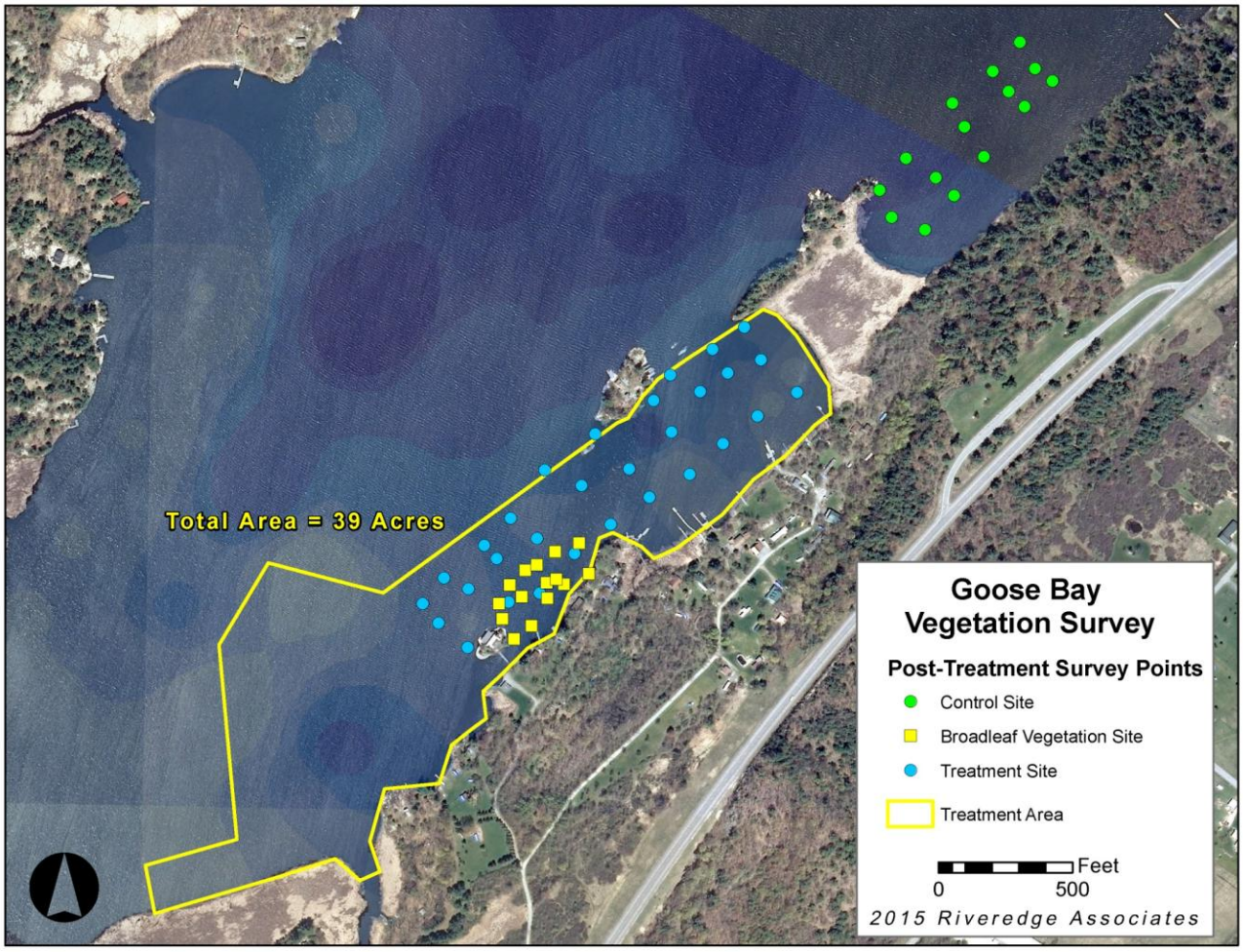

FIGURE 6. VEGETATION PLOT LOCATIONS AT GOOSE BAY.

FIGURE 7. PLANT SAMPLES WERE COLLECTED AND IDENTIFIED.

3.0 RESULTS AND DISCUSSION

The average percent cover of Eurasian water-milfoil decreased after treatment with Renovate OTF (Table 1). In fact, no Eurasian water-milfoil was recorded in any of the 45 vegetation plots within the area treated (Table 1, Figure 8). Cover of other vascular plant species also decreased in both the treatment and reference areas.

Pre-treatment survey results showed no significant difference in the average cover of Eurasian water-milfoil between the treatment area (28.9%), the control area (20.7%), or the native broad-leaved (or reference) area (28.4%). Some individual plots in the pre-treatment survey had 100% coverage by Eurasian water-milfoil.

Post-application survey results showed a significant difference between treatment and control areas ($p<.05$) using one way ANOVA. In addition, the percent cover of milfoil was significantly different between pre- and post-application surveys (Table 1).

Mean total cover of all aquatic vegetation in the treatment area (including reference plots, n=45) in 2015 was 19.7%. While total cover was not calculated in the pre-treatment survey, a qualitative estimation can be estimated based on the percent cover of all the species added together within each plot as well as verbal communication with landowners, with an estimate close to 90% overall. The most prevalent species (not including algae) noted in 2015 were tape-grass (*Vallisneria americana*) and water stargrass (*Heteranthera dubia*), both of which are considered valuable fish habitat and food plants for waterfowl.

Percent cover of the next most dominant species within plots (*Vallisneria*) increased within the treatment area from 5.2% in 2014 to 15.5% in 2015 (Figures 9 and 10). Total cover of additional species was estimated to be higher in 2014 than in was in 2015.

Percent cover sampled before treatment of milfoil was not that high as an average, though closer to shore landowners reported very high coverage. The application of Renovate in these areas was an effective milfoil control, and may also have contributed to a decline of native vegetation in both the treatment and reference areas. Water monitoring test results showed that low levels of Renovate OTF migrated within the bay, presumably due to wind, and this may have affected the vegetation in other areas, although aquatic vegetation density and composition also varies naturally from year to year.

Dissolved oxygen in treatment plots was higher but not significantly so in 2015 compared to 2014 (Table 2), though it was significantly different in the control and reference plots, lower in 2015 than in 2014 (both $p<.05$). The lower dissolved oxygen in 2015 is most likely a function of the higher temperatures during the post-application survey.

Fifteen vascular plant species and three algal species were recorded in the pre-treatment survey and 12 vascular plant species and a number of algal species in the post-application survey (Table 3). Algal species in the post-application survey were quantified as either *Nitella* sp., a macroalga (no *Chara vulgaris* was noted) or as mixed algae (as the blooms present during the time of sampling consisted of multiple algal species, including but not limited to *Pithophora, Rhizoclonium, Cladophora, Spirogyra*, various epiphytes, *Hydrodictyon*, various cyanobacteria, various desmids, and various diatoms). Numerous vagrant clumps consisting primarily of the duckweed *Lemna trisulca* were floating around within the treatment area and were not counted as occurring within the plots as they were not stationary. Apparently the wind had caused floating vegetation (including *Lemna trisulca*, pieces of coontail *Ceratophyllum demersum*, waterweed *Elodea canadensis* and clumps of algae) to coalesce and roll around on the bottom or underwater, forming balls or masses of vagrant vegetation. Uprooted and floating cow-lily (*Nuphar variegata*) roots were also noted in the post-survey in the treatment area.

The number of species present within the plots decreased slightly from the pre-treatment survey, though the differences may be due to a number of factors besides the herbicide, including differences in species identifications from 2014 to 2015, variations between years, and variation due to the effects of wind.

In Goose Bay, aquatic vegetation may vary from year to year depending on prevailing winds and rainfall amounts as well as other factors. Windblown vegetation tends to concentrate in areas along the shoreline. With the removal of dense beds of milfoil through treatment with Renovate OTF, other vegetation may have been more prone to breaking off and forming floating clumps. The winds were noticeable during the post-application survey, causing floating masses of vegetation to move in a northeasterly direction, concentrating in the northern portion of the bay. Residents in this area reported a noticeable reduction in the amount of milfoil washing up on shore in 2015.

TABLE 1. PERCENT COVER FOR EURASIAN WATER-MILFOIL PRE- AND POST-APPLICATION.

Area	N Plots	2014			2015		
		Mean (%)	Minimum (%)	Maximum (%)	Mean (%)	Minimum (%)	Maximum (%)
Treatment	30	28.9	0	100	0	0	0
Reference	15	28.4	0	100	0	0	0
Control	15	20.7	0	80	4.2	0	30

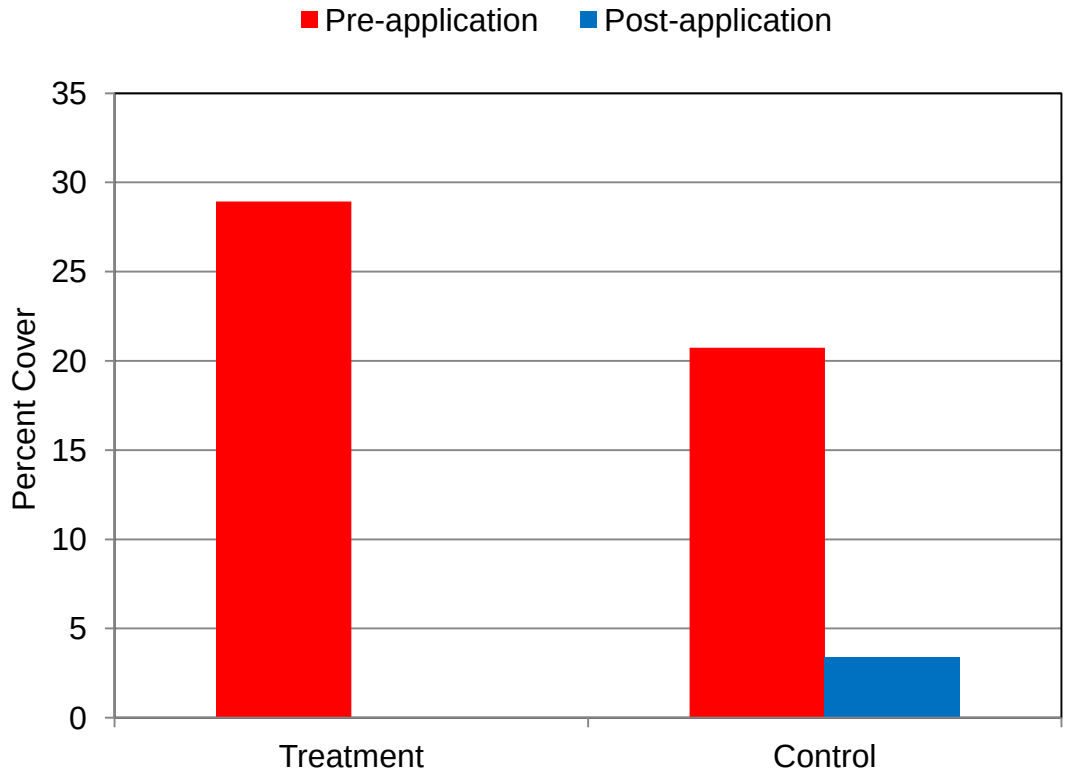

FIGURE 8. EURASIAN WATER-MILFOIL COVER IN PRE- AND POST-APPLICATION SURVEYS.

TABLE 2. DISSOLVED OXYGEN AND TEMPERATURE PRE- AND POST-APPLICATION.

Area	N Plots	Mean Dissolved Oxygen (mg/L)		Mean Temperature (^{o}C)	
		2014	2015	2014	2015
Treatment	30	9.7	10.1	22.3	26.5
Reference	15	12.3	11.0	23.7	27.0
Control	15	10.3	8.7	22.7	25.2

TABLE 3. LIST OF PLANTS ENCOUNTERED IN THE POST-APPLICATION SURVEY.

	Scientific Name	Common Name
1	*Ceratophyllum demersum*	Coontail
2	*Elodea canadensis*	Waterweed
3	*Heteranthera dubia*	Water Stargrass
4	*Lemna minor*	Duckweed
5	*Lemna trisulca*	Duckweed
6	*Myriophyllum cf. spicatum*	Eurasian Water-milfoil
7	*Najas flexilis*	Water Naiad
8	*Nuphar variegata*	Cow-lily
9	*Nymphaea odorata*	White Water-lily
10	*Potamogeton amplifolius*	Large-leaved Pondweed
11	*Potamogeton perfoliatus*	Perfoliate Pondweed
12	*Ranunculus longirostris*	White Water Crowfoot
13	*Spirodela polyrrhiza*	Duckweed
14	*Utricularia maculata*	Bladderwort
15	*Vallisneria americana*	Tape-grass

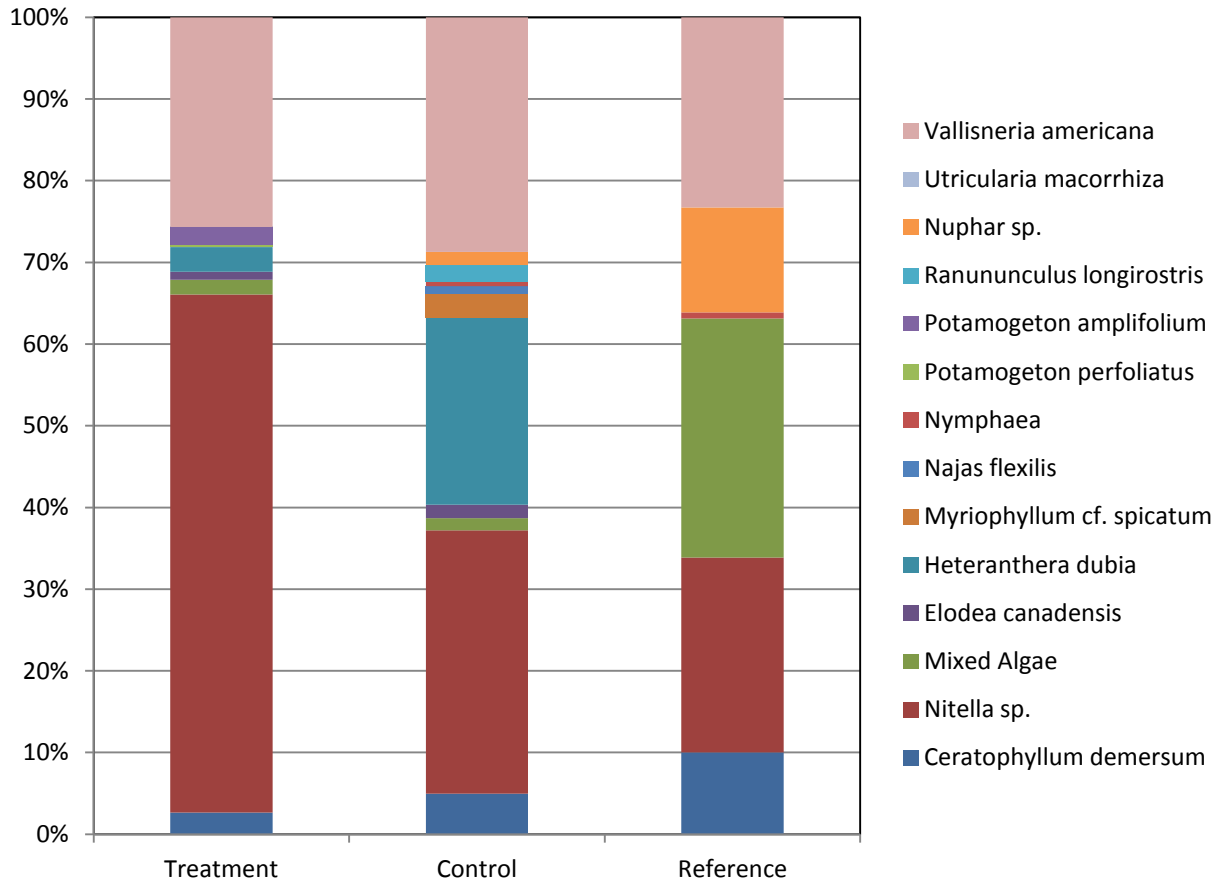

FIGURE 9. PERCENT COVER OF PLANTS FOUND IN THE POST-APPLICATION SURVEY.

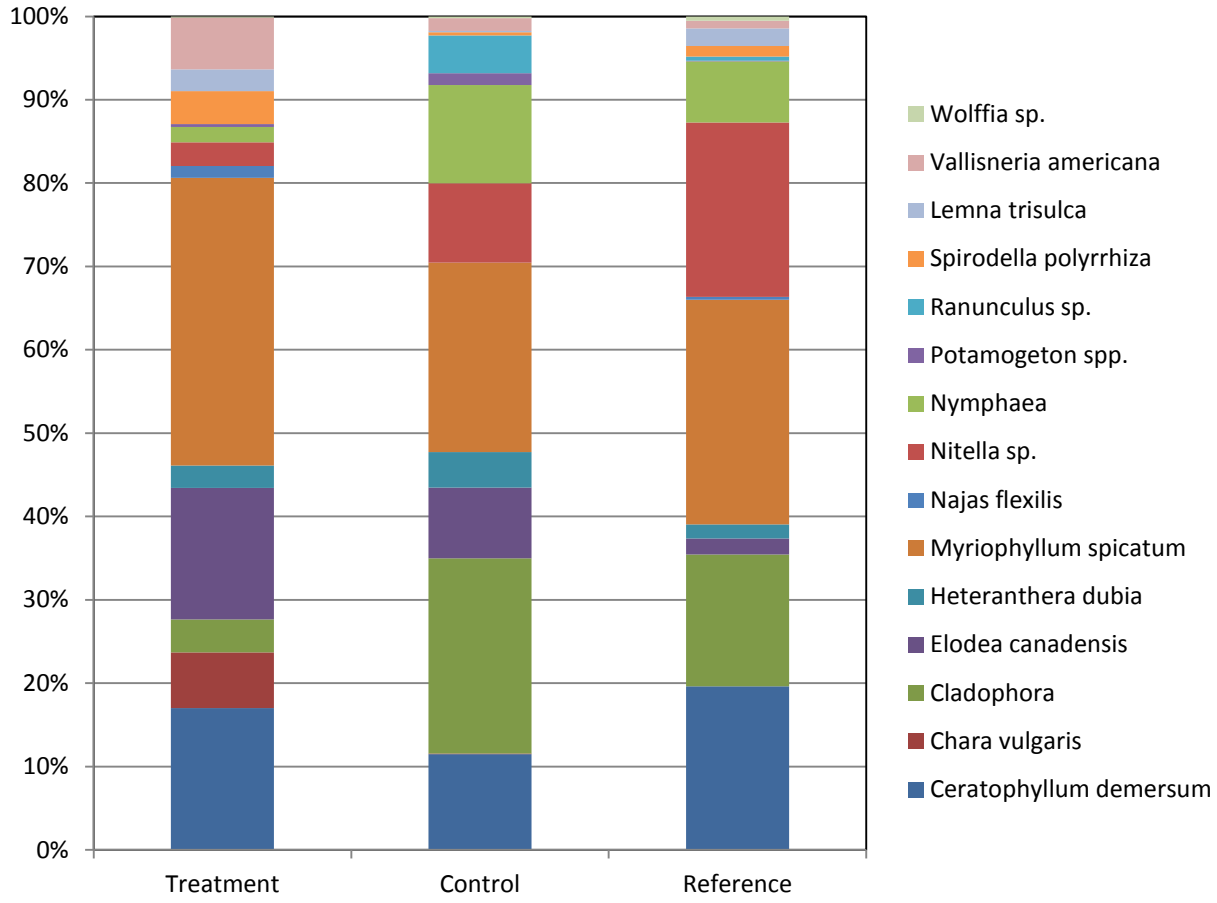

FIGURE 10. PERCENT COVER OF PLANTS FOUND IN THE PRE-APPLICATION SURVEY.

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