Supplemental Interim CMT Year 2 Report:
Bottom Barriers
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INTRODUCTION

The Control Methods Test (CMT) Year 2 Summer 2023 Interim Special Report was published October 16, 2023 (Anderson 2023) and is available at the Tahoe Keys website link: keysweedsmanagement.org under "Resources" > "Reports". The October 16th report summarizes preliminary results of Year 2 "Group B" (non-herbicide) methods except for Bottom Barriers since these treatments were still in place through late September to early October and therefore monitoring for aquatic plants within Bottom Barrier installations was not completed. This supplement to the Interim Report summarizes (1) the abundance and species of the aquatic invasive plants (AIP) present before Bottom Barriers were installed and during subsequent weeks post-removal; and (2) turbidity monitoring during installation and removal of Bottom Barriers.

While this Interim Report highlights the general results of the Bottom Barrier treatments in Year 2, the final CMT Year 2 Efficacy Report submitted to Tahoe Regional Planning Agency (TRPA) and Lahontan Regional Water Quality Control Board in March 2024 will provide more detailed information as well as the context of the Bottom Barrier results with the other Group B methods [Diver Assisted Suction Harvesting (DASH) and UV-Spot Treatments).

BOTTOM BARRIER TREATMENT INSTALLATIONS AND REMOVAL

Bottom barriers were used to cover specific areas within the larger CMT site (Figure 1). The intent of these treatments was to determine if the successful reduction in AIP from Year 1 treatments (i.e., efficacy greater than 75% reduction in biovolume or biomass) could be sustained in Year 2. The locations for bottom barrier installations were identified on plot maps provided to divers and to monitoring crews. The areas chosen to be covered by the barriers were selected to represent the Year 1 Group A treatments as well as presence of representative AIP species (Eurasian watermilfoil, Curlyleaf pondweed and Coontail). Although most areas included nearshore (shallow) locations, some areas were chosen to include deeper water (e.g., Site 10 and Site 8). Divers installed three types of bottom barrier materials: 1) impermeable yellow "turbidity" curtains (Enviro USA); 2) gas-permeable "Lake Bottom Blanket" (Lake Weed Solutions); and (3) impermeable "BTL-20 Pond Liner" (20 mil thickness). All bottom barrier materials were cut to fit the selected areas and cut sections were combined as necessary with an overlap. The turbidity curtain and "Pond Liner" materials were impermeable to gas whereas the commercial "Lake Bottom Blanket" material allowed transfers of gas with the water column. The decay of covered plants typically generates gases (for example CO_2, H_2S) and these gases can escape through the permeable material, but the impermeable turbidity curtains and "BTL-20" had to be "burped" (releasing gas) and in some instances, small openings were made in the impermeable barriers to allow gases to escape. Divers installed the barriers and secured them in place with rebar and anchors. (Note that turbidity curtains that had been re-purposed for use as bottom barriers had heavy chains attached along one edge.) The corners of the barriers were georeferenced (GPS), and the NE corner was marked with an underwater label. The integrity of the barriers was checked bi-weekly and other monitoring crews reported if abnormalities were observed.

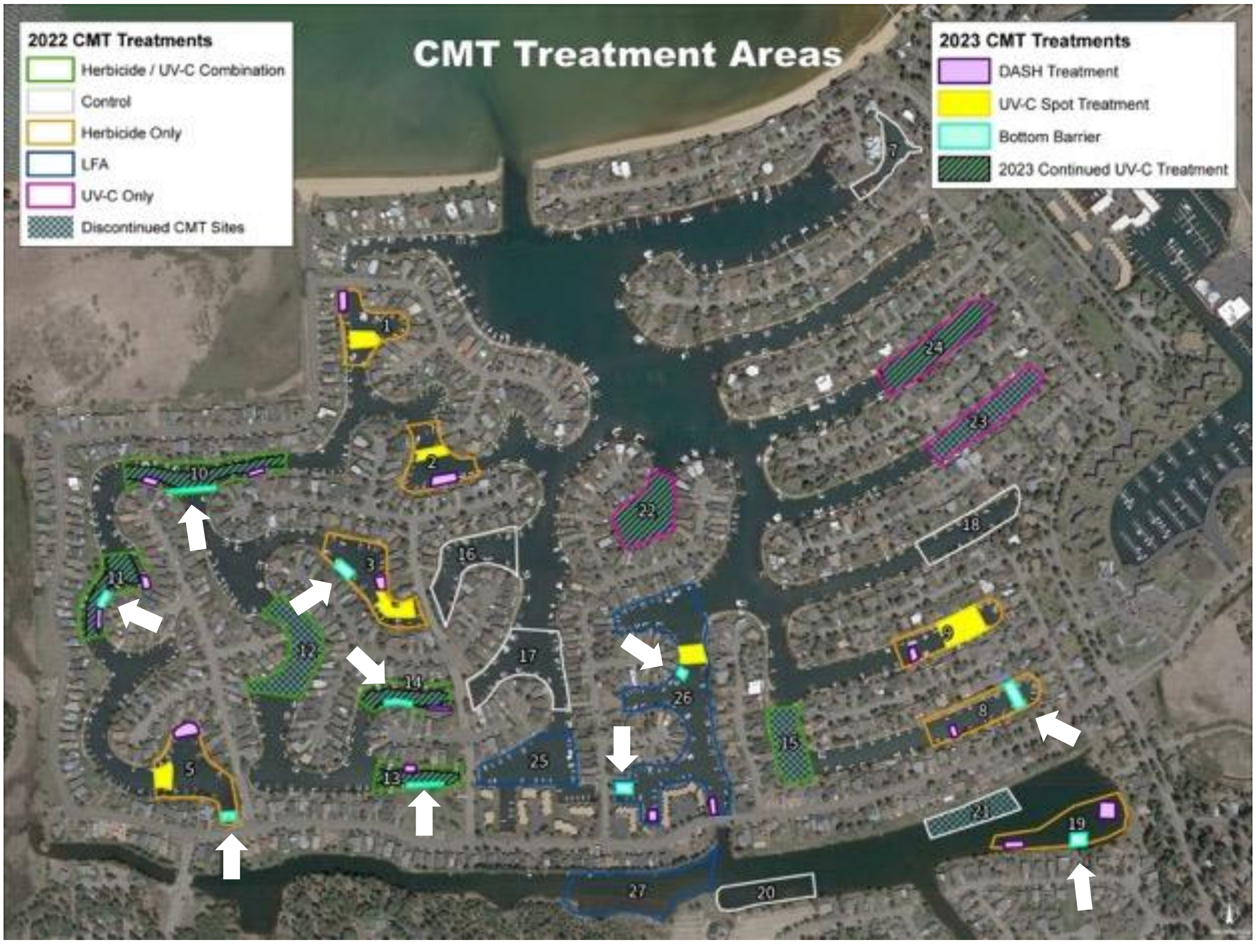


Figure1. CMT Treatment Sites and Year 2 Group B Treatment Areas: DASH, UV-C Spot Treatment, Bottom Barriers (Arrows show the Bottom Barrier Areas).

Table 1. Summary of Bottom Barrier Installation and Removal Dates and Associated Turbidity.
Note: Single red highlighted data shows the transient turbidity level that was greater than 110% of the pre-installation level (Turbidity Compliance Sources: APAP 1, Table 11. Group B: Spot Treatments of DASH and/or Bottom Barriers Monitoring; pg. 59, MMRP, Attachment B, Section 2.0; pg. 21-22)

Bottom Barrier Site:	Size (Sqft)	Installled	Turbidity: Pre/24 hr Post Install (NTU)	Removed	Turbidity: Pre/24 hr Post Remobal (NTU)	Days Installed
3 BBa	3,068	7/10/2023	7.9/6.8	10/9/2023	3.5/3.5	103
		7/11/2023	9.2/8.8			
5BBa	2,305	6/19/2023	2.2/2.1	9/19/2023	5.8/4.6	104
8BBa	6,305	6/27/2023	0.8/1.0	9/25/2023	5.1/5.1	91
		6/28/2023	1.9/1.7	9/26/2023	5.1/3.9	
10BBa	3,068	6/21/2023	3.0/3.0	9/20/2023	9.1/7.8	90
		6/26/2023	2.0/4.7			
			6/28/2023 :1.30 NTU			
11BBa	2,538	7/12/2023	8.4/7.2	9/21/2023	7.6/6.8	46
13BBa	2,489	6/13/2023	3.4/3.6	9/12/2023	4.2/4.5	67
14BBa	2,343	6/14/2023	4.9/2.6	9/19/2023	5.7/5.8	74
19BBa	4,418	6/20/2023	0.9/0.9	10/9/2023	1.4/1.4	81
26BBa	3,120	6/6/2023	4.0/3.3	9/12/2023	9.3	99
		6/7/2023	3.3/3.3			
26BBb	2,600	6/12/2023	4.3/2.8	9/14/2023	6.8/6.3	97

BOTTOM BARRIER MACROPHYTE SURVEY (AIP MONITORING)

The Bottom Barriers were in place from 46 to 104 days, but most were in place for approximately 3 months (Table 1). To prevent damage to the Bottom Barriers, rake sampling was only done as a “Pre-install” assessment of AIP and at the end of the summer when Bottom Barriers were removed (see Table 2). Each Bottom Barrier area was sampled for the presence and abundance of AIP before installations and after removal of Bottom Barriers in fall, 2023. Within 1 to 7 days after a Bottom Barrier was removed, physical rake samples were taken in the uncovered areas and additional surveys were made in subsequent weeks to determine the AIP abundance [Rake Fullness (RF)] and species present [Species Relative Abundance (SRA)]. The Bottom Barrier areas were surveyed several times in October and in early November. The rake sampling methods for Group B sites are described in the October 16 Interim Report and consisted of multiple physical rake samples in each bottom barrier area. It should be noted that the standard number of CMT macrophyte rake samples taken is 30 per CMT Site. Since the Bottom Barrier areas were small compared to the Sites in which they were installed (Figures 1, 2), the number of rake samples per square foot in each Bottom Barrier area was increased compared with the entire Site and ranged from 4 to10 per area. An example of Bottom Barrier areas in Site 26 is shown in Figure 2. (Note the cluster of 5 sample points in each area.) A summary of Bottom Barrier areas, installation and removal dates, and turbidity monitoring results is provided in Table 1.

In addition to “focused” rake sampling in each Bottom Barrier area, the standard bi-weekly physical (rake) macrophyte sampling was continued in Year 2 in all CMT sites. Since these “non-Bottom Barrier” rake samples were taken outside the Bottom Barrier area, but within the same Site, these data represent “untreated control” conditions. Macrophyte sampling results from the designated CMT Control Sites 16, 17, 18 (West Lagoon) and Site 20 (Lake Tallac) (Figure 1) also serve as full-site control conditions. Therefore, the pre-installation and post-removal macrophyte samples in each specific Bottom Barrier area can be compared with conditions in the Site where they were installed, and with macrophyte sampling in the CMT Control sites. The Bottom Barrier macrophyte sampling schedule is summarized in Table 2. All Bottom Barrier areas received at least four post-removal macrophyte surveys and most were surveyed at five sequential post-removal times. The turbidity was monitored before, during and after barrier installation and removal. Turbidity levels were considered acceptable if turbidity did not exceed 10 percent pre-treatment levels (APAP 1, Table 11 and MMRP). With the exception of one 24-hour post-removal measurement in Site 10, all turbidity values were acceptable and did not require pause in installation or removal of Bottom Barriers. (Note that the turbidity in Site 10 was below pre-installation levels within 48 hours).

Figure 2. Example of Bottom Barrier macrophyte rake sample points from a single monitoring event: A, Site 26a Bottom Barrier Area; B, Site 26b Bottom Barrier Area (Purple dots represent each rake sample taken within the respective Group B area.)

Table 2. Summary of Bottom Barrier Post-Removal Macrophyte Surveys

Bottom Barrier Site and Rake Fullness (RF)	Pre Install Date	Macro Survey Date	Days After Removal (DAR)	Macro Survey Date	DAR	Macro Survey Date	DAR	Macro Survey Date	DAR	Macro Survey Date	DAR	Macro Survey Date	DAR
3 BB	27-Jun	10/2/2023	2	10/17/2023	8.0	10/24/2023	15	10/31/2023	22	11/6/2023	28		
RF	**6.66**		**0.00**		**0.60**		**0.83**		**1.25**		**0.80**		
5BB	7-Jun	9/25/2023	7	10/9/2023	20.0	10/23/2023	34	11/6/2023	56				
RF	**7.30**		**30.60**		**23.00**		**33.00**		**39.00**				
8BB	26-Jun	10/2/2023	7	10/10/2023	14.0	10/16/2023	18	10/25/2023	27	10/30/2023	32	11/7/2023	39
RF	**21.50**		**0.22**		**0.10**		**0.60**		**0.90**		**2.80**		**5.2**
10BB	20-Jun	9/25/2023	5	10/9/2023	19.0	10/23/2023	33	11/6/2023	47				
RF	**1.75**		**0.00**		**1.20**		**0.40**		**0.20**				
11BB	10-Jul	9/25/2023	4	10/9/2023	18.0	10/23/2023	32	11/7/2023	46				
RF	**14.50**		**0.00**		**0.50**		**0.20**		**0.20**				
13BB	6-Jun	9/13/2023	1	9/26/2023	14.0	10/10/2023	27	10/24/2023	41	11/7/2023	56		
RF	**1.25**		**26.80**		**32.50**		**27.80**		**33.00**		**10.40**		
14BB	6-Jun	9/25/2023	6	10/9/2023	20.0	10/16/2023	27	10/23/2023	34	10/30/2023	41		
RF	**1.20**		**0.10**		**0.20**		**0.20**		**6.40**		**5.20**		
19BB	20-Jun	10/10/2023	1	10/24/2023	15.0	11/7/2023	29						
RF	**36.60**		**19.10**		**8.80**		**54.00**						
26 BBa	5-Jun	9/13/2023	1	9/18/2023	6.0	10/2/2023	20	10/16/2023	34	10/30/2023	38		
RF	**10.25**		**5.10**		**2.60**		**6.20**		**0.70**		**2.00**		
26 BBb	5-Jun	9/18/2023	4	10/2/2023	18.0	10/16/2023	32	10/30/2023	46				
RF	**19.30**		**1.20**		**5.60**		**0.70**		**1.40**				
Control Site 16	7-Jun			9/12/2023	14.0	9/26/20-23	26	10/9/2023	40	11/8/2023	56		
RF	**6.6**				**13.5**		**15.4**		**19.5**		**29.1**		
Control Sie 17	7-Jun			9/11/2023	14.0	10/9/2023	26	10/23/2023	40	11/7/2023	56		
RF	**19.5**				**10.7**		**10.4**		**16.6**		**17.4**		
Control Site 18	7-Jun			9/11/2023	14.0	10/11/2023	26	10/24/2023					
RF	**25.5**				**13.9**		**6.3**		**4.7**	11/7/2023	56		
											8.5		
Control Site 20	20-Jun			9/28/2023	14.0	10/10/2023	26	10/24/2023	40	11/7/2023	54		
RF	**46.4**				**79.7**		**29.6**		**20.6**		31		
					14.0		26		40		56		
Mean Controls 16,17,18	**17.2**				**12.7**		**10.7**		**13.6**		**18.3**		

EFFECTIVENESS OF BOTTOM BARRIER TREATMENTS

Barrier Integrity and Anchoring

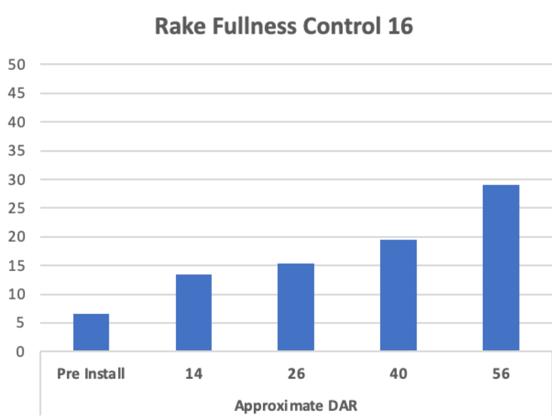
The ability of the Bottom Barrier materials to control AIP requires good, reliable anchoring and maintenance of the general integrity of the barriers. Barriers were inspected frequently (minimum of every 2 weeks), and anchoring was adjusted if necessary. The most common maintenance challenge was releasing accumulated gases beneath the non-permeable barriers as the covered AIP decomposed and as conditions became hypoxic (low dissolved oxygen). Shallow water installations can be susceptible to boat prop damage, or other physical disturbances. However, this was not noted as a major issue. All the barriers remained in place for the intended duration.

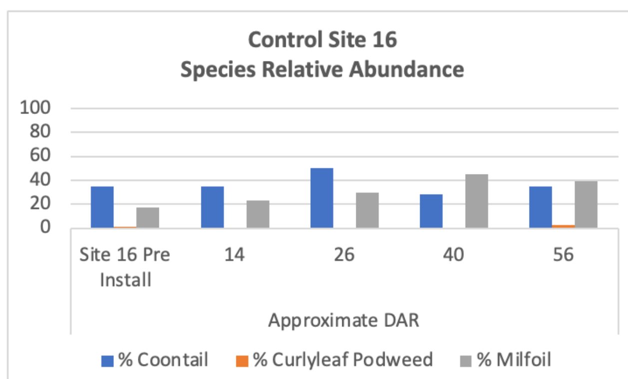
CMT Group B Methods Goal: Sustain Reduced AIP Achieved in Year One: 75% Reduction in Biomass and Acceptable Vessel Hull Clearance (VHC)

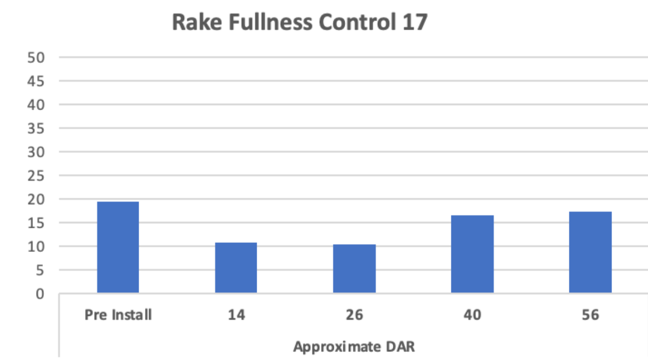
Since the Bottom Barriers remained in place for about three months, any plants beneath them would either be dead (and decomposing), or possibly might "recover" once the barriers were removed. The multiple post-removal macrophyte surveys were made to determine if plants recovered, or if plants may have moved into the previously covered areas from un-treated areas. Since Coontail has no roots, this plant could easily move within the CMT sites and onto Bottom Barrier areas either while the barriers were in place, or after the barriers had been removed. Movement of Coontail plants or plant fragments is easily caused by water movement, wind, vessel activity, or by waterfowl feeding activity.

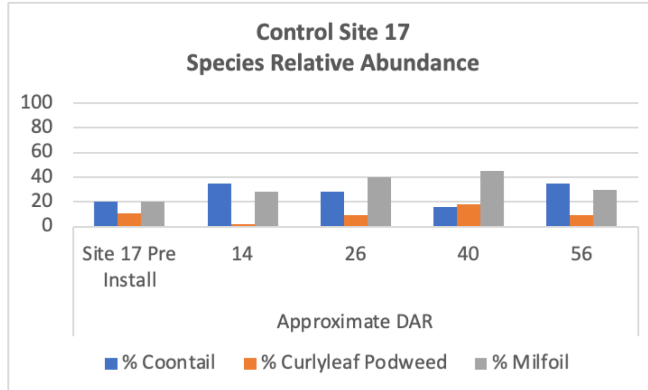
RF is a measure of how much total plant material (all species) was retrieved on each rake sample. SRA is the percent of rake sample represented by each species, The SRA metric identifies what species were present on the rake sample and how much of the sample it represented. This data is useful in determining what species were present before the Bottom Barriers were installed (See "Pre-Install" in the graphs in Figure 3) and what species if any were present after the barriers were removed. The RF data and sample dates from the macrophyte rake sampling are summarized in Table 2. The RF and SRA data from in the Bottom Barrier areas were also compared with the RF and SRA data from the CMT Control Sites 16, 17, and 18 in the West Lagoon, and Control Site 20 in Lake Tallac (see Figure 1).

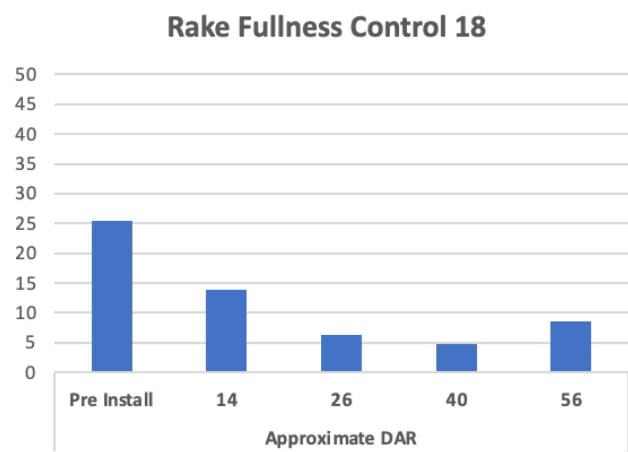
The following graphs (collectively Figure 3) summarize the RF and the SRA for each Bottom Barrier area. The graphs are paired so that the RF changes and changes in SRA can easily be seen. Each graph includes the "Pre-install" RF and SRA value obtained from macrophyte rake sampling that was done just before Bottom Barriers were installed. The post-barrier removal rake sample data (RF and SRA) is shown as sequence of "Days After Removal" (DAR). Note that the DAR was variable because barriers were removed at different times and the sequence of rake surveys varied as well. The duration (days) of barrier deployment is shown for each Bottom Barrier area (Table 1 and Figure 3). Note that the "DAR" rake sampling data for Control Sites is within 7 to 12 days of the DAR for the Bottom Barrier areas may vary 7 to 10 days from the DAR for the Bottom Barrier areas. Since the Control Sites were surveyed on a bi-weekly interval, these dates did not necessarily coincide with the separate intervals for Bottom Barrier surveys. Sample dates are included in Table 2. However, all macrophyte sampling occurred during several weeks in the fall after barriers had been removed, and the multiple Control Site sample events (4 to 5 macrophyte monitoring events) provide a reasonable comparison between Bottom Barrier areas and the CMT Control Sites.

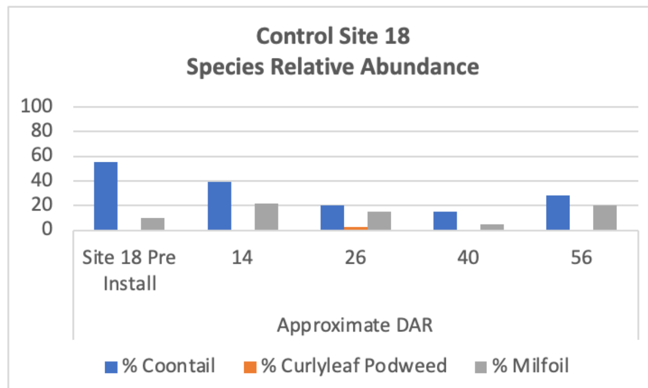


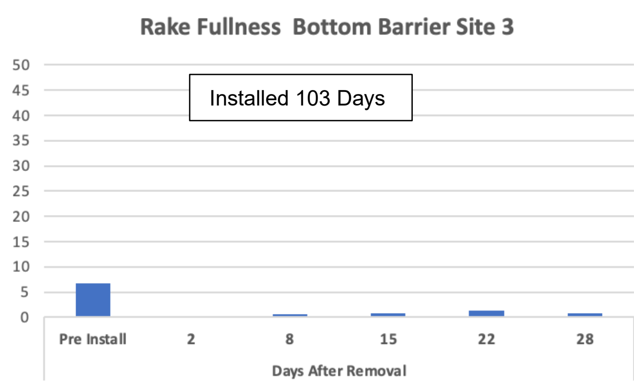


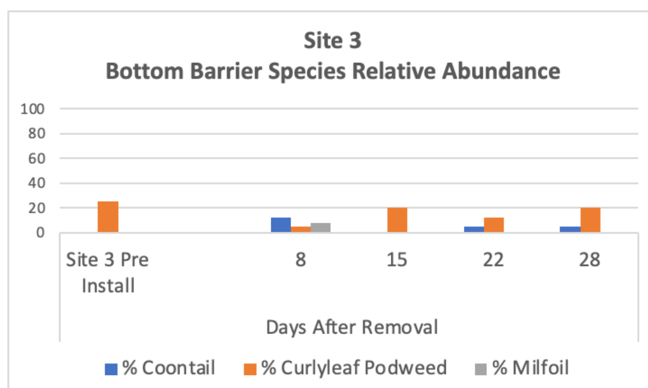

Rake Fullness Control 17
50
45
40
35
30
25
20
15
10
5
0
Pre Install
14
26
40
56
Approximate DAR

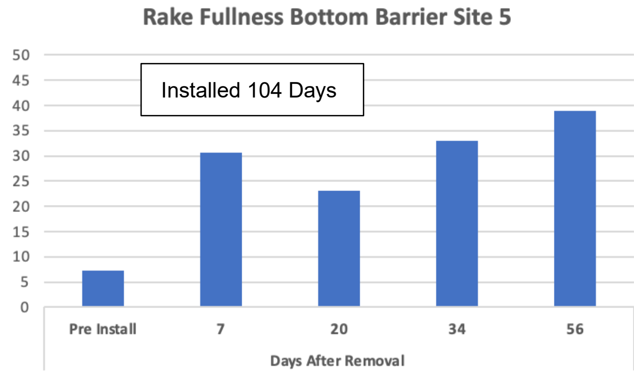

Control Site 17
Species Relative Abundance
100
80
60
40
20
0
Site 17 Pre Install
14
26
40
56
Approximate DAR
% Coontail
% Curlyleaf Podweed
% Milfoil

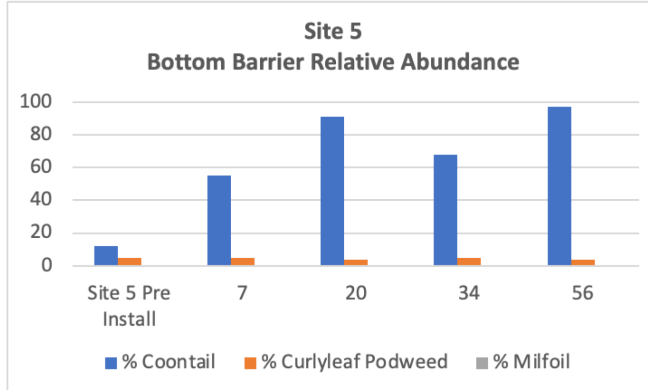

Rake Fullness Control 18
50
45
40
35
30
25
20
15
10
5
0
Pre Install
14
26
40
56
Approximate DAR

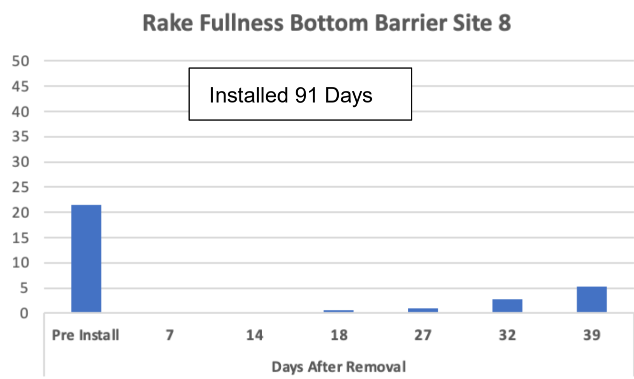

Control Site 18
Species Relative Abundance
100
80
60
40
20
0
Site 18 Pre Install
14
26
40
56
Approximate DAR
% Coontail
% Curlyleaf Podweed
% Milfoil

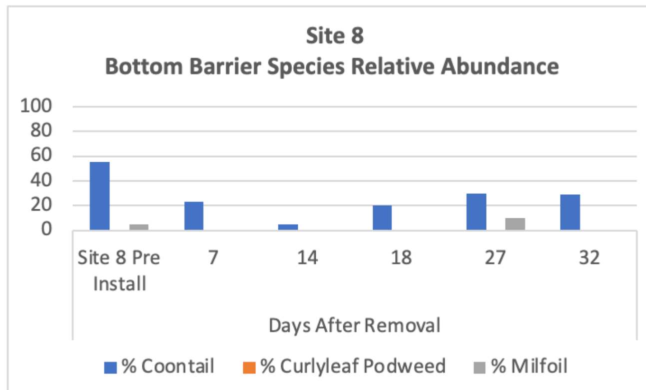

Rake Fullness Bottom Barrier Site 3
Installed 103 Days
50
45
40
35
30
25
20
15
10
5
0
Pre Install
2
8
15
22
28
Days After Removal

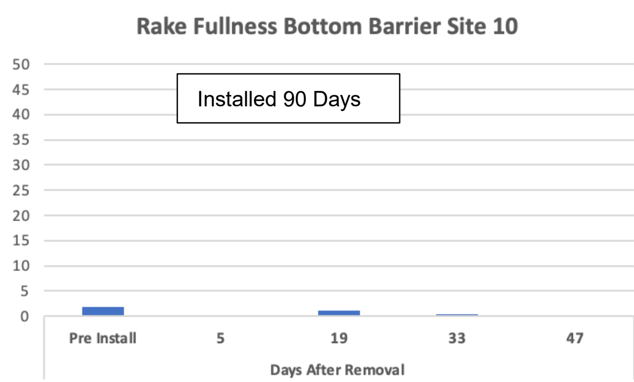

Site 3
Bottom Barrier Species Relative Abundance
100
80
60
40
20
0
Site 3 Pre Install
8
15
22
28
Days After Removal
% Coontail
% Curlyleaf Podweed
% Milfoil

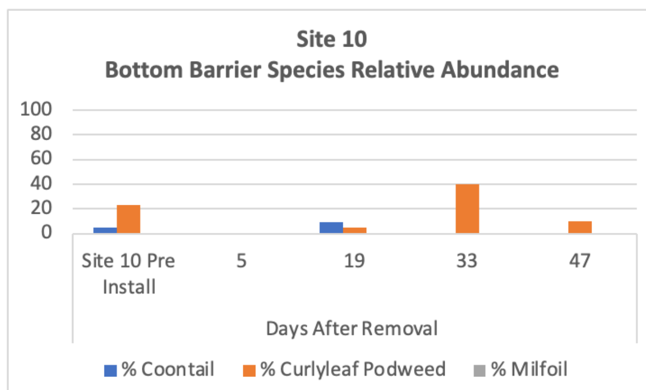

Rake Fullness Bottom Barrier Site 5
Installed 104 Days
50
45
40
35
30
25
20
15
10
5
0
Pre Install
7
20
34
56
Days After Removal

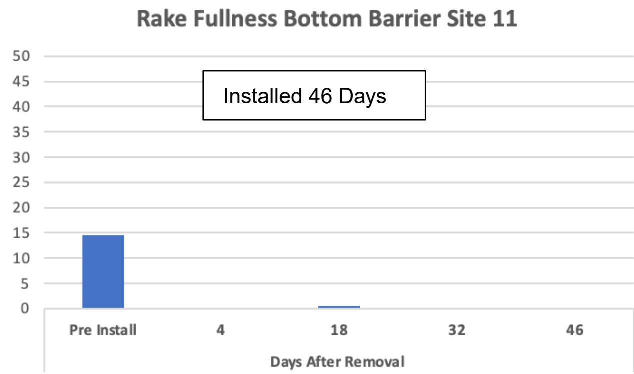

Site 5
Bottom Barrier Relative Abundance
100
80
60
40
20
0
Site 5 Pre Install
7
20
34
56
% Coontail
% Curlyleaf Podweed
% Milfoil

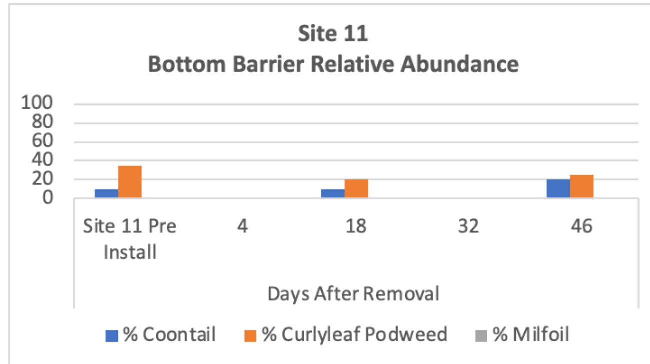

Rake Fullness Bottom Barrier Site 8
Installed 91 Days
50
45
40
35
30
25
20
15
10
5
0
Pre Install
7
14
18
27
32
39
Days After Removal

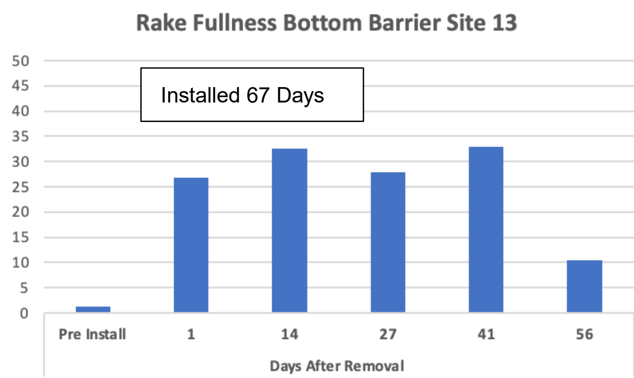

Site 8
Bottom Barrier Species Relative Abundance
100
80
60
40
20
0
Site 8 Pre Install
7
14
18
27
32
Days After Removal
% Coontail
% Curlyleaf Podweed
% Milfoil

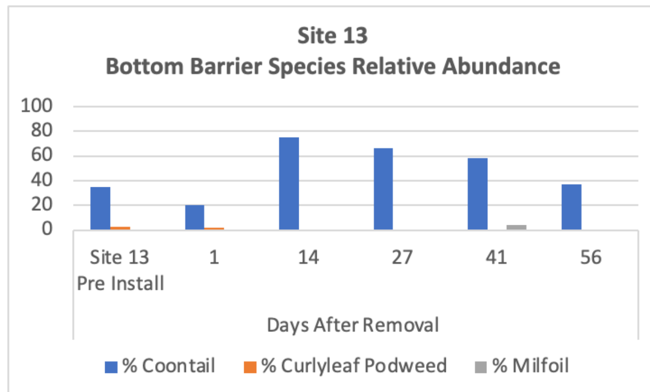

Rake Fullness Bottom Barrier Site 10
Installed 90 Days
50
45
40
35
30
25
20
15
10
5
0
Pre Install
5
19
33
47
Days After Removal

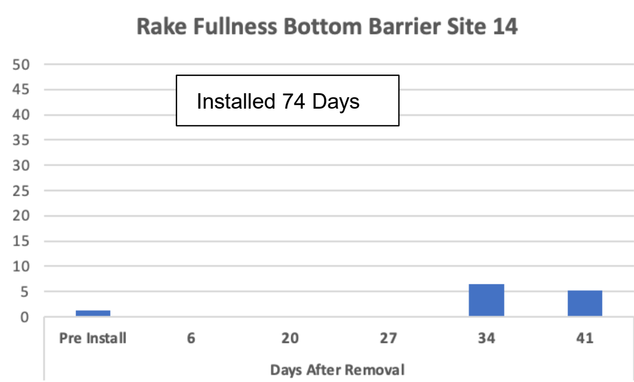

Site 10
Bottom Barrier Species Relative Abundance
100
80
60
40
20
0
Site 10 Pre Install
5
19
33
47
Days After Removal
% Coontail
% Curlyleaf Podweed
% Milfoil

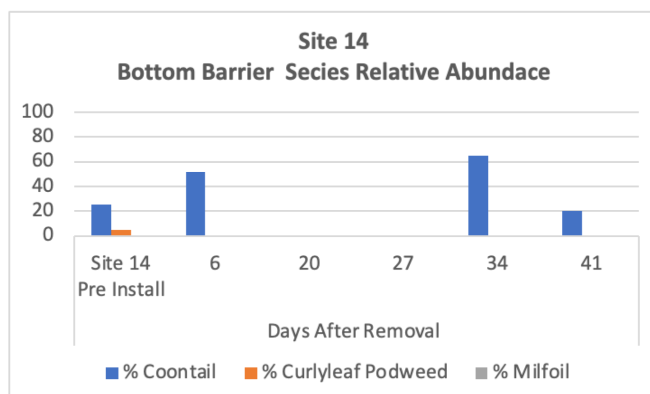

Rake Fullness Bottom Barrier Site 11
Installed 46 Days
50
45
40
35
30
25
20
15
10
5
0
Pre Install
4
18
32
46
Days After Removal

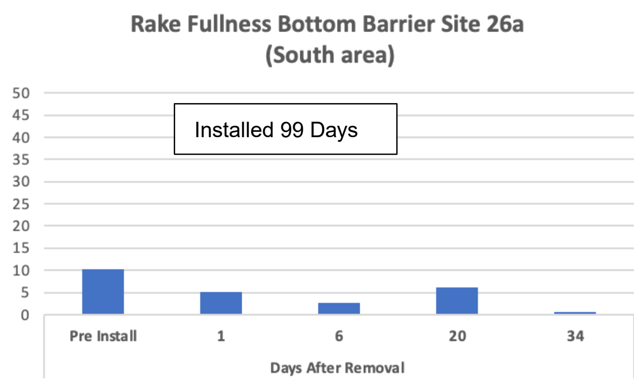

Site 11
Bottom Barrier Relative Abundance
100
80
60
40
20
0
Site 11 Pre Install
4
18
32
46
Days After Removal
% Coontail
% Curlyleaf Podweed
% Milfoil

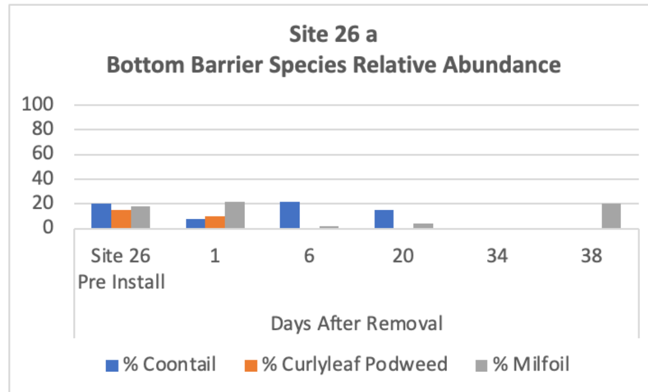

Rake Fullness Bottom Barrier Site 13
Installed 67 Days
50
45
40
35
30
25
20
15
10
5
0
Pre Install
1
14
27
41
56
Days After Removal

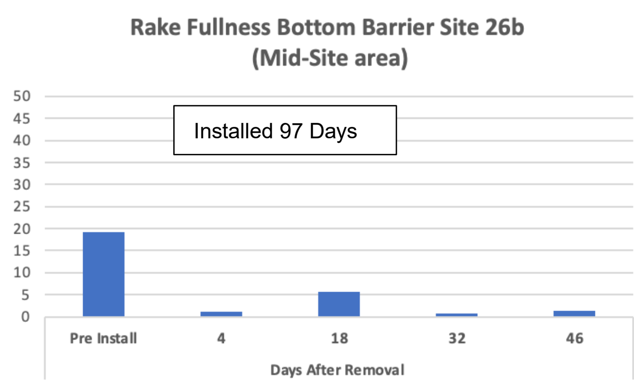

Site 13
Bottom Barrier Species Relative Abundance
100
80
60
40
20
0
Site 13 Pre Install
1
14
27
41
56
Days After Removal
% Coontail
% Curlyleaf Podweed
% Milfoil

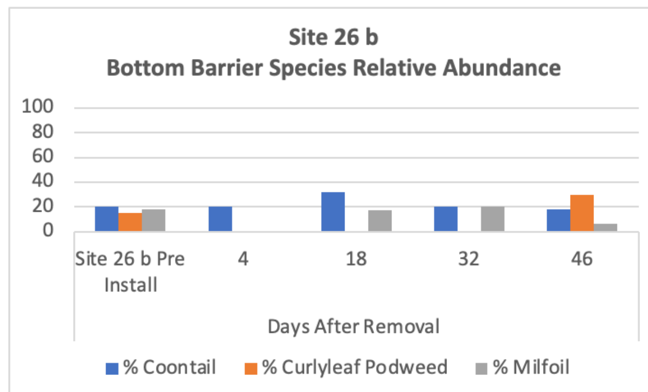

Rake Fullness Bottom Barrier Site 14
Installed 74 Days
50
45
40
35
30
25
20
15
10
5
0
Pre Install
6
20
27
34
41
Days After Removal

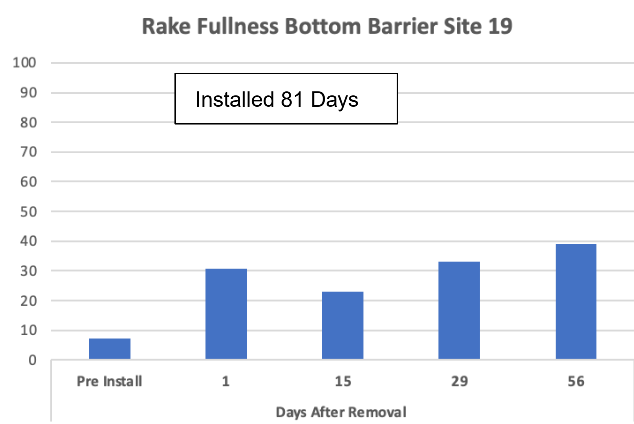

Site 14
Bottom Barrier Secies Relative Abundace
100
80
60
40
20
0
Site 14 Pre Install
6
20
27
34
41
Days After Removal
% Coontail
% Curlyleaf Podweed
% Milfoil

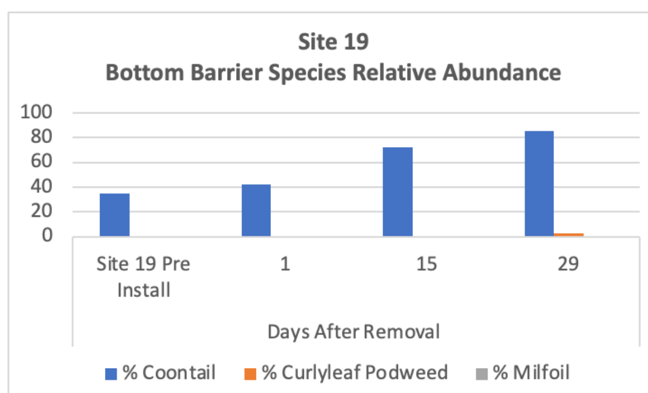

Rake Fullness Bottom Barrier Site 26a
(South area)
Installed 99 Days
50
45
40
35
30
25
20
15
10
5
0
Pre Install
1
6
20
34
Days After Removal

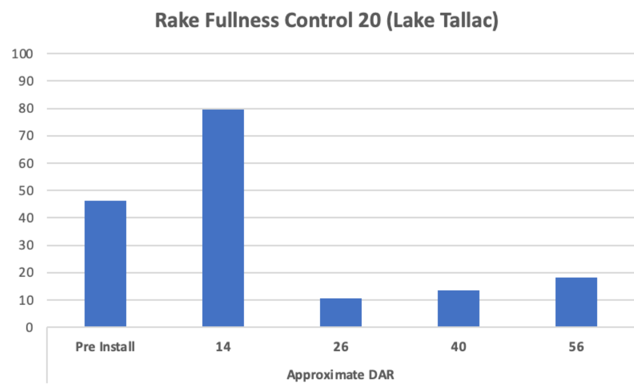

Site 26 a
Bottom Barrier Species Relative Abundance
100
80
60
40
20
0
Site 26 Pre Install
1
6
20
34
38
Days After Removal
% Coontail
% Curlyleaf Podweed
% Milfoil


Rake Fullness Bottom Barrier Site 26b
(Mid-Site area)
Installed 97 Days
50
45
40
35
30
25
20
15
10
5
0
Pre Install
4
18
32
46
Days After Removal


Site 26 b
Bottom Barrier Species Relative Abundance
100
80
60
40
20
0
Site 26 b Pre Install
4
18
32
46
Days After Removal
% Coontail
% Curlyleaf Podweed
% Milfoil


Rake Fullness Bottom Barrier Site 19
Installed 81 Days
100
90
80
70
60
50
40
30
20
10
0
Pre Install
1
15
29
56
Days After Removal


Site 19
Bottom Barrier Species Relative Abundance
100
80
60
40
20
0
Site 19 Pre Install
1
15
29
Days After Removal
% Coontail
% Curlyleaf Podweed
% Milfoil



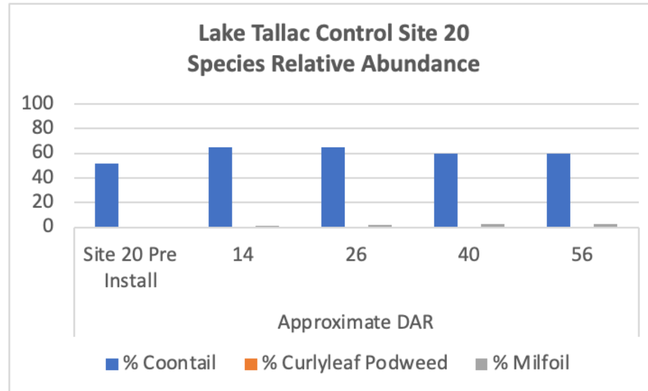


Figure 3. Summary graphs of RF and SRA in Bottom Barrier areas and Controls in West Lagoon Sites 3,5,8,10,11,13,14, 16, 17, 18, and 26 (a,b) and in Lake Tallac Bottom Barrier Site 19 and Lake Tallac Control Site 20. Note that the "Pre-Install" data are from rake samples taken within 1 to 7 days before Bottom Barrier installations were made. For the Control Sites, the "Pre Install" sample was taken within 7 to 12 days of the the "Pre Install" sampling for Bottom Barrier areas. (Where no bars are present, no plants were recorded or were < 2). Data specifically from Bottom Barrier areas are from 4-10 rake samples per sampling event whereas data from entire Control Sites are from 30 rake samples per sampling event.

GENERAL TRENDS IN MACROPHYTE PRESENCE AND ABUNDANCE

From the RF values, it is evident that most Bottom Barrier applications were effective in most areas (except for Sites 5, 13 and 19), and sustained low AIP abundance (low RF) during the weeks sampled following the barriers removal. Control RF levels were higher than the post-removal RFs in most cases. The RF in Sites 5, 13, and 19 increased with time after barrier removal. The SRA clearly shows that in most areas, Coontail was the dominant AIP present after barriers were removed. This is particularly true for Lake Tallac Site 19 and in Sites 5, 13, and 14. Coontail, which has no roots, may have entered the treated areas after the barriers were removed.

In general, the time period following the barriers removal is a slower growth period (compared to spring or summer) for aquatic plants due to the decreasing sunlight and cooling temperatures associated with the changing of the seasons. Therefore, it would be normal for biomass (e.g., RF values) to decrease from late September to mid-November. However, curlyleaf pondweed typically sprouts during the fall period from turions that were produced in mid-summer. Curlyleaf pondweed occurrences were noted in the post-barrier removal samples in Sites 3, 10, 11, and the LFA Site 26. (Note the orange bars in the SRA graphs that represent curlyleaf pondweed). This suggests that either sprouted turions moved into the re-exposed (treated) areas, or that some (un-sprouted) turions may have been present before the Bottom Barriers were installed and sprouted within a few weeks after the barriers were removed.

In contrast to the RFs in Bottom Barrier areas, the RF values for the West Lagoon Control Sites 16, 17, and 18 during the "post-removal" sampling period are much higher. However, the RF values in Lake Tallac Control Site 20 are similar to those in the post-removal Bottom Barrier area in Lake Tallac Site 19: both were high (Figure 3). The control sites in general as well as the LFA sites (e.g., Site 26) had a more diverse representation of AIP, particularly Eurasian watermilfoil, which has remained nearly absent from sites that had been exposed to the herbicide Endothall and Triclopyr in CMT Year 1.

Table 3. Summary of CMT Year 2 Group B Methods Efficacy including Bottom Barriers. (Note: This Table was provided in the October 16 CMT 2023 Special Interim Report, but at that time the Bottom Barriers had not been removed.)

Group B Treatment Type	CMT Site	CMT Year One Treatment Type	Maintained Year One Control? Yes ↑ Partial → No ↓	Notes and Limitations
Bottom Barrier	3	Endothall only	↑ →	Curlyleaf pondweed present after barrier removal
	5	Triclopyr only	↓	Did not sustain control compared to controls
	8	Triclopyr only	↑	Sustained control after barrier removal
	10	Endothall combo	↑ →	Curlyleaf pondweed present after barrier removal
	11	Endothall combo	↑ →	Curlyleaf pondweed present after barrier removal
	13	Triclopyr combo	↓	Did not sustain control compared to controls
	14	Triclopyr combo	→	Sustained control after removal until mid-Oct.
	19	Endothall only	↓	Did not sustain control compared to controls
	26a	LFA	↑	Sustained control after barrier removal
	26b	LFA	↑	Sustained control after barrier removal
Diver Assisted Suction Harvesting (DASH)	1	Endothall only	↑	
	2	Endothall only	↑	
	3	Endothall only	↑	
	5	Triclopyr only	↑	
	8	Triclopyr only	↑	
	9	Triclopyr only	→	
	10	Endothall combo	↑	
	11	Endothall combo	↑	
	13	Triclopyr combo	→	Eurasian watermilfoil was controlled
	14	Triclopyr combo	→	Eurasian watermilfoil was controlled
	19	Endothall only (L.Tallac)	↑ →	DASH 19a is good; 19b partial control
	26	LFA	↑	
UV-C Spot (Four 1/2 Treatments)	1	Endothall only	↑	
	2	Endothall only	↑	
	3	Endothall only	↑	
	5	Triclopyr only	↑	
	9	Triclopyr only	↑	
	26	LFA	↑ →	Middle area is good; shoreline is partial
UV-C Combo (Group A) (Two Full Treatments)	10	Endothall combo	↑	
	11	Endothall combo	↑	
	13	Triclopyr combo	↓	Neither middle nor shoreline controlled
	14	Triclopyr combo	↑ ↓	Middle area good; shoreline poorly controlled
UV-C Only (Group A) (Four 1/2 Treatments)	22	UV only	↑	
	23	**One treatment only**	→	Note: Sites 22 and 24 were treated 4 times
	24	UV only	↑	

SUMMARY AND CONCLUSIONS

Installation, Removal and Maintenance of Bottom Barriers

All three types of types of bottom barriers required divers and top-side assistants to install. The modified "turbidity curtains" had one edge with a sewn-in chain weight which helped anchor them. However, since the turbidity curtains and the BTL-20 material were impermeable, the gases from degradation of plants underneath the barriers necessitated more maintenance ("burping") than the more gas-permeable "pond liners". The heavier turbidity curtain material was also more cumbersome to manipulate. Another challenge was the variable muck depth (which can provide habitat for AIP to root on top of the barriers) and disturbance of the bottom sediments. Areas with deep, loose sediment (muck) are also more difficult to securely anchor the barriers. However, with one exception (described earlier), turbidity levels during installation and removal were acceptable. The analysis of time and costs per acre will be discussed in the final report.

Efficacy of Bottom Barriers

As long as the barriers remained intact and in place, these covered areas had no visible plant growth. Due to resource limitations, high water levels in 2023, and the differences in macrophyte growth in the various CMT sites, the timing of installations was also variable (Table 1). The duration of cover (see Table 1 and Figure 3) was driven mainly by the timing of installation; earlier installations resulted in longer coverage time since all barriers were removed in a similar fall timeframe. The most revealing data on the barriers was the post-removal RF, a metric that indicates the abundance of plants in the area sampled. Most of the barrier covered areas sustained low RF for several weeks after barrier removal. The exceptions were in Sites 5, 13, and 19 where plants either regrew from the sediment, or were perhaps “imported” from areas outside the original barrier locations. Coontail was the most common AIP appearing in those sites, possibly due to the lack of roots and its mobility within the water column. The other concern when barriers are removed is potential colonization by sprouting curlyleaf pondweed turions. These can be dislodged from sediments surrounding the barriers. Similarly, if invasive curlyleaf pondweed turions (or seed from this plant) survived the covering, these propagules may re-infest the areas covered in 2023.

Vessel Hull Clearance

The CMT goal and intent of VHC is to sustain a 3-foot distance between the top of the AIP “canopy” (top of plant shoots) and the water surface. This goal is aimed at reducing contact of boat hulls and boat propellers with the AIP to reduce plant fragments production and spread of plants. The VHC also reduces the likelihood of plants and plant fragments entering the water intake of motorized vessel. The VHC above installed and maintained Bottom Barriers would therefore meet this goal if they were installed at depths greater than 3 feet since there would be no plants in that specific area. However, if Bottom Barrier Areas are too small, it is likely that plants growing adjacent to the barriers might easily drift (rooted or not) over the covered area, or plants might grow on top of the barriers during the 3-4 months that the barriers are in place. The divers did not detect new rooted growth on top of the barriers; however as noted before, Coontail can drift and settle above or on a barrier. The fact that Coontail was very frequently detected in the post-removal areas suggest that this plant may pose a recuring problem even over deployed barriers.

Native Plant Impacts

Bottom Barriers are non-selective AIP control methods; they cover and kill desirable native plants as well as targeted AIP. For example, the desirable native plant Elodea canadensis was not among plant species “recurring” after removal of the barriers. If there is native plant seed bank tolerable to the 3 months’ covering, then native plants could re-grow in the subsequent spring and the macrophyte surveys in 2024 should reveal that.

Conclusions

The Bottom Barriers effectively excluded AIP from growth beneath them as long as the barriers remained anchored and intact. The variable installation time may have added to variability in post-removal plant growth, though this is not a clear pattern: Some of the shortest durations led to good post-removal control (e.g., Site 11) and some long-duration deployments had recurrence of plants (Site 5).

Recommendations for Year 3 Bottom Barrier Use

- Use gas-permeable barriers to reduce maintenance time and resources.
- Continue conducting thorough "pre-installation" macrophyte (and propagule) monitoring before deploying barriers.
- Install all barriers in early summer within a 15-day period and remove all barriers in fall within a 15-day period, to provide a more standardized duration of cover.
- If Spring 2024 baseline macrophyte surveys show similar early season AIP growth, repeat 2023 barrier locations unless the spring 2024 surveys indicate more critical areas to be included. It will be important to determine the presence of sprouted curlyleaf pondweed turions in spring in 2023 Bottom Barrier areas. Control of small plants (sprouted turions) in the fall and spring will be key components of any long-term management strategy.
- Due to the mobility of Coontail, it would be useful to consider some way to exclude its in-migration when the barriers are removed in fall 2024, perhaps using a 1 in. mesh "fishnet" material. However, boat traffic would be a limitation unless those areas were clearly marked to avoid having "nets" tangled. In addition, skimming diligently around the Bottom Barrier areas might help prevent "re-infestation" of the previously covered areas.
- Next fall, it might be instructive to take sediment samples after Bottom Barriers are removed in order to assess the presence of un-sprouted turions.

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