Final

TAHOE KEYS LAGOONS ANNUAL MACROPHYTE CONTROL EFFICACY MONITORING REPORT

Year 3

Prepared for
Tahoe Regional Planning Agency (TRPA)

March 2025





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TAHOE KEYS LAGOONS ANNUAL MACROPHYTE CONTROL EFFICACY MONITORING REPORT

Year 3

Background

The Tahoe Keys is a residential development in the south shore area of Lake Tahoe, consisting of approximately 1,500 homes (almost all of which have private docks or slips) and approximately 170 acres of waterways within three distinct areas. The West Lagoon is the largest portion and where most of the homes and docks/slips are located. The East Lagoon includes a commercial marina and a smaller number of residences that have docks/slips. The East and West Lagoons are not connected to each other but are both directly connected to Lake Tahoe via two separate channels. These areas are major access points for recreational watercraft to Lake Tahoe. The third waterway is Lake Tallac, which is separated from the West Lagoon by a dam and does not allow any type of passage by recreational vessels. Lake Tallac does not support motorized watercraft and there is no direct connection to Lake Tahoe.

These waterways are almost entirely infested with two aquatic non-native invasive weeds, Eurasian Watermilfoil (*Myriophyllum spicatum*) and Curlyleaf Pondweed (*Potamogeton crispus*), and one excessively abundant native plant, Coontail (*Ceratophyllum demersum*). Management of these aquatic weeds by the Tahoe Keys Property Owners Association (TKPOA) over the last fifty years has been almost exclusively by mechanical harvesting. In spite of this effort, the infestation continues to grow and spread and is a significant threat to Lake Tahoe's ecosystem and famed clarity. The infestation within the Tahoe Keys waterways is the Lake Tahoe Aquatic Invasive Species (AIS) Program's highest priority for control (Wittmann and Chandra 2015).

The Tahoe Regional Planning Agency (TRPA) Environmental Improvement Project (EIP) No. 510-101-00 and the Lahontan Regional Water Quality Control Board (Water Board) Order No. R6T-2022-0004 authorized a three-year program to assess the effectiveness of a range of aquatic weed control methods, both as stand-alone treatments and as combination treatments. The Tahoe Keys Lagoons Aquatic Weed Control Methods Tests (CMT) (the "Project") evaluates two categories of treatment methods with the overarching goal of finding solutions for treating high priority locations that will result in sustained control.

The purpose of this Annual Efficacy Monitoring Report is to summarize and evaluate macrophyte control efficacy resulting from Project activities in Year 3, as required by TRPA Permit File #EIPC2018-001, Special Condition 22 and the National Pollutant Discharge Elimination System (NPDES) Order No. R6T-2022-0004. It includes the effects of CMT treatments on plant biovolume, vessel hull clearance, and plant species composition within CMT test sites compared to untreated reference sites (controls).

In particular, this report describes whether the following CMT objectives/metrics related to macrophyte efficacy were achieved in Year 3: A “synoptic” report will evaluate all three years of the Project.

- Reduction of 75 percent in total invasive and nuisance plant biomass (“biovolume”[1]) within treated CMT sites
- Maintenance of three (3-) foot vessel hull clearance
- Increase in occurrence and relative abundance/percent composition of native plants relative to non-native plants

Methods

Sites and Control Approaches

In Year 1 (2022), the Project evaluated stand-alone treatments using aquatic herbicides (one time only), ultraviolet (UV) light (throughout the season), and laminar flow aeration (LFA) (throughout the season), as well as combined herbicide + UV treatments. These treatments are referred to as Group A Methods. Two aquatic herbicides: Endothall (USEPA 2019) and Triclopyr (USEPA 2013) were used as a stand-alone treatment and were intended to be used in “Combination Sites” with UV light. However, due to inaccessibility of the Combination Sites in 2022 by the UV-treatment vessels, UV treatments were not made in those sites until 2023 and 2024. Per the labels, Endothall is known to target the aquatic invasive plants (AIP) Eurasian Watermilfoil, Curlyleaf Pondweed, and Coontail while Triclopyr is intended to target Eurasian Watermilfoil. UV light in the germicidal spectrum of 254 to 275 nanometers (nm) is a patented control method for treating aquatic weeds. LFA is a technology originally used for improving water quality in wastewater treatment plants by assisting in the organic breakdown of sludge. LFA has recently been adapted for water body restoration by accelerating the capability to process nutrients, purge harmful gases such as ammonia and hydrogen sulfide, precipitate iron and manganese, and reduce algae growth (Jermalowicz-Jones 2012). Macrophyte monitoring for the Project has involved a suite of protocols aimed at assessing the efficacy of treatments on AIP composition, biovolume, and vessel hull clearance as measured by the depth to the top of the macrophyte canopy (described in the Methods section). Detailed methods and results from Years 1 and 2 macrophyte monitoring may be found in TRPA (2023 and 2024, respectively).

In Years 2 and 3, Group B methods were implemented in subsections of Year 1 Group A sites and included UV-spot treatments, bottom barriers, and diver assisted suction harvesting (DASH) (described below). In Years 2 and 3, Group A UV-only and LFA treatments were continued but no aquatic herbicide treatments were made in Years 2 or 3. The Aquatic Pesticide Application Plan (APAP) provided project managers with a decision tree for selecting follow-up treatments Group B methods. Drivers in selecting Group B methods include: the presence of target and native plants, acreage of target plants, and end of season biovolume measured from hydroacoustic scans. All sites slated for Group B methods were highly vetted among stakeholders. The location of all Group A and Group B sites are provided in **Figure 1**. Unique to Year 3 was the addition of “sequential treatments” with either DASH or UV-spot treatments in select sites following the removal of bottom barriers.

[1] Biovolume, as defined in the Tahoe Keys Lagoons Environmental Impact Report – Environmental Impact Statement (EIR-EIS), is the percentage of the water column occupied by aquatic vegetation.

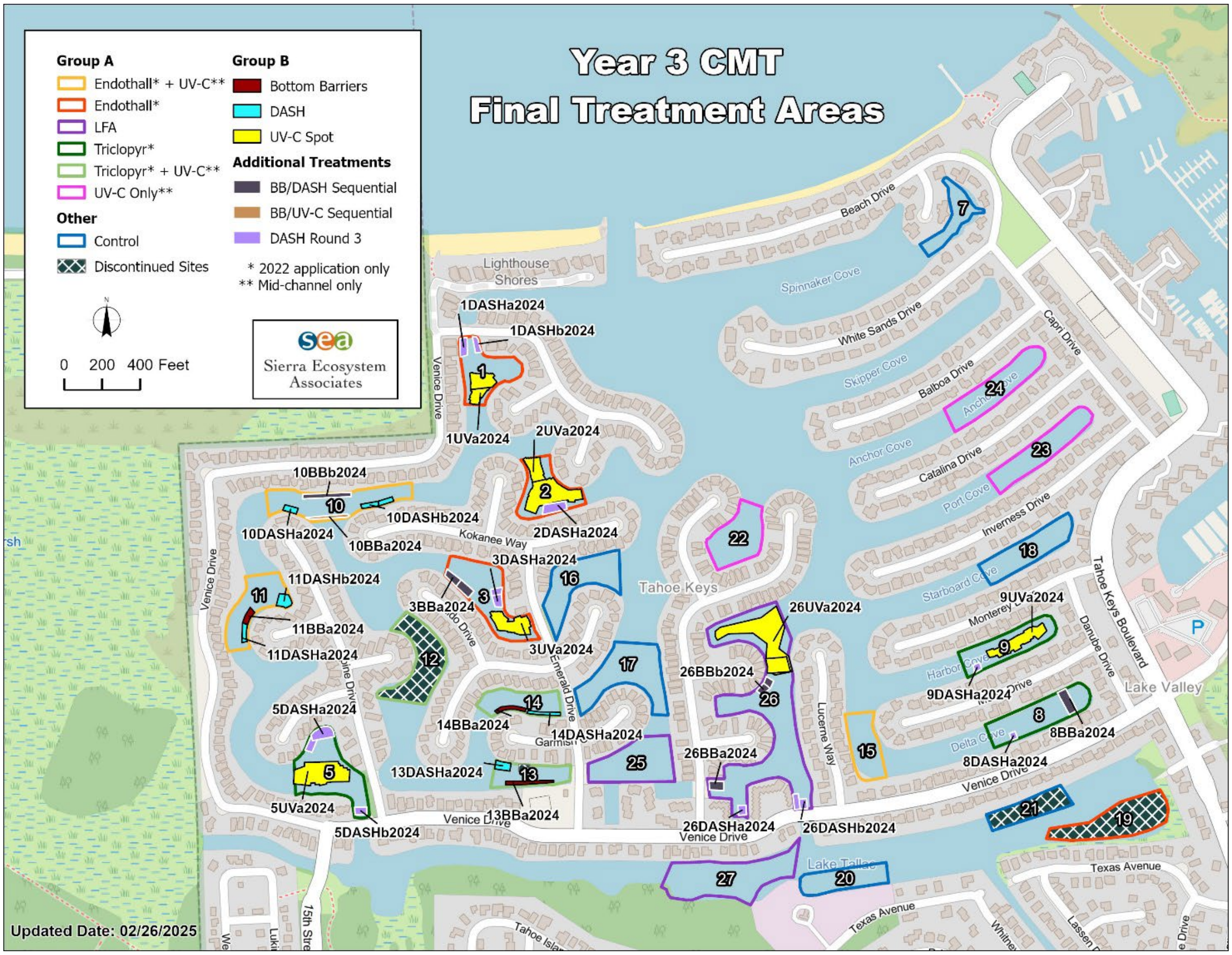


Figure 1. Tahoe Keys Aquatic Weed CMT Treatment Sites: Year 3.

The UV-spot treatments occurred in areas ranging from around 5,500 sq. feet to nearly 50,000 sq. feet with substantially larger areas in Year 3 compared to Year 2. Site numbers and treatment dates for all UV treatments (UV-spot, UV-only, and combinations) are provided in **Table 1**. Specific details on UV methods are provided in Appendix L.

TABLE 1
SITE NUMBER AND INITIAL AND FOLLOW-UP DATES FOR UV SPOT, UV-ONLY AND UV-COMBINATION SITES.

CMT Site No.	Initial Date	Follow-Up Treatment Date(s)
UV-C Spot (Group B) Sites		
1	7/8-7/9/24	8/13-8/14, 9/19-9/20,10/25, 10/28/24
2	7/10-7/12, 7/15-7/16/24	8/19-8/22,9/23-9/26, 10/21-10/25/24
3	6/20-6/21/24	6/20-6/21, 7/24-7/25, 8/30, 9/3, 10/7-10/8/24
5	6/17-6/19/24	7/26, 7/29-7/31, 9/4-9/6, 9/9, 10/9-10/11, 10/14/24
9	6/14-6/15/24	7/20, 7/22-7/23, 8/22, 8/24, 10/2-10/3/24
26	5/30-6/1, 6/3-6/5/24	7/1-7/2, 7/9-7/13, 8/9-8/10, 8/12-8/16, 9/17-9/21, 9/23-9/24/24
UV-C Combination (Group A) Sites		
10	6/27, 7/1-7/3/24	8/6-8/9, 8/12, 9/13, 9/16-9/18, 10/18, 10/21-10/24/24
11	6/24-6/26, 6/28/24	8/1-8/2, 8/5, 9/10-9/12, 1015-10/17/24
13	6/10-6/12/24	7/17-7/18, 8/27-8/29, 9/27, 9/30, 10/1/24
14	6/12-6/14/24	7/19, 7/22-723, 8/23, 8/26, 10/2-10/4/24
15	6/6, 6/10-6/13/24	5/15-7/19, 8/18-8/21, 9/26-9/28, 9/30-10/1/24
UV-Only (Group A) Sites		
22	6/17-6/20/24	7/24-7/27, 8/25-8/28, 10/4, 10/7-10/9/24
23	6/26-6/29, 7/1/24	7/29-8/2, 9/6-9/7, 9/9-9/11, 10/10-10/12, 10/14/24
24	6/21-6/22, 6/24-6/25/24	8/3, 8/5-8/8, 9/12-9/14, 9/16, 10/16-10/19/24

Bottom barriers are a non-chemical approach to weed management that is used for localized control by compressing plants and blocking sunlight, similar to a garden shade cloth (Gettys et al. 2020). A variety of materials can be used so long as they are not buoyant and anchoring is still generally needed. As mentioned in the *Supplemental Interim CMT Year 3 Report: Bottom Barriers*, which describes deployment and preliminary results of bottom barriers, divers installed two types of bottom barrier materials in Year 3:(1): “Lake Bottom Blanket” (Lake Weed Solutions), a partially gas-permeable material, and (2) “BTL-20 Pond Liner”, a non-gas permeable material (20 mil thickness). Bottom barriers were installed in areas ranging from around 2,000 sq. feet to 7,500 sq. feet with slightly larger areas in Year 3 compared to Year 2; none were installed in three sites in Year 3 (Sites 5, 9, and 19). As previously mentioned, different in Year 3 were “sequential” treatments of either UV-spot or DASH in a limited number of sites following the removal of bottom barriers. **Table 2** summarizes dates for barrier installation/removal and sequential treatments (UV or DASH) following barrier removal in some sites. Specific details on bottom barrier methods are provided in Appendix M.

TABLE 2
SITE NUMBER AND INSTALLATION/REMOVAL DATES FOR BOTTOM BARRIERS

CMT Site No. [a]	Installation Date(s) [b]	Removal Date	Number of Days BB in Place	DAR in Place [c]	Sequential Treatment (and Date) [d]
3BBa2024	5/20-5/22/24	9/16-9/18/24	119	9/18/24	DASH (10/7/24)
8BBa2024	6/12-6/13, 6/17/24	10/9/24	114	10/14/24	UV (10/25/24)
10BBa2024	6/6/24	9/30, 10/1/24	117	10/2/24	UV (10/24/24)
10BBb2024	6/3-6/5/24	9/26, 9/30/24	117	10/2/24	DASH (10/16/24)
11BBa2024	6/10/24	10/3, 10/7/24	119	10/8/24	N/A
13BBa2024	6/11/24	10/2/24	113	10/8/24	N/A
14BBa2024	5/23/24	9/19, 9/23-9/24/24	124	9/30/24	N/A
26BBa2024	5/29/24	9/23-9/24/24	118	9/30/24	DASH (10/9/24)
26BBb2024	5/28/24	9/25/24	120	9/30/24	DASH (10/9/24)

NOTES:
a “a” and “b” indicate more than one bottom barrier within the CMT site
b Maintenance dates not included
c DAR = days after removal before macrophyte sampling to determine any sequential treatments
d Refers to the UV-spot or DASH treatment that followed the removal of bottom barriers

During DASH activity, divers physically uproot and loosen aquatic plants by hand and direct them into the tubing of a suction system that transfers the plants topside and into mesh bags (“socks”) to capture them for disposal offsite. When visibility is clear, DASH can be a selective method for removing target AIP while retaining native species. DASH treatment areas ranged from around 2,000 sq. feet to nearly 9,000 sq. feet, again with larger areas in Year 3. Specific details on DASH methods employed as part of Group B CMT methods are provided in Appendix M. The locations of DASH sites are provided in Figure 1 and the initial and follow-up dates are provided in **Table 3** (not including previously described sequential DASH treatments listed in Table 1).

TABLE 3
SITE NUMBER AND INITIAL AND FOLLOW-UP DATES FOR D.A.S.H.

CMT Site No. [a]	Initial Date	Follow-Up Treatment Date(s)
1a	6/18-6/19/24	8/7-8/8, 10/1-10/2/24
1b	6/20/24	8/8, 10/2/24
2	6/24-25/24	8/12, 10/17/24
3	6/26-6/27/24	8/13, 10/17/24
5a	7/22-7/25/24	8/27-8/28, 10/9-10/10, 10/14/24
5b	7/29-7/30/24	8/29, 9/3-9/4, 9/30-10/1/24
8	8/5/24	9/9, 10/17/24
9	8/6-8/7/24	9/10, 10/2-10/3/24
10a	7/1-7/2/24	8/13, 8/15/2024
10b	7/2-7/3/24	8/15, 8/19/24
11a	7/8-7/9/24	8/19, 10/15/24
11b	7/9-7/11, 7/15/24	8/19-8/21/24
13	7/17-7/18/24	8/22, 8/26/24
14	7/15-7/17/24	8/21-8/22/24
26a	7/31/24	9/5, 10/8/24
26b	7/31-8/1/24	9/5, 9/9, 10/9/24

NOTES:
[a] "a" and "b" indicate more than one DASH area within the CMT site.

Efficacy Metrics

As in Years 1 and 2, macrophyte control efficacy was evaluated using the following field collected metrics: macrophyte biovolume and vessel hull clearance from hydroacoustic scans conducted by TKPOA, and rake fullness, relative abundance, frequency of occurrence, plant health condition, and fresh weights from rake point sampling conducted by ESA and subcontractor MTS. Hydroacoustic scans of each site were conducted at approximately 14 day intervals from April to November (TKPOA) and rake point sampling was conducted May through November.

Hydroacoustic Scans

Biovolume

The comprehensive assessment method for overall macrophyte abundance, and assessment of percent reduction, was derived from hydroacoustic scans using an echosounder (Lowrance HDS) and proprietary data processing tool (BioBase EcoSound) that have been used for over 10 years by the TKPOA and has become a standard method for assessing aquatic plant abundance in the Tahoe Keys Lagoons. Determination of biovolume uses a geostatistical interpolated grid data, that is "interpolated and evenly spaced values representing kriged (smoothed) output of aggregated data points", meaning the BioBase's kriging interpolation model makes predictions for the unsampled locations. These data represent the percent of all submersed aquatic vegetation (SAV) in a given volume of water beneath the transducer scan path or "biovolume". Unless plant samples are collected, this method does not distinguish between species and therefore provides data on abundance and extent of both CMT- target and non-target macrophytes.

It should be noted that the control sites were harvested throughout the peak season (June to September) as is typical in the Keys to improve navigation and to reduce boat transport of AIP within the lagoons or to Lake Tahoe. These harvesting activities significantly reduce AIP abundance during the critical mid-summer window and confound efficacy of CMT treatments from year to year. Since the assessment of reduction in AIP is in comparison with untreated "reference Control" sites, it is likely that harvesting of Control sites has led to an underestimate of the effectiveness (percent reduction of AIP) resulting from CMT treatments. To compensate, samples collected within a CMT treatment site, but outside a Group B treated area, can be used to assess efficacy (discussed in more detail later).

Vessel Hull Clearance

Data from the hydroacoustic scans was also used to determine "vessel hull clearance" (VHC), an average of the depth from the top of the plant canopy to the water surface. Plant height/vessel hull clearance data is calculated from point data that contains the actual GPS points recorded on the water with "each point's associated depth, biovolume or composition value for that location". These values were used by TKPOA to determine if the total water column depth and the depth from the water surface to the plant canopy is deep enough for boat navigation with a 3-foot hull clearance. Assessments were made at the same time as biovolume measurements, beginning in April and continuing until November. Hydroacoustic scan data sets were used to determine the plant canopy height over time in feet and compared against the 3-foot hull clearance goal.

Point Sampling

The Monitoring and Reporting Program (MRP) and Quality Assurance Project Plan (QAPP) specify that physical "point sampling" be used to 1) determine the extent and composition of aquatic plants in the Tahoe Keys lagoons and 2) assess the effectiveness of the CMT treatments on the targeted plant species. For each main CMT site, at least 30 rake pulls were taken. For sites with Group B treatment areas, the number of rakes collected in the Group B areas were commensurate with the size of the Group B treated area, but generally ranged 4-8 rakes per Group B site, with a cumulative total of at least 30 rakes per CMT treatment site with Group B methods implemented.

Rake data were recorded according to the Year 1 site name, Group B area, and areas within the site, but outside a Group B area (referred to as "site-wide"). For example, Site 1 was treated with Endothall in Year 1, had two DASH areas, and one UV-spot area. Rake data were recorded to capture this diversity by indicating, for example, Site 1DASHa2024 and Site 1UVa2024. Samples collected outside a Group B area were noted as "N/A" in the field forms and represent site-wide conditions three years following Group A treatments and a better comparison of the effectiveness of Group B treatments within a site (**Figure 2**). Group B to site-wide comparison is not applicable in UV-only sites which are compared to CMT control sites.

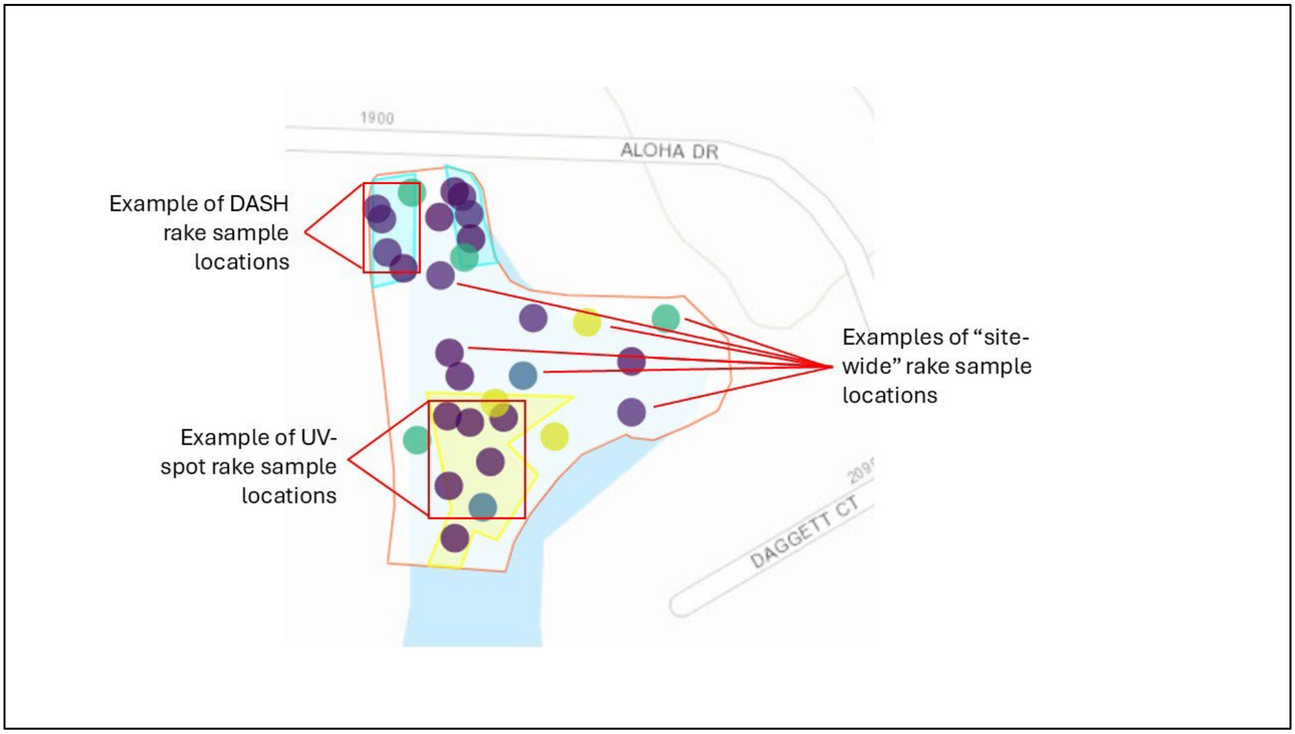


Figure 2. Example of Rake Sampling Locations in DASH (light blue polygon) and UV-spot (light yellow polygon) Areas Compared to "Site-Wide" Non-Group B (outside polygons) Areas.

Samples collected from the mid-channel versus shoreline were recorded, allowing for those data to be filtered in later assessments. **Figure 3** illustrates some examples of a typical visit to (a) Site 22 (mid-channel only shown), (b) Site 11 with bottom barrier and DASH areas, and (c) Site 8 also with bottom barrier and DASH areas. This separation of mid-channel versus shoreline, especially important for evaluations of UV and UV-Combinations treatment effectiveness as UV was only applied to mid-channel areas and herbicides in Year 1 were only applied to the shoreline areas.

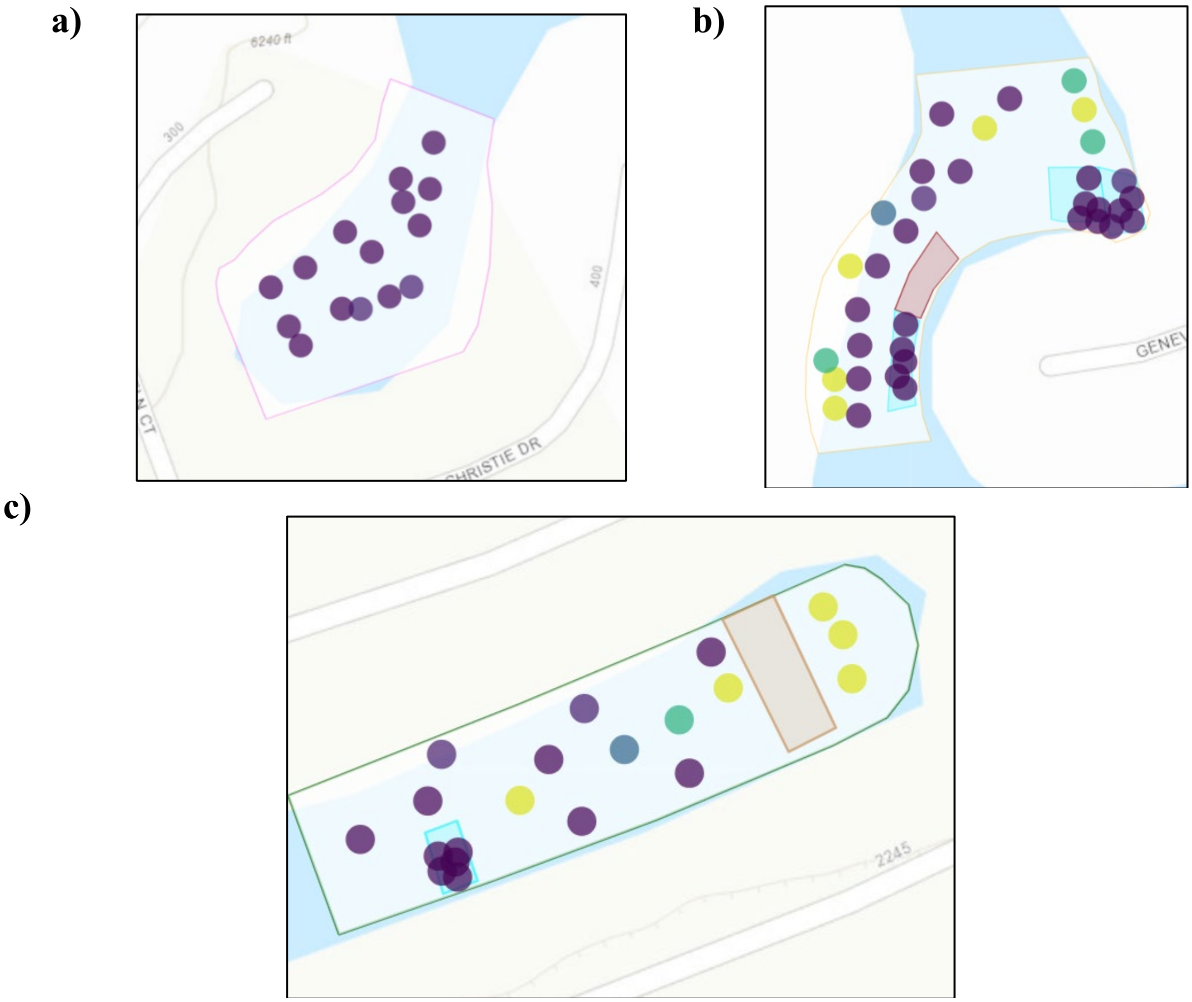


Figure 3. Example of Midchannel Point Sampling in Site 22 (a) and Site-wide and DASH Sampling in Sites 11 (b), and 8 (c).

For each rake sample, the following data were collected in the field and are more fully described below: 1) the percent composition of each species (relative abundance of each species present), 2) all species observed on the rake to calculate frequency of occurrence, 3) rake fullness, 4) plant health, and 5) fresh weight (subsample). Water depth was also collected for each rake. Data were recorded on personal tablets with Fulcrum software along with a photo of each rake. Tablets were connected to submeter antenna (EOS Positioning Systems Arrow Series). Digital data collection forms were developed in Fulcrum specifically for the CMT Project and synced daily. Once synced, Project stakeholders were able to view the data on desktop through a web application developed in R Shiny. The schedule for rake point sampling was based on set days after treatment dependent upon treatment type (**Table 4**).

TABLE 4
YEAR 3 MACROPHYTE ASSESSMENT SCHEDULE BASED ON CMT TREATMENT TYPE

CMT Treatment Type	Assessment Frequency [a]
Control	Every 14 days until fall
Herbicide-Only (applied in Year 1)	Every 14 days until fall
UV-Only	Every 14 days following end of first treatment until fall
Combination Herbicide and UV	Pre-treatment, 14DAT, then every 14 days until fall
LFA	Spring and fall (except Group Bs in Site 26,)
Bottom Barriers	Every 14 days following removal until fall
UV-spot	Every 14 days following end of first treatment until fall
DASH	Every 14 days following completion until fall
Sequential Treatments[b]	At least once following removal of bottom barrier and once after UV or DASH Sequential Treatment

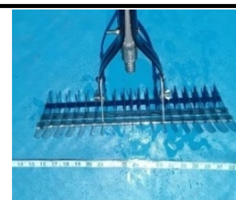
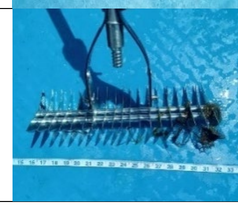
NOTES:
a References: MMRP and Anderson (2022)
b Either UV-spot or DASH following the removal of bottom barrier

Rake Fullness

For each rake sample collected, a rake “fullness” value was assigned according to ranks illustrated in **Table 5**. The rake fullness schema applied is similar to those used by others (Kenow et al. 2007, Hauxwell et al. 2010, IDNR 2018, Madsen and Wersal 2012, Helminen et al. 2019, Howell and Richardson 2019). By assigning a rake fullness rank, the average fullness per site per sampling event was compared by treatments.

As previously mentioned, the BioBase system has been employed in the Tahoe Keys lagoons for over 10 years to document changes in the SAV community. This easy-to-use system provides basic maps without the need for expensive tools or complex data processing. The metric of rake fullness provides additional information over the biovolume metric. Rake fullness is evaluated at each sampling point within a treatment site rather than across each treatment site. The disadvantage with scan-derived data is that the “heat maps” showing total plant biovolume do not distinguish species. However, the data from rake samples can be used in conjunction with BioBase mapping data to generate species-specific biovolume (see SEA 2025).

TABLE 5
PLANT RAKE FULLNESS SCHEMA AND EXAMPLES

Rake Fullness Rating	Description	Example
0	0%; no plants (but filamentous/macro algae (e.g., Chara) may be present	
1	1-5%; handful of sprigs	
6	6-25%; less than one-fourth of the rake full	
26	26-50%; a fourth to half of the rake full; tines visible	
51	51-75%; more than half of the rake full; some tines still visible	
76	76%+; completely full rake; no tines visible	

Relative Abundance

The relative abundance (percent composition) of each species is critical to understanding the differential effects of CMT treatments on each target species as well as non-target desirable native plants. Since the herbicides used in Year 1 have different selectivity and UV selectivity is relatively unknown, this metric was included to better understand species-specific responses to different treatment types. Additionally, describing the increase in relative abundance of native plants to non-native plants is a fundamental goal of the Project. The abundance of each species was determined in the field by assigning the percentage of each plant species represented on each rake, determined for target as well as non-target native species. Where a rake was void of any plants, 0 percent was assigned to all species. Where plants were observed, the total abundance of each rake would equal 100 percent. For example: rake sample 1 had three species (A, B, and C). Species A was dominant and comprised 50% of the composition on the rake. Species B and C each comprised 25% of the composition for a total of 100%. As another example, rake sample 2 was void of any macrophytes or macroalgae, thus the percent composition for all species was 0%. For a final example, rake sample 3 was completely covered by Species C thus the composition was 100% Species C. The example rake sample 3 was very common for Coontail. Example figures are provided in the Results section associated with each treatment type.

Frequency of Occurrence

Calculating frequency of occurrence is routinely used to assess the efficacy of control efforts (Madsen 1999, Madsen and Wersal 2017, Polk County Wisconsin 2020). Additionally, describing the increase in frequency of occurrence of native plants to non-native plants is a fundamental goal of the Project. As assessed here, it was simply a count of the number of observations of a species on a rake, divided by the total number of rakes per site and multiplied by 100. While this approach does not demonstrate reductions in overall biovolume it does detect species-specific treatment effects and provides a method to calculate percent reduction in frequency of occurrence, by species. Example figures are provided in the Results section associated with each treatment type.

Plant Health Condition

The plant condition rating scheme was designed to provide a semi-quantitative metric to distinguish healthy plants (with no apparent treatment symptoms) from those with physically discernable symptoms or conditions. The rating has five levels: from 1-5 with 1 being decomposed/decomposing and 5 is a robust, healthy plant (**Table 6**). For each species on each rake, a plant health rating was applied in the field. This metric was used to better inform subsequent analyses such that unviable plant fragments were not further considered, for example, in frequency of occurrence and percent composition assessments. Including unviable fragments would bias the outcome by including plant species that are essentially not present in any meaningful way.

TABLE 6
PLANT HEALTH CONDITION RATINGS

Rating	Description
1	Plants are barely recognizable due to decomposed or disintegrating tissues including leaves, stems, roots and rhizomes, and any attached reproductive parts (flowers, fruit/seed/ turions)
2	Plants are defoliated, roots and stems are recognizable, intact but disintegrating. Plants easily come apart with minor physical force.
3	Plants are defoliated but stems are mostly intact; roots and rhizomes are mostly intact and firm; reproductive parts are intact (if present). Some plants may appear almost normal.
4	Some plants are partially defoliated or have “bleached” or pale leaves; most plant parts are otherwise intact and appear normal: stems, rhizomes, roots, reproductive parts if present.
5	Plants are consistently intact and appear normal with green tissues (leave/stems); rhizomes and roots are firm and intact and reproductive parts if present are normal.

SOURCES: TKPOA (2022) and Anderson (2022)

Fresh Weight

Measuring the fresh weight (FW) of aquatic plant material is a common method to evaluate changes in plant community. It provides a rapid and relatively easy approach to assess plant density without using more labor-intensive approaches such as divers to harvest plant material, dry the material, then weigh. In Year 3, samples were evaluated for wet weight by removing plant material from the rake, draining for one minute, placing in a 10-gallon handled bucket, and weighing (minus the weight of the bucket). Plants were collected from May through November and represented a range of rake fullness categories (Table 5). Previously described metrics were also collected. The purpose of this exercise was to inform how rake fullness ranks and wet weight values correlate. Using wet weight values reduces some inherent subjectivity embedded in the rake fullness assessment. Further, equations exist in the literature that allow for a conversion from FW to dry weight (DW). Couple this information with the estimated area the rake pulls are from, then a DW per square meter result can be presented and compared with other studies.

Curlyleaf Pondweed Turions

Curlyleaf Pondweed produces specialized, hardened structures, called turions, that act as a reproductive unit for the plant. Turions are generally produced late spring/early summer, followed by a summer senescence (die-back) until late summer/early fall when some turions will sprout and produce a second ‘wave’ of growth. Turions also allow the plant to survive through the winter months and sprout new plants in the spring. This reproductive strategy makes Curlyleaf Pondweed one of the most invasive aquatic plants and challenging to manage.

In Year 3, observations of turions were recorded when rake metrics were being assessed. In particular, the number of turions per rake were recorded and, if present, the maximum lengths of new shoot growth was also recorded. This information will be essential for planning future management efforts for Curlyleaf Pondweed.

Results

Between April 8, and November 17, 2024, TKPOA conducted bi-weekly hydroacoustic scans across the Lagoons and Lake Tallac. Between May 6 and November 5, 2024, nearly 9,000 rake samples were collected from across the West Lagoon and Lake Tallac as part of the Project. All sites were sampled according to schedule, with the following exceptions/omissions: Site 3: two sampling visits between 7/1/2024 and 8/20/224; Site 3: two rake samples on 9/4/2024, and Site 8: two rake samples each on 10/14/2024 and 10/28/2024.

Though the scans do not differentiate between submersed aquatic vegetation (SAV) species, they do detect *total* SAV and results can be used in conjunction with rake point sampling to evaluate target species control efficacy, as described later. In Year 1, the large number of physical rake point samples taken was well-correlated with biovolume data derived from hydroacoustic scans and corroborates similar studies (Valley et al. 2015, Helminen et al. 2019). In Year 2 and 3, however, scan-calculated biovolume was not directly comparable to rake fullness, presumably due to greater water depth (**Figure 4**). However, there is still tremendous benefit in using rake data to understand plant composition and better understand the effects of Group B methods where scans may not detect changes on a small scale. In short, rake data may not always be well correlated with “% biovolume” generated from hydroacoustic scans but provides fine details on species composition.

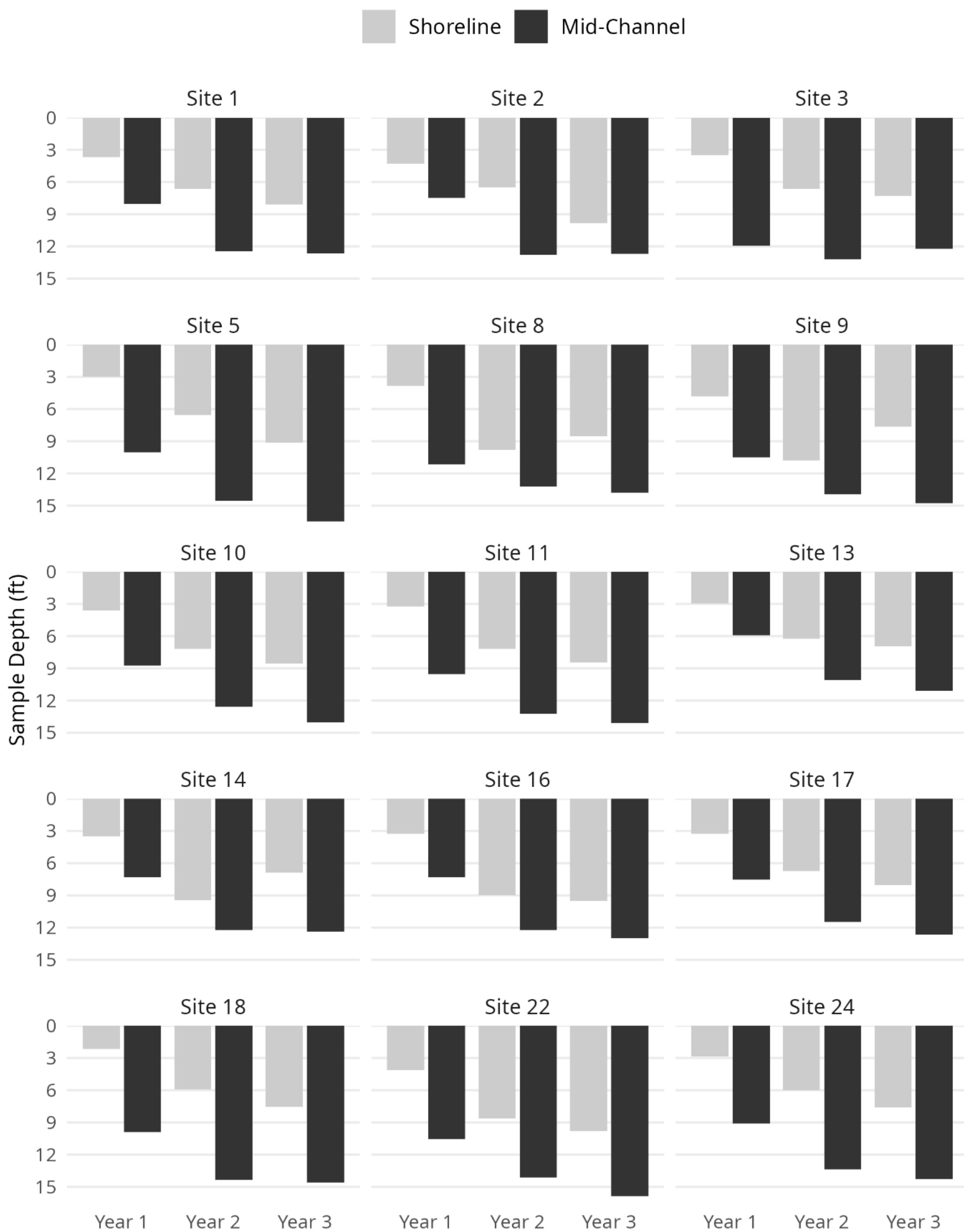


Figure 4. Average Sample Depth (ft) from Main Lagoon CMT Sites Collected from Shoreline (gray) and Midchannel (black) Locations in all Three Years.

Results are presented by treatment type based on Group A applications in Year 1 with a notation for any Group B methods applied in Year 3. Within each treatment type, results are presented in the following order: hydroacoustic scans (biovolume and VHC), rake fullness, relative abundance, and frequency of occurrence. While the entire season (May to November) of CMT data are presented. For some metrics, a good deal of attention is given to the peak growing season (June to September). Fresh weight and turion assessment results are discussed following treatment types.

Endothall-Only Sites with Group B Methods

Endothall-only sites included Sites 1, 2, 3, and 19 that were treated in Year 1. Group B methods in Year 3 included two DASH areas and one UV-spot area in Site 1, one each of UV-spot and DASH in Site 2, and one of all three Group B treatments in Site 3. Also in Site 3, a sequential DASH treatment following the removal of the bottom barrier. Site 19 received no Group B methods in Year 3. Rake fullness was consistently greater site-wide in Site 19 compared to control Site 20 in Lake Tallac.

Hydroacoustic Scans

Biovolume

In Year 3, biovolume measured in the Endothall-only sites of the Main Lagoon during the peak summer months (July to September) ranged greatly from 11% to 48% (**Figure 5**). The average biovolume in the controls in the Main Lagoon over the same time period was 48%. Overall, there was 41% less biovolume in the Main Lagoon Endothall-only sites compared to controls. On a site basis, Site 2 had the greatest difference in biovolume compared to controls at 54% lower.

Comparing the mean biovolume in Site 19 during the peak summer months to Control Site 20, there was 20% lower biovolume although no Group B methods were implemented in Site 19 in Year 3.

It should be noted that the standard hydroacoustic scans do not have the spatial resolution needed to differential "biovolume" specific to Group B methods in place during the time of scans. However, the size of Group B methods areas were a small fraction of the size of site-wide scans so the scans most accurately assess site-wide biovolume.

Vessel Hull Clearance (VHC)

All CMT sites (including controls in the Main Lagoon and Lake Tallac) had VHC levels equal to or greater than 3 feet in May, August, and November with the exception of Site 27 at 2.9 feet in August (examples in **Figure 6**). Data indicate that the metric for VHC was achieved in Year 3; however, it should be noted that water levels were substantially greater in Year 3 compared to both Years 1 and 2, which likely played a role in achieving this metric.

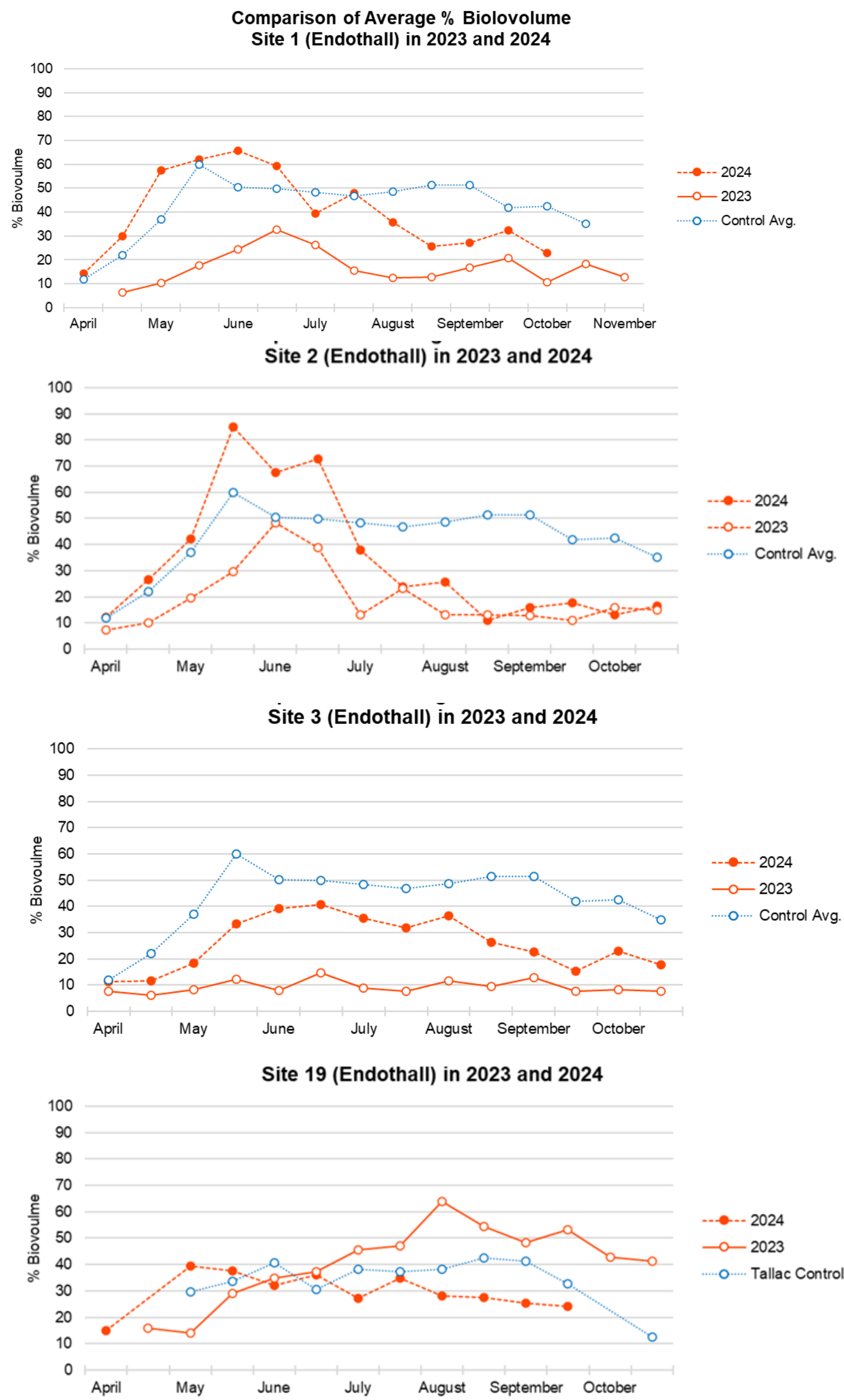
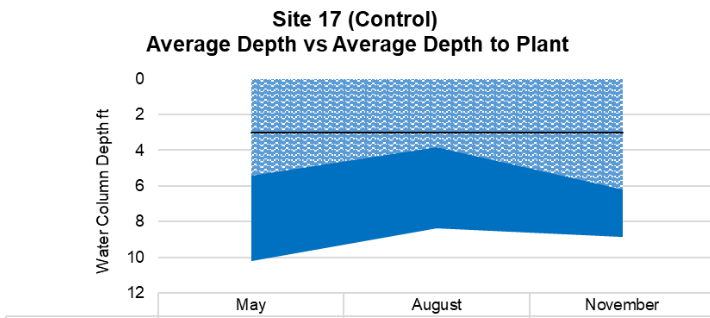


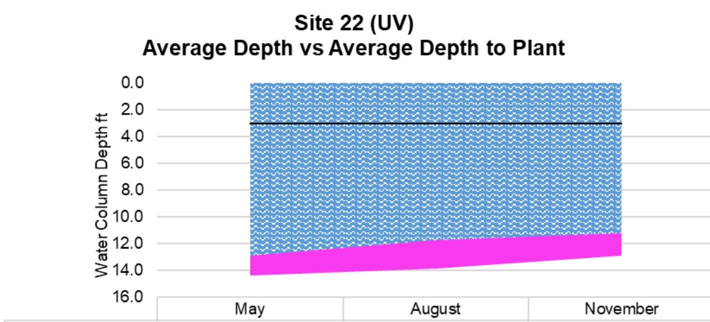
Figure 5. Average Percent Biovolume in Control Sites (Blue; 2024 data) and Sites 1, 2, 3, and 19 in 2023 and 2024 (open and closed orange circles, respectively).

SOURCE: TKPOA

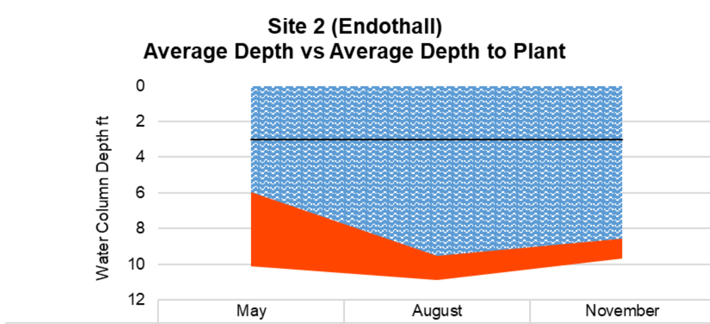
Note: all control sites were harvested throughout the summer



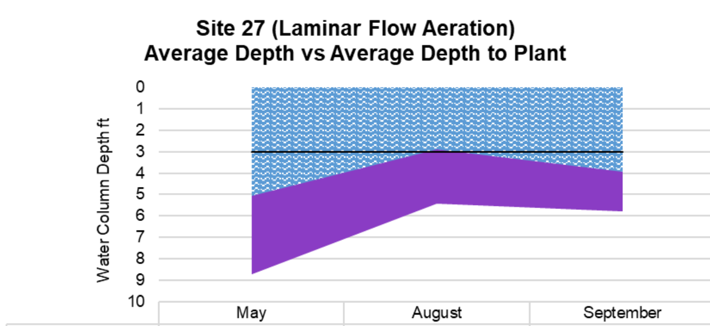
	May	August	November
Water Depth	10.2	8.39	8.86
Depth to Plant	5.43	3.85	6.20
Minimum VHC	3	3	3



	May	August	November
Water Depth	14.4	13.8	12.9
Depth to Plant	12.9	11.7	11.2
Minimum VHC	3	3	3



	May	August	November
Water Depth	10.1	10.9	9.70
Depth to Plant	5.98	9.55	8.57
Minimum VHC	3	3	3



	May	August	September
Water Depth	8.73	5.43	5.80
Depth to Plant	5.05	2.90	3.92
Minimum VHC	3	3	3

Figure 6. Examples of Average Water Depth versus Average Depth to Plant Canopy for Sites 17, 22, 2, and 26.

SOURCE: TKPOA

Point Sampling

The schedule for all Group B methods can be found in Tables 1 through 3. Note that for all the metrics described below, the dates in figures represents the first day of a two-week period because all sites could not be assessed within the same week.

Rake Fullness

Using rake fullness as the metric, sustained site-wide (non-Group B areas/NA) control of aquatic weeds was observed in Year 1 Endothall-only sites (red bars in **Figure 7**) compared to controls (blue bars). During the peak summer season, rake fullness was on the order of 30% site-wide compared to near 50% in control sites.

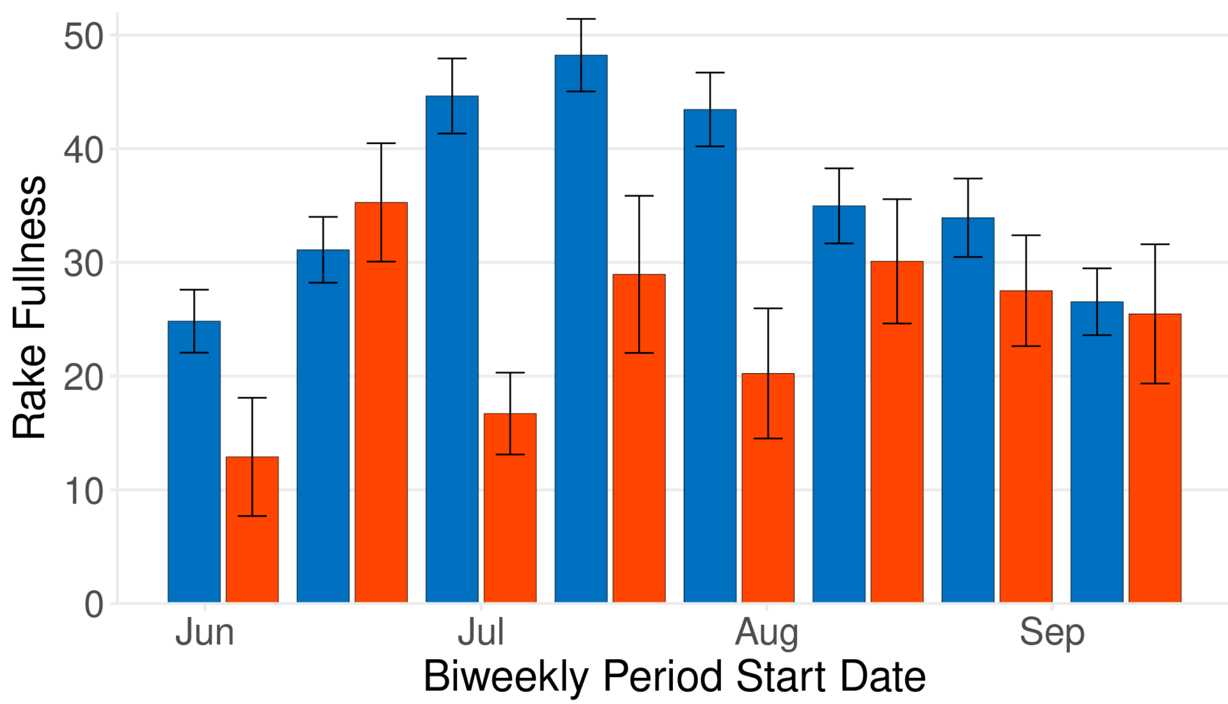


Figure 7. Average Rake Fullness of the Control Sites (Blue) and Year 1 Endothall-only Site-wide (Red) (combined mid-channel and shoreline).

Group B Areas

All Endothall-only sites received two or more Group B methods (**Figure 8**). Site 1 had two DASH areas and one UV-spot area, Site 2 had one relatively large UV-spot area and one DASH area, and Site 3 had one UV-spot, one DASH and one bottom barrier with a sequential DASH treatment.

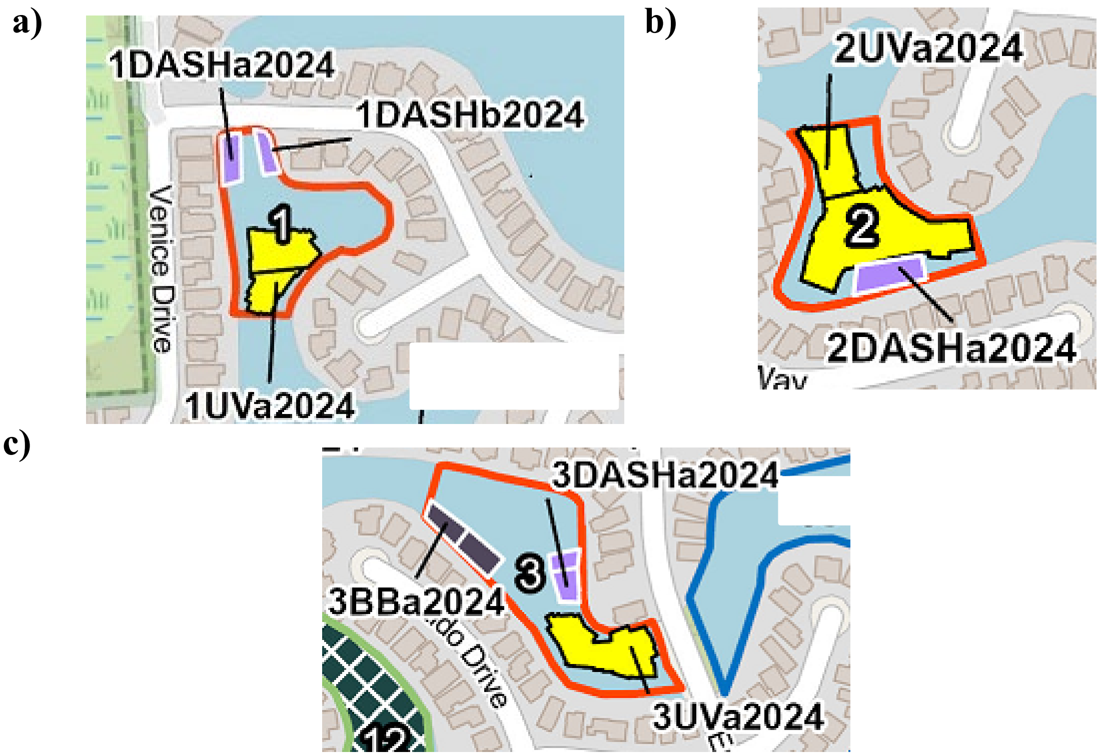


Figure 8. Location of Group B Methods in Site 1 (a), Site 2 (b), and Site 3 (c).

Following the removal of the bottom barrier in Site 3, rake fullness was around 15% (**Figure 9**). In general, DASH resulted in low rake fullness once treatments began and continued to end of season. This was particularly the case for Site 2 where fullness was substantially lower than site-wide as well as controls. UV-spot treatments were routinely implemented throughout the summer in all Main Lagoon Endothall-only sites, with a relatively large area in Site 2. In all sites, rake fullness was generally substantially lower in UV-spot areas compared to site-wide samples (less than 10% to end of season). The sequential bottom barrier to DASH treatment in Site 3 was highly variable but generally similar to site-wide and controls (~20%) It should be noted that the relative abundance of Coontail (discussed below) was on the order of 60% later summer/early fall in Site 3 bottom barrier areas.

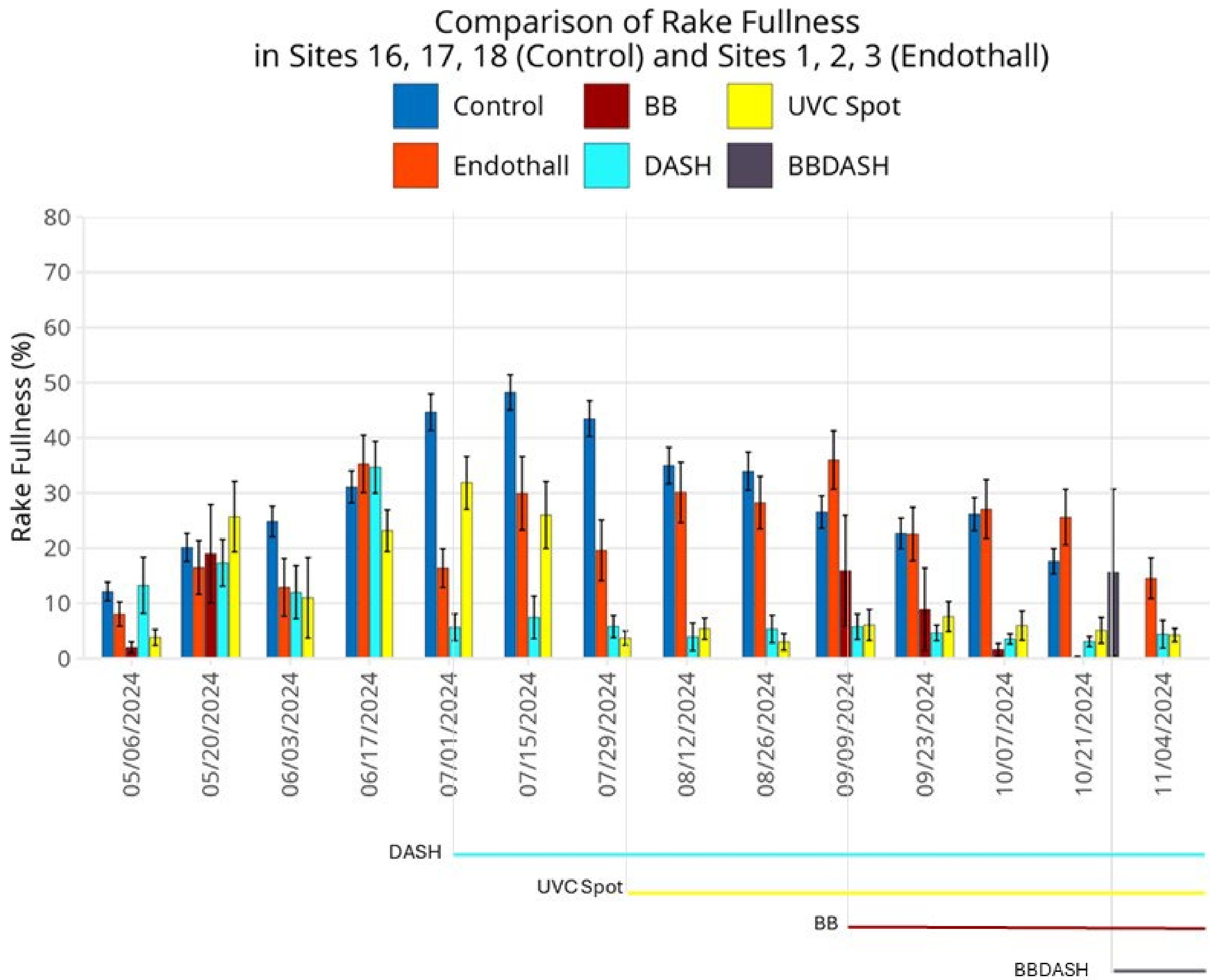


Figure 9. Average Rake Fullness of Control Sites (Blue) and Endothall-only Site-wide (Red), Bottom Barrier (Dark Red), DASH (Aquamarine), UV-spot (Yellow), and Sequential DASH following Barrier Removal (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Relative Abundance

The relative abundance of all AIP in Endothall sites were similar to or greater site-wide (red bars in **Figure 10**) compared to controls (blue bars). The abundance of Coontail increased by 60% following the removal of the bottom barrier in Site 3 but was reduced to approximately 20% after a sequential DASH treatment. DASH treatments alone did not provide appreciable control of any AIP, presumably due to fragments rapidly colonizing these relatively small areas. UV-spot was generally effective in sustaining low relative abundance of Coontail and especially Eurasian Watermilfoil; however, the abundance of curlyleaf was over 60% by end of season, approximately three times that of site-wide abundance of curlyleaf. Further, the relative abundance of Curlyleaf Pondweed in all Endothall sites exhibited a classic “biomodal” distribution with the highest abundances in the spring, declining during the summer, and peaking again late summer/early fall.

The relative abundance of native plant species was generally less than 5% for Sites 1, 2, and 3; however, the abundance of native species in Site 19 (site-wide) was on the order of 20%. Again, no Group B methods were implemented in Year 3.

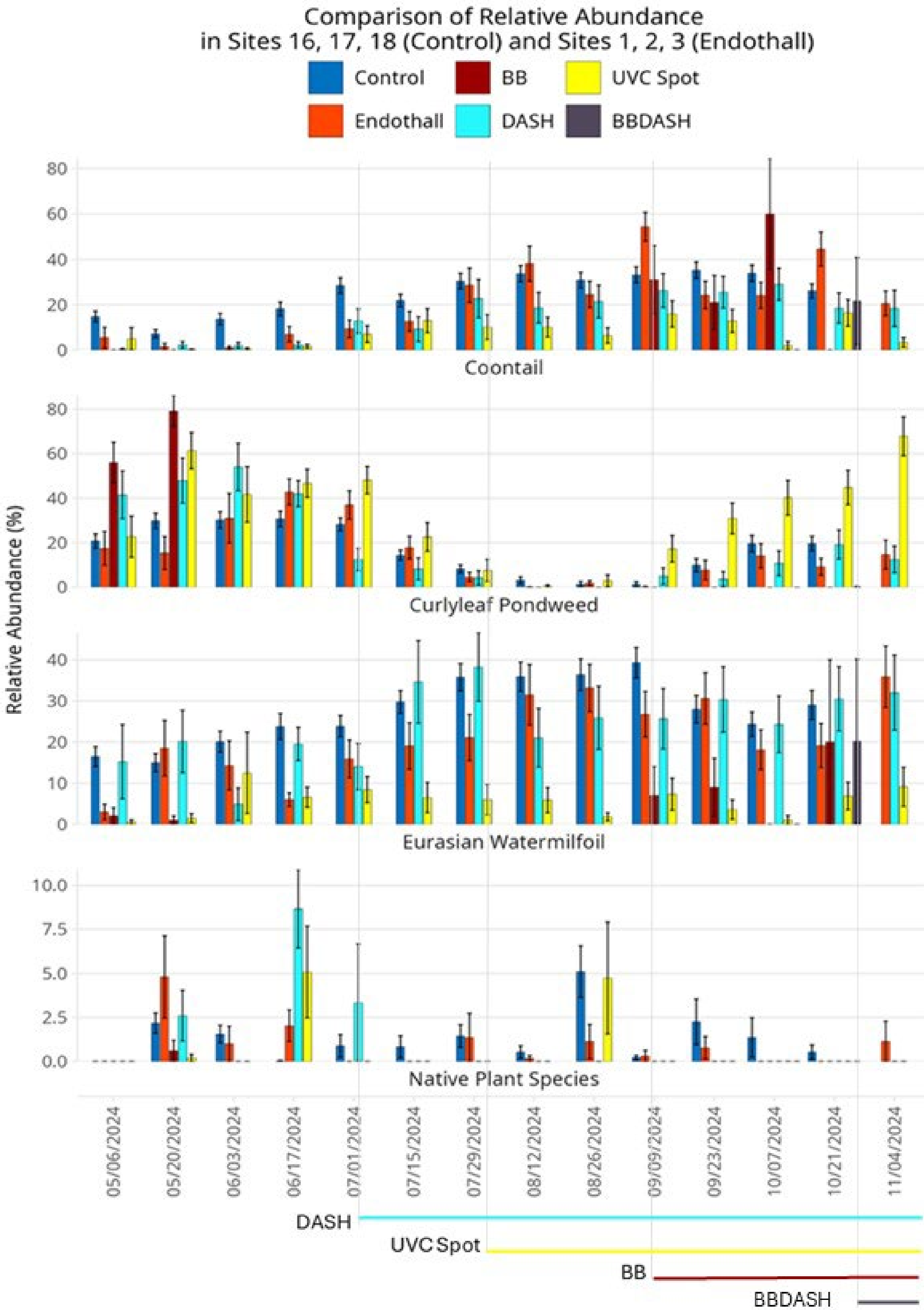


Figure 10. Average Relative Abundance of Control Sites (Blue) and Endothall-only Site-wide (Red), Bottom Barrier (Dark Red), DASH (Aquamarine), UV-spot (Yellow), and Sequential DASH following Barrier Removal (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Note variable scale on y-axis

Frequency of Occurrence

Similar to relative abundance, the frequency of occurrence of all AIP species were similar to or greater than site-wide (red bars in **Figure 11**) compared to controls (blue bars). The frequency of Coontail was 30% following the removal of the bottom barrier in Site 3, but unlike abundance, its frequency increased to 40% following sequential DASH treatment. DASH treatments alone slightly reduced the frequency of Curlyleaf Pondweed compared to site-wide, but this pattern was not so conspicuous for Coontail or Eurasian Watermilfoil. UV-spot was generally effective in sustaining low occurrence of Coontail and Eurasian Watermilfoil; however, the occurrence of curlyleaf was approximately 70% by end of season. Like relative abundance, the occurrence of Curlyleaf Pondweed also exhibited a bimodal distribution over the season.

The frequency of occurrence of native plant species was generally less than 20% and substantially lower in Group B areas following implementation of treatments.

Plant Health Condition

It was intended that plant health condition would not only demonstrate the herbicidal effects of Group A applications in Year 1 but provide additional information of the effects of Group B methods, particularly UV. Results across all treatments provided no clear pattern and scores lower than 4 or 5 were rarely recorded. Where no plants were observed, no score was recorded thus skewing the average for a sampling event. A discussion on the criteria for assessing plant health condition will be included in the synoptic report of Years 1 to 3 of the Project and not discussed further here.

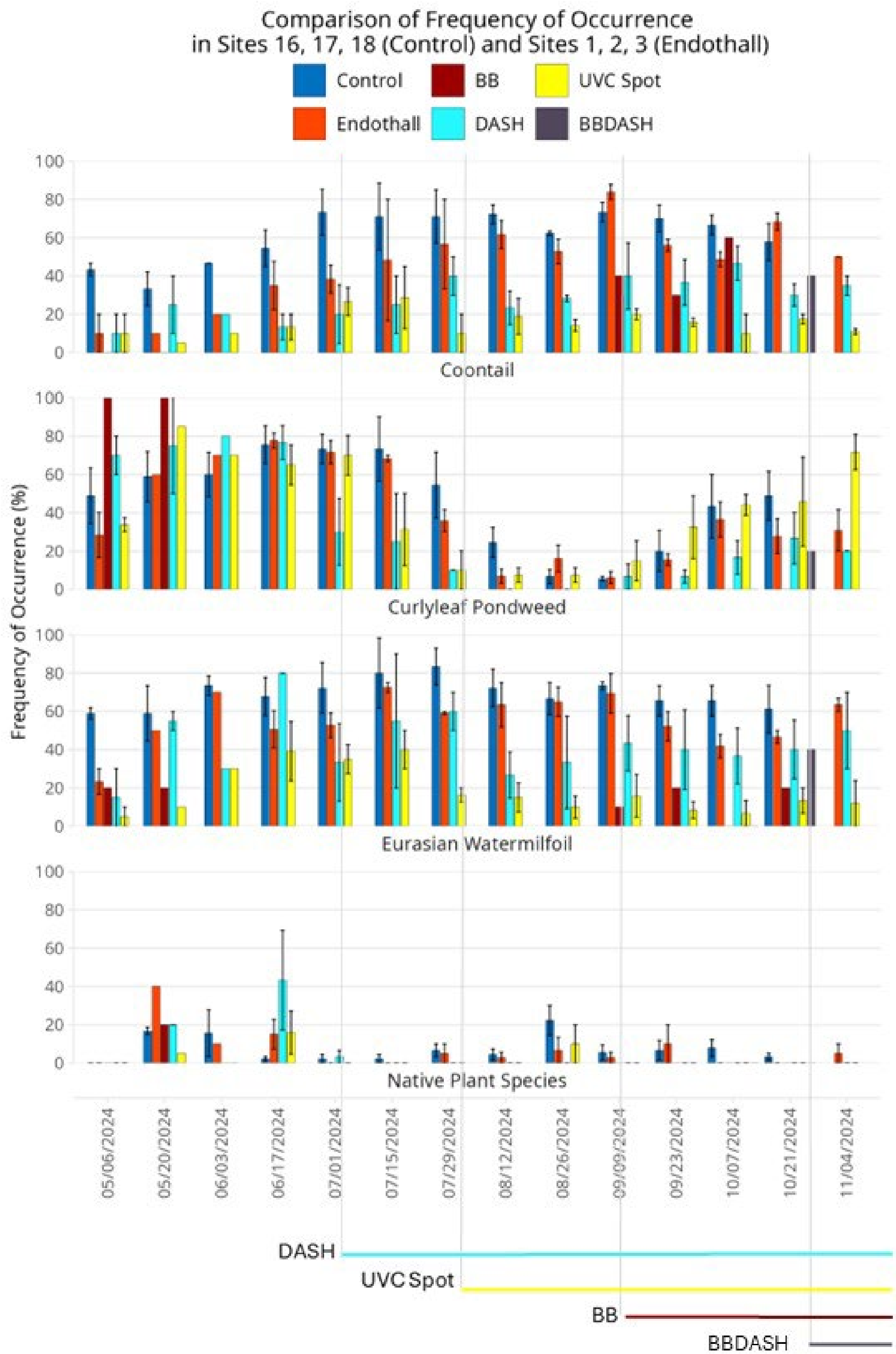


Figure 11. Average Species Frequency of Occurrence of Control Sites (Blue) and Endothall-only Site-wide (Red), Bottom Barrier (Dark Red), DASH (Aquamarine), UV-spot (Yellow), and Sequential DASH following Barrier Removal (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Triclopyr-only Sites with Group B Areas

Triclopyr-only sites included Sites 5, 8, and 9 that were treated in Year 1. Group B methods in Year 3 included two DASH areas and one UV-spot in Site 5, one bottom barrier and one DASH in Site 8, and one UV-spot and one DASH in Site 9. Also in Site 8 was a sequential UV-spot treatment following the removal of the bottom barrier.

Hydroacoustic Scans

Biovolume

In Year 3, biovolume measured in Triclopyr-only sites of the Main Lagoon during peak summer months (July to September) ranged widely from 18 to 56% (**Figure 12**). Average biovolume in the controls in the Main Lagoon over the same time period was 48%. Overall, there was 25% less biovolume in the Main Lagoon Triclopyr-only sites compared to controls. On a site by site basis, Site 9 had the greatest difference in biovolume compared to controls at 46% lower.

Vessel Hull Clearance

All CMT sites (including controls in the Main Lagoon and Lake Tallac) had VHC levels equal to or greater than 3 feet in May, August, and November with the exception of Site 27 at 2.9 feet in August (Figure 3).

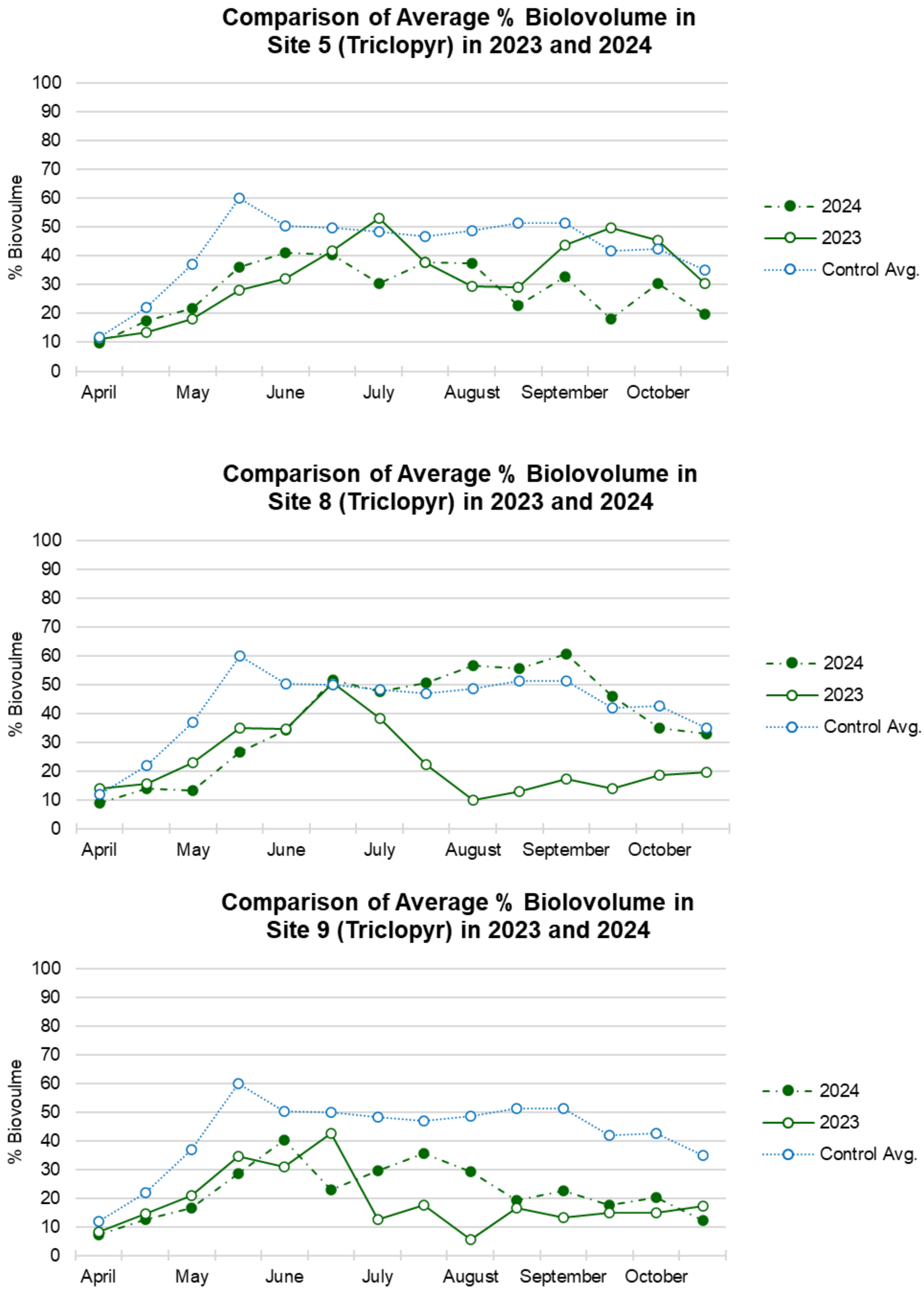


Figure 12. Average Percent Biovolume in Control Sites (Blue; 2024 data) and Sites 5, 8, and 9 in 2023 and 2024 (open and closed green circles, respectively).

SOURCE: TKPOA

Note: all control sites were harvested throughout the summer

Point Sampling

The schedule for all Group B methods can be found in Tables 1 through 3. Note that for all the metrics described below, the dates in figures represents the first day of a two-week period because all sites could not be assessed within the same week.

Rake Fullness

Using rake fullness as the metric, sustained site-wide (non-Group B/NA) control of aquatic weeds was marginally observed in Year 1 Triclopyr-only sites (green bars in **Figure 13**) compared to controls (blue bars). During the peak summer season, rake fullness was on the order of 25% site-wide compared to near 50% in control sites.

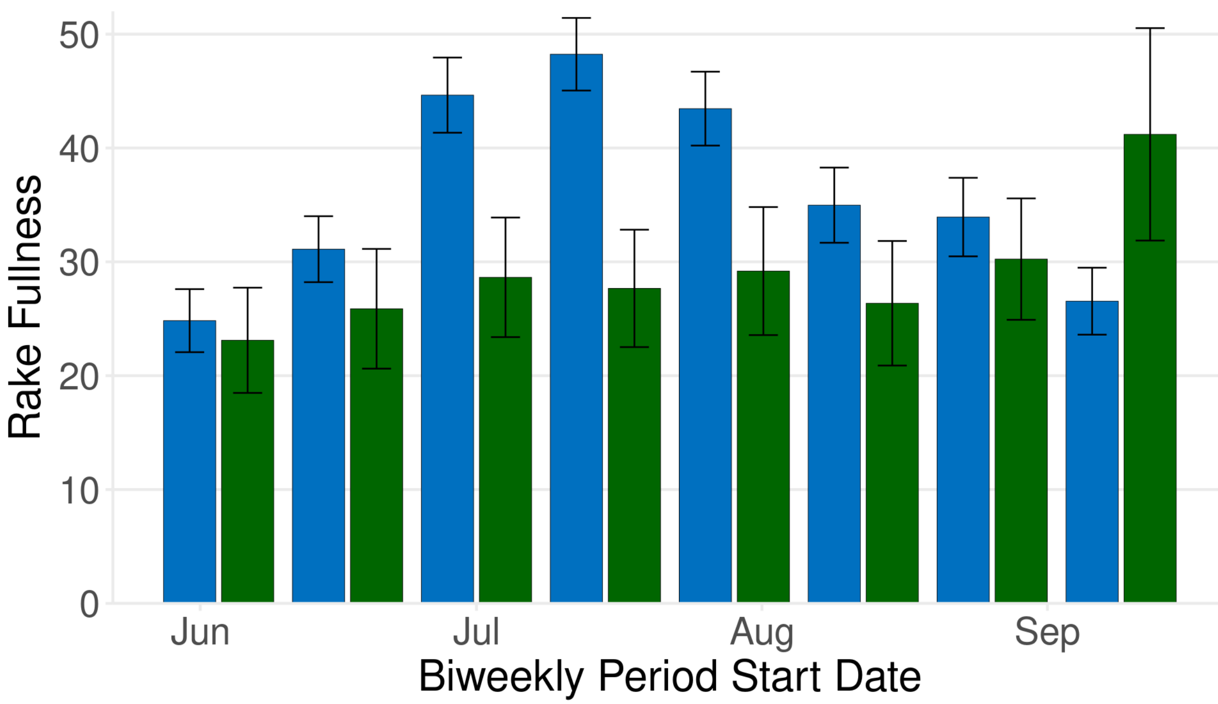


Figure 13. Average Rake Fullness of the Control Sites (Blue) and Year 1 Triclopyr-only Site-wide (Green) (combined mid-channel and shoreline).

Group B Areas

All Triclopyr-only sites received two or more Group B methods (**Figure 14).** Site 5 had two DASH and one UV-spot treatment, Site 8 had one small DASH and one cross-channel bottom barrier, and Site 9 had one large UV-spot treatment.

Figure 14. Location of Group B Methods in Site 5 (a), Site 8 (b), and Site 9 (c).

The bottom barrier installed in Site 8 had very low rake fullness following removal (<5%) and received sequential DASH following removal after which, fullness remained less than 5% to end of season (**Figure 15**). In general, DASH was most successful in Sites 8 and 9 with rake fullness values less than 10% for much of the season. DASH results in Site 5 were much more variable at both locations. Discussed later, this may be attributed to the lack of susceptibility of Coontail to Triclopyr and floating plant fragments moving into the treatment areas.

UV-spot treatments were also implemented routinely during the summer in Sites 5 and 9 with rake fullness substantially lower than site-wide samples and controls, generally less than 10% throughout the season.

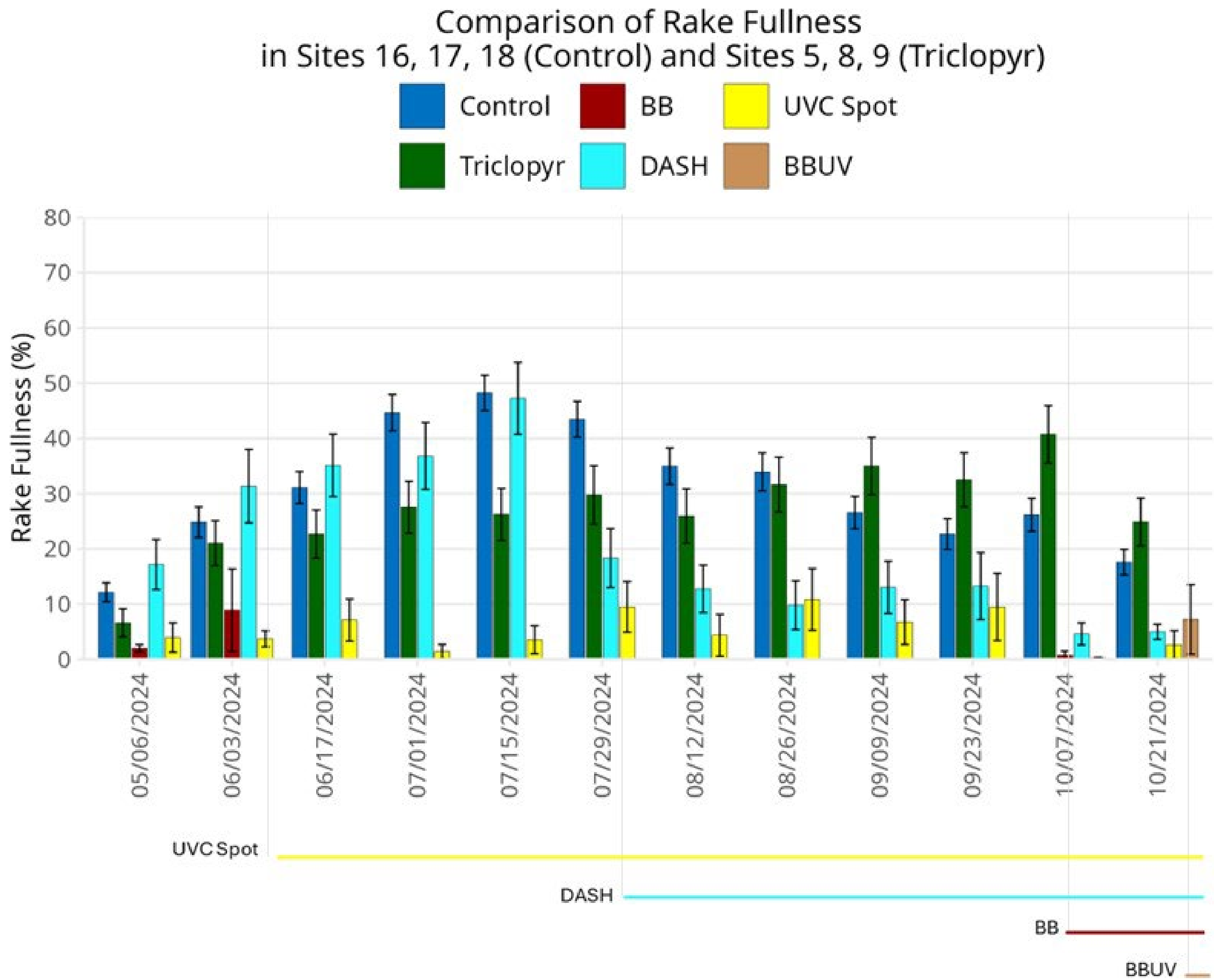


Figure 15. Average Rake Fullness of Control Sites (Blue) and Triclopyr-only Site-wide (Green), Bottom Barrier (Dark Red), DASH (Aquamarine), UV-spot (Yellow), and Sequential Bottom Barrier to UV-spot (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Relative Abundance

Low relative abundance of Eurasian Watermilfoil was decisively achieved in all Triclopyr-only sites (green bars in **Figure 16**) compared to controls (blue bars). This can be attributed to both the known high selectivity of Triclopyr to Eurasian Watermilfoil as well as the ability of this systemic herbicide move into the roots, rhizomes and root-crowns of Eurasian Watermilfoil. It is clear that one-time application of Triclopyr in 2022 resulted in successful reduction of Eurasian Watermilfoil into 2024. Though not widely cited (and not included on the manufacturer's label), Triclopyr also reduced abundance of Curlyleaf Pondweed compared to reference control sites. As expected, the abundance of Coontail site-wide exceeded controls. Following removal of the bottom barrier in Site 3, the abundance of Coontail was on the order of 15%; however, increased to near 30% following sequential UV-spot treatment. The abundance of other AIP however, we less than 5% following removal of the barrier and sequential UV-spot. In general, DASH treatments had no clear impact on the abundance of AIP compared to site-wide. In general, UV-spot treatments were as effective or more so than DASH in reducing the abundance of Coontail (near 60% compared to 25%, respectively).

The abundance of native plant species was highly variable in the Triclopyr-only sites, ranging from less than 2% up to ~15% in Site 8 which was also greater than control sites.

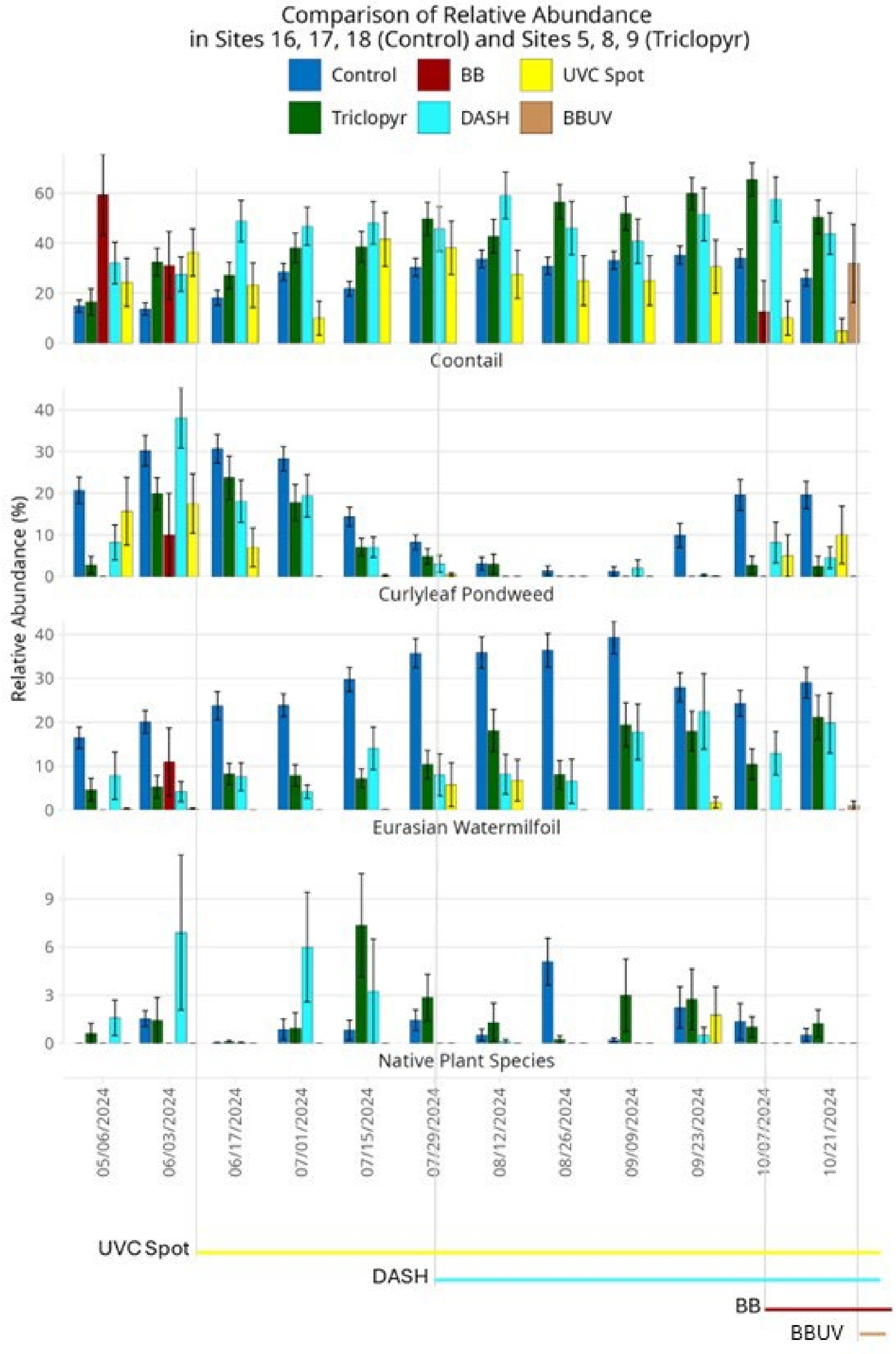


Figure 16. Average Relative Abundance of Control Sites (Blue) and Triclopyr-only Site-wide (Green), Bottom Barrier (Dark Red), DASH (Aquamarine), UV-spot (Yellow), and Sequential Bottom Barrier to UV-spot (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Note variable scale on y-axis

Frequency of Occurrence

Similar to relative abundance, the frequency of occurrence of Eurasian Watermilfoil was roughly half in all Triclopyr-only sites (green bars in **Figure 17**) compared to controls (blue bars). Again, this is attributed to the known high selectively of Triclopyr to Eurasian Watermilfoil and systemic mode of action. There was also reduced frequency of Curlyleaf Pondweed compared to controls. The occurrence of Coontail was equal to or greater than controls. Following removal of the bottom barrier in Site 8, all AIP were less than 10% occurrence compared to site-wide; however, the occurrence of Coontail and, to some extent, Eurasian Watermilfoil, increased following the sequential UV-spot treatment. In general, DASH treatments highly variable for all AIP, particularly Coontail, and most effective on Curlyleaf Pondweed. UV-spot treatments reduced the occurrence of Coontail and Eurasian Watermilfoil to levels far lower than site-wide; however, curlyleaf occurrence was similar to site-wide at end of season.

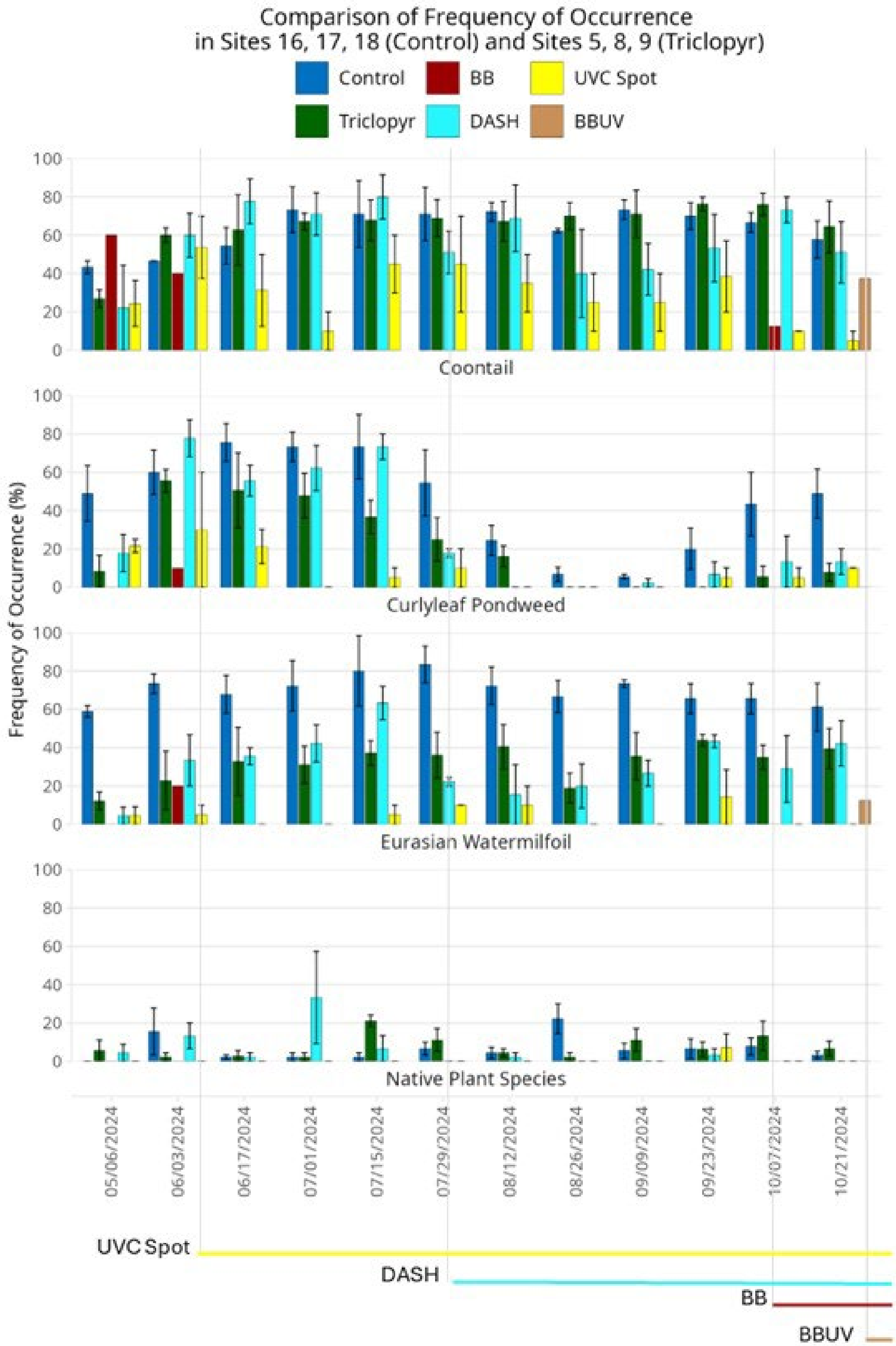


Figure 17. Average Species Frequency of Occurrence of Control Sites (Blue) and Triclopyr-only Site-wide (Green), Bottom Barrier (Dark Red), DASH (Aquamarine), UV-spot (Yellow), and Sequential Bottom Barrier to UV-spot (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

UV-only Sites

UV-only sites included Sites 22, 23, and 24 with no additional Group B methods implemented.

Hydroacoustic Scans

Biovolume

In Year 3, biovolume measured in the UV-only sites of the Main Lagoon during the peak summer months (July to September) ranged from 11 to 42% (**Figure 18**). Average biovolume in the controls in the Main Lagoon over the same time period was 48%. Overall, there was 52% less biovolume in the Main Lagoon UV-only sites compared to controls. On a site-by-site basis, Site 22 had the greatest difference in biovolume compared to controls at 65% lower.

Vessel Hull Clearance

All CMT sites (including controls in the Main Lagoon and Lake Tallac) had VHC levels equal to or greater than 3 feet in May, August, and November with the exception of Site 27 at 2.9 feet in August (Figure 3).

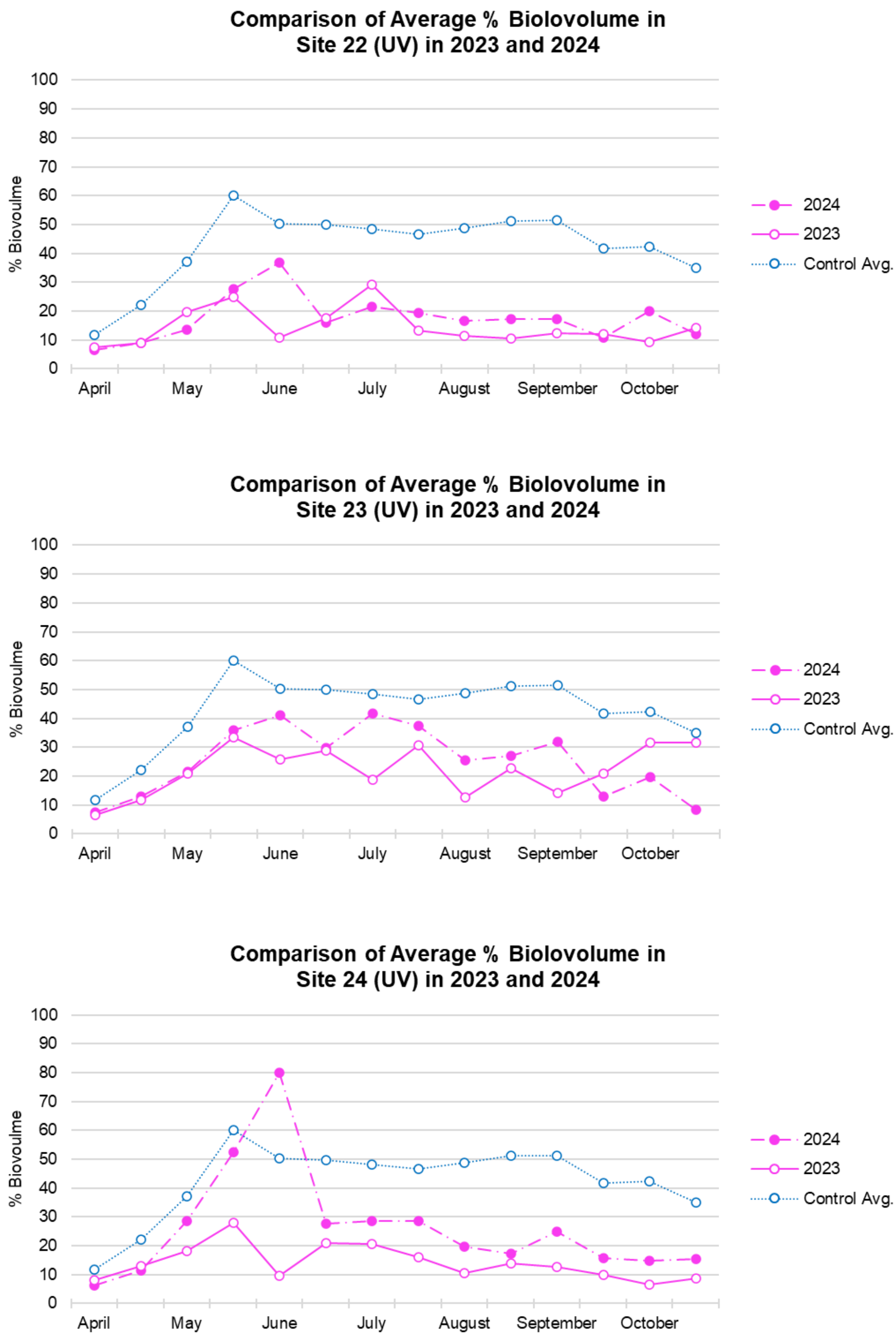


Figure 18. Average Percent Biovolume in Control Sites (Blue; 2024 data) and Sites 22, 23, and 24 in 2023 and 2024 (open and closed pink circles, respectively).

SOURCE: TKPOA

Note: all control sites were harvested throughout the summer

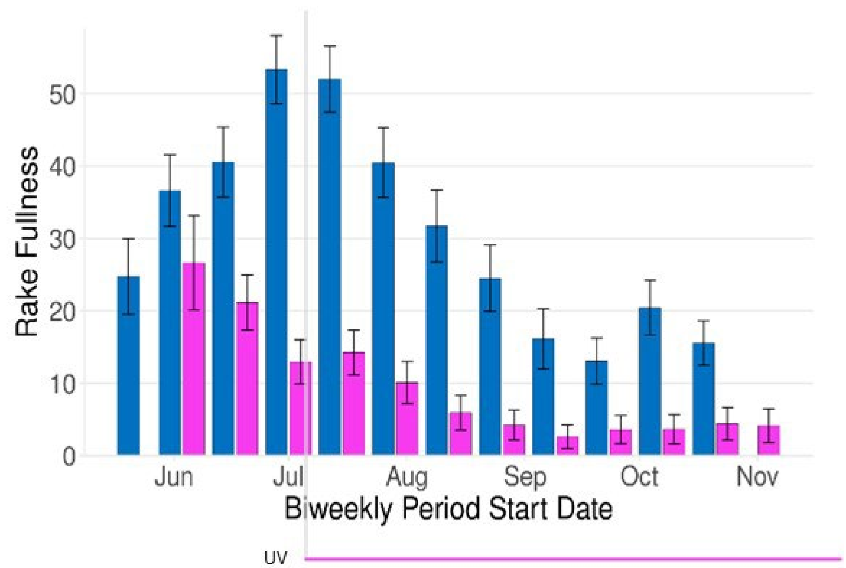
Point Sampling

The schedule for all Group B methods can be found in Tables 1 through 3. Note that for all the metrics described below, the dates in figures represents the first day of a two-week period because all sites could not be assessed within the same week.

Rake Fullness

Using rake fullness as the metric, sustained control of aquatic weeds was clearly observed mid-channel in UV-only sites (pink bars in **Figure 19a**) compared to controls (blue bars). Conversely, where UV was not applied along the shorelines, rake fullness frequently exceeded that of controls by as much as 20% more (**Figure 9b**).

a) Mid-channel



b) Shoreline

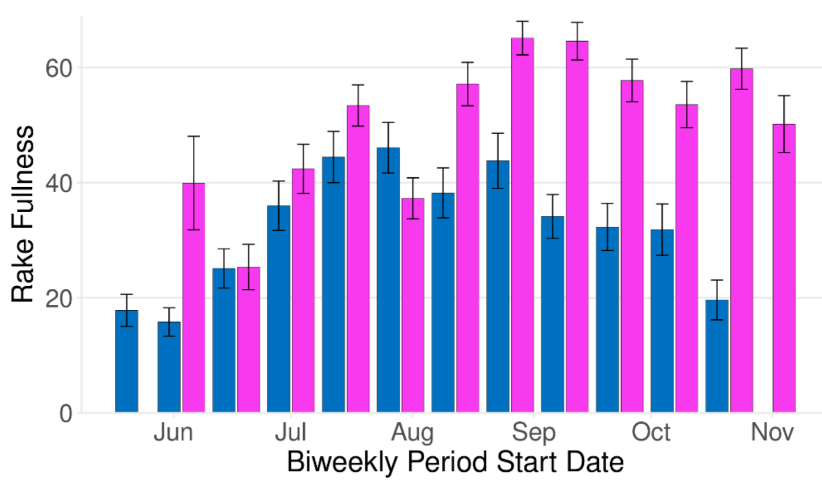


Figure 19. Average Rake Fullness of (a) Midchannel Control Sites (Blue) and Mid-channel Year 3 UV-only and (b) Shoreline Control Sites and UV-only. Line Indicates Approximate Range of Assessments Following End of First Treatment.

Group B Areas

No Group B methods were implemented in any UV-only sites.

Relative Abundance

Using relative abundance as the metric, sustained control of mid-channel Curlyleaf Pondweed and Eurasian Watermilfoil were generally achieved (pink bars in **Figure 20**) compared to control (blue bars). Relative abundance of Coontail was reduced in all UV-only treatments but only minimally in Site 24. Note that Site 23 was not treated in 2023.

Native plant species in the UV-only sites was highly variable and ranged from non-detected up to ~8%.

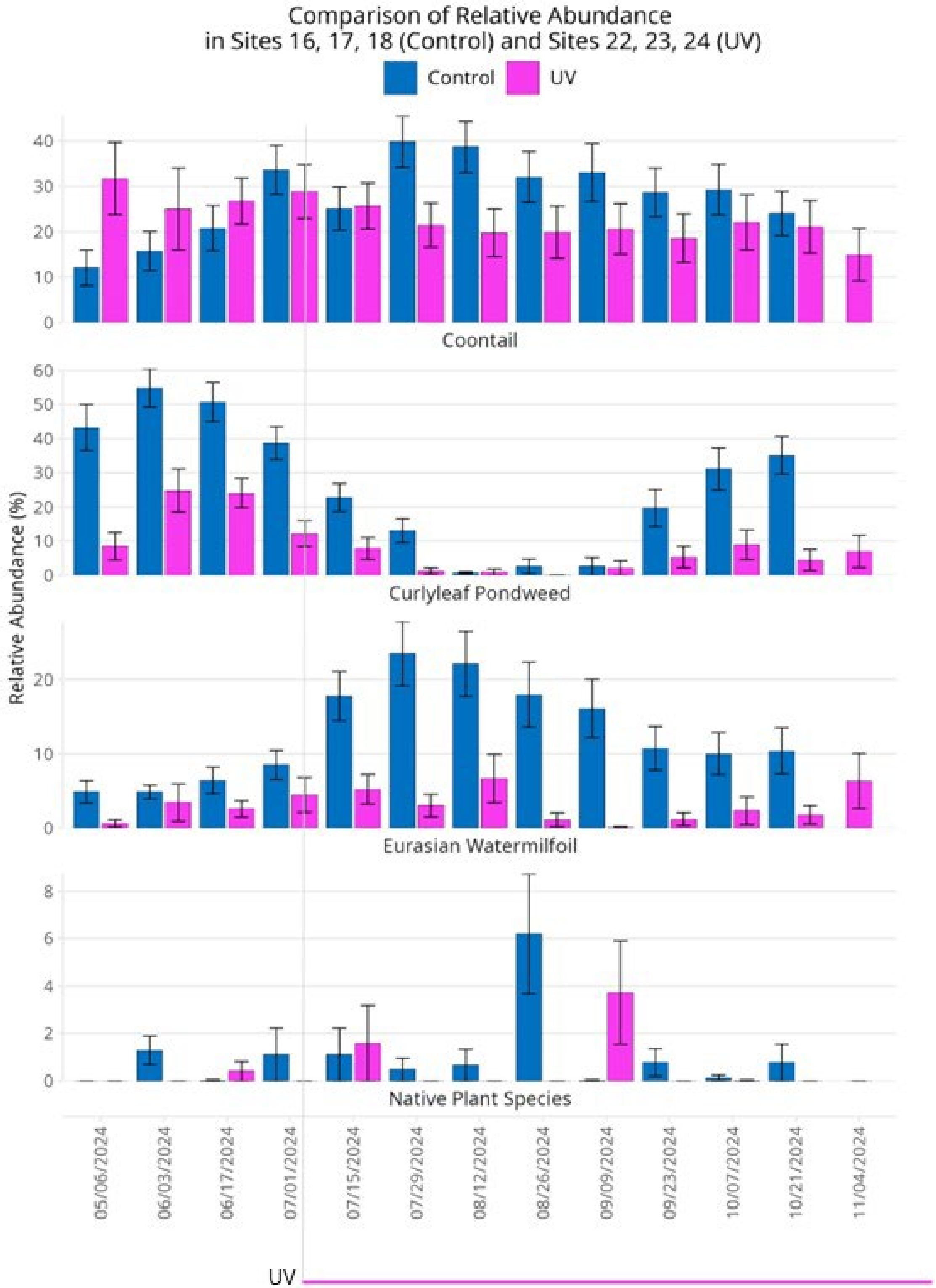


Figure 20. Average Relative Abundance of Mid-Channel Control Sites (Blue) and UV-only Site-wide (Pink). Line Indicates Approximate Range of Assessments Following End of First Treatment.

Note variable scale on y-axis

Frequency of Occurrence

Using frequency of occurrence as the metric, sustained control of aquatic weeds was high in mid-channel of UV-only sites (example Site 23; pink bars in **Figure 21**) compared to control sites (blue bars). This was the case for all AIP species, but also native species, supporting the lack of selectivity of this method.

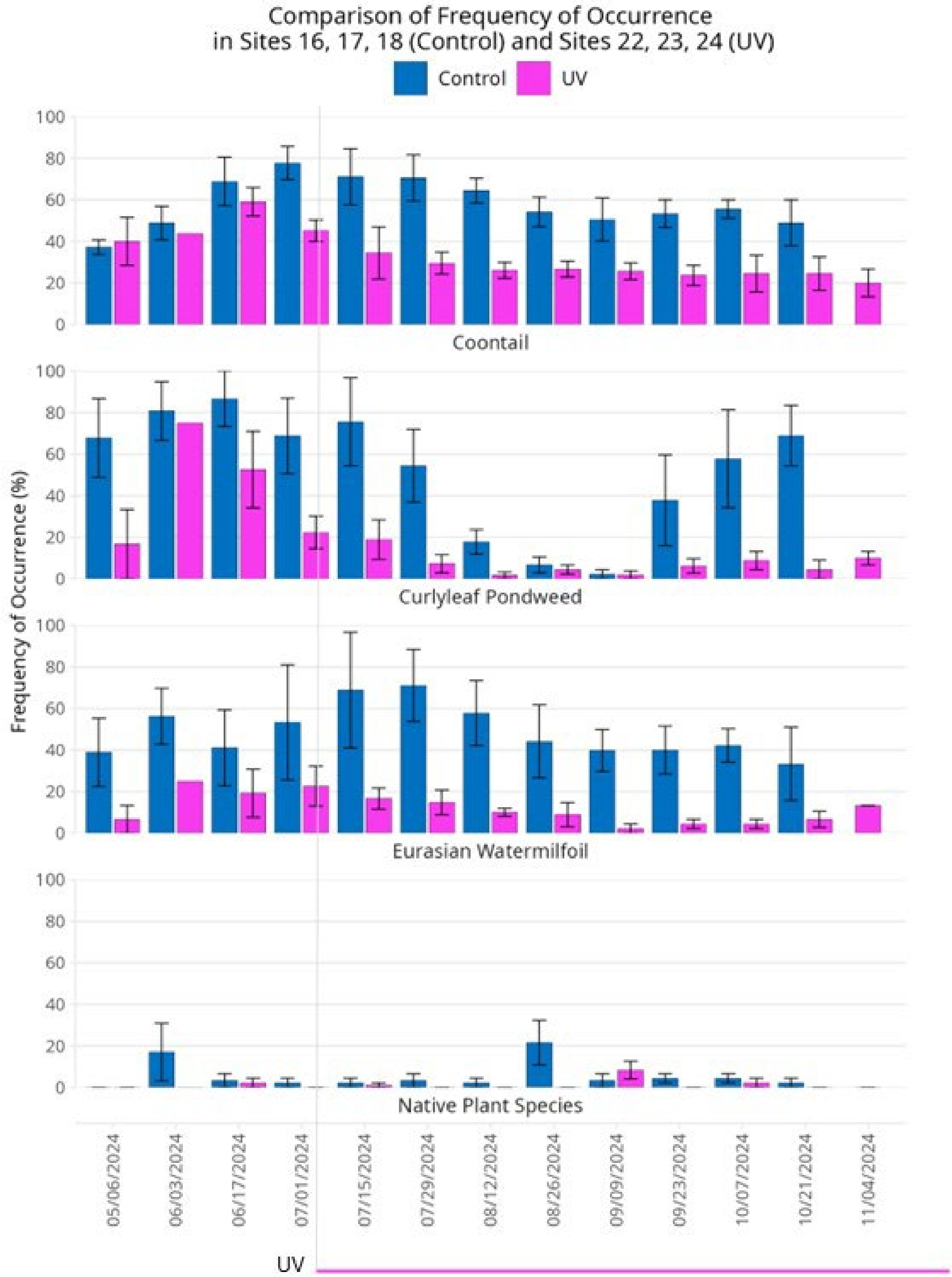


Figure 21. Average Species Frequency of Mid-Channel Control Sites (Blue) and UV-only (Pink). Line Indicates Approximate Range of Assessments Following End of First Treatment.

Endothall + UV Sites with Group B Areas

Endothall + UV sites included Sites 10, 11, and 15 that were treated in Year 1. Group B methods in Year 3 included two DASH areas in Site 10, two DASH areas and one bottom barrier in Site 11, and no Group B methods in Site 12. Also in Site 10 was a sequential UV treatment in one DASH site and a sequential DASH treatment in the other.

Hydroacoustic Scans

Biovolume

In Year 3, biovolume measured in the Endothall + UV sites of the Main Lagoon during peak summer months (July [following the start of UV treatments] to September) ranged from 9 to 51% (**Figure 22**). Average biovolume in the controls in the Main Lagoon over the same time period was 48%. Overall, there was 44% less biovolume in the Main Lagoon Endothall + UV sites compared to controls. On a site-by-site basis, Site 10 had the greatest difference in biovolume compared to controls at 60% lower.

Vessel Hull Clearance

All CMT sites (including controls in the Main Lagoon and Lake Tallac) had VHC levels equal to or greater than 3 feet in May, August, and November with the exception of Site 27 at 2.9 feet in August (Figure 3).

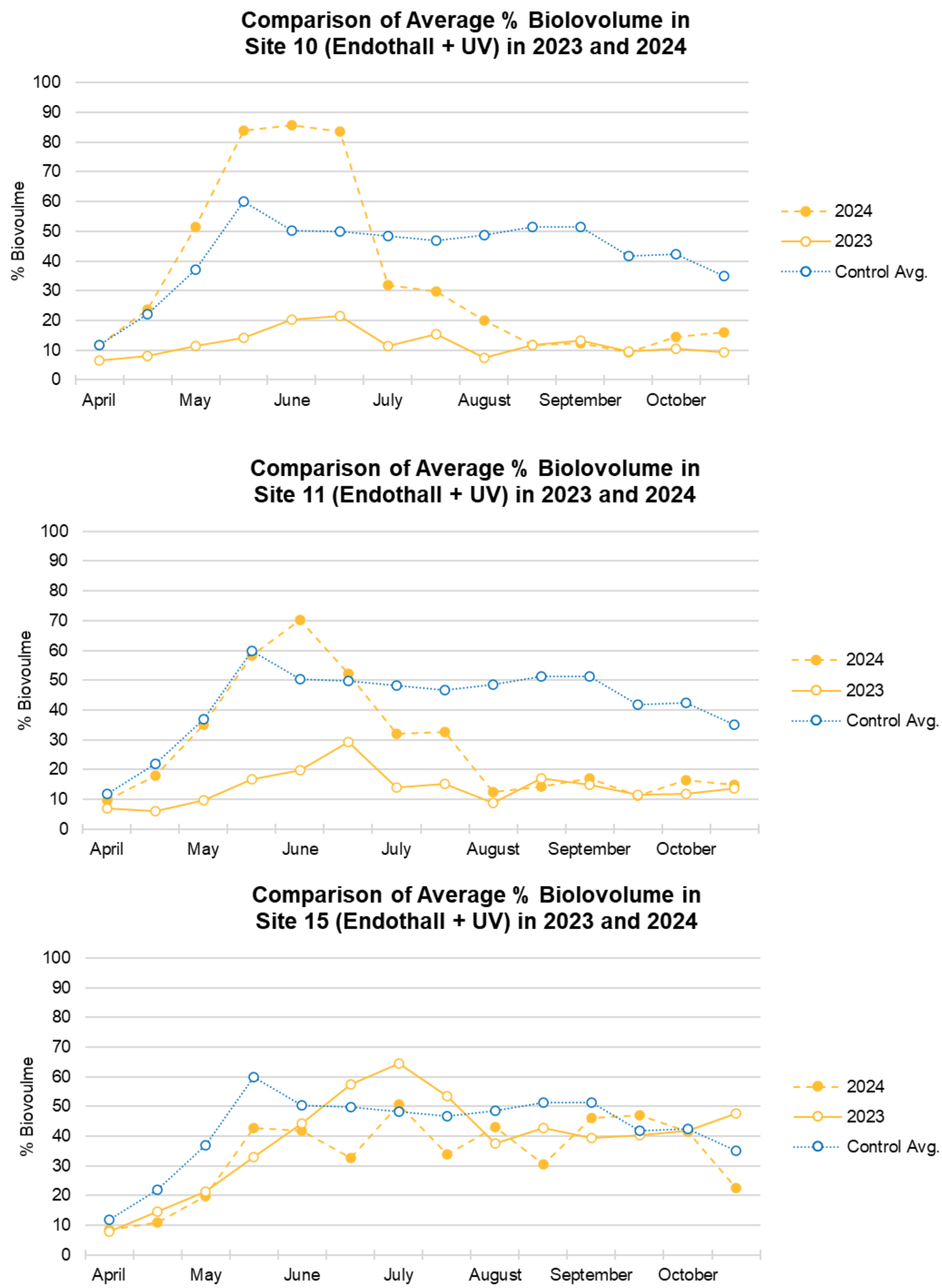


Figure 22. Average Percent Biovolume in Control Sites (Blue; 2024 data) and Sites 10, 11, and 15 in 2023 and 2024 (open and closed orange circles, respectively).

SOURCE: TKPOA

Note: all control sites were harvested throughout the summer

Point Sampling

The schedule for all Group B methods can be found in Tables 1 through 3. Note that for all the metrics described below, the dates in figures represents the first day of a two-week period because all sites could not be assessed within the same week.

Rake Fullness

Using rake fullness as the metric, sustained site-wide (non-Group B/NA) control of aquatic weeds was generally not observed along the shorelines (where Group A Endothall was applied in Year 1 but no UV treatments) during the peak summer months (golden bars in **Figure 23**) compared to controls (blue bars). It should be noted that, due to substantially higher water depth, the areas of shoreline assessed in Year 3 were not inundated in Year 1 when Endothall treatments occurred. Site 15 was discontinued in Year 3. **Figure 24** illustrates the locations of mid-channel UV treatments that occurred as part of the combinations. In these areas, rake fullness was around 10% compared to mid-channel areas in control sites at over 50% (**Figure 25**).

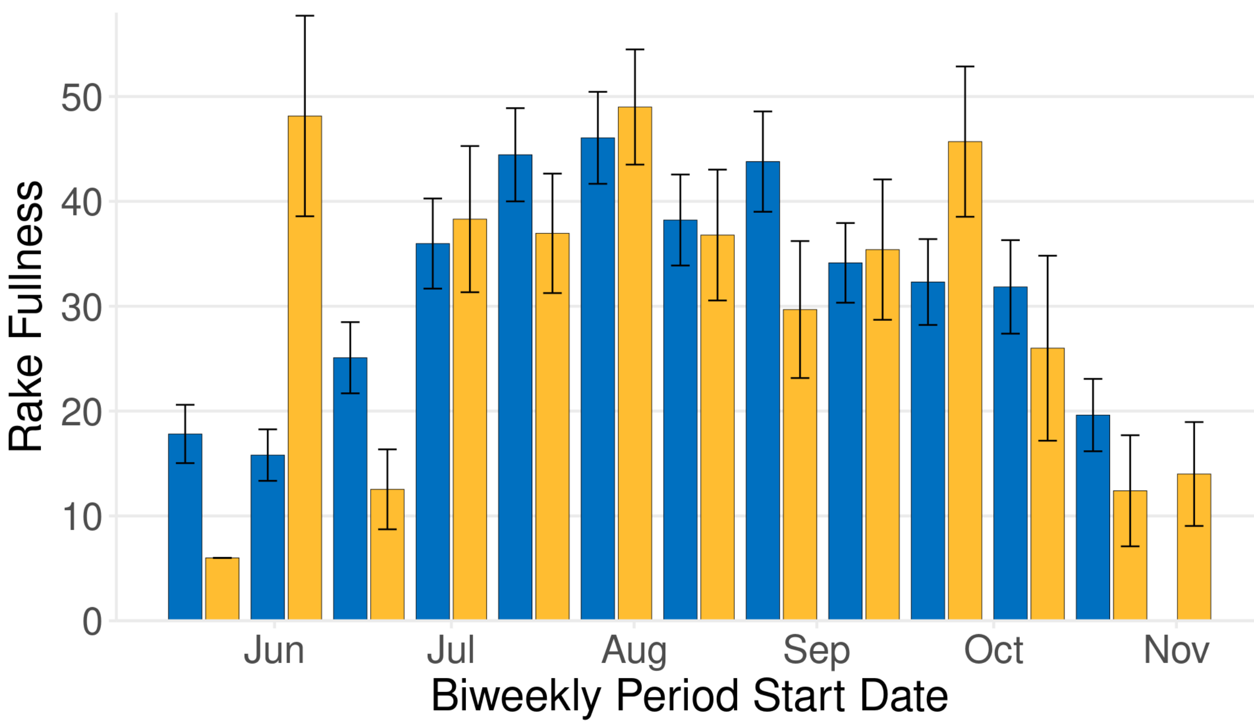


Figure 23. Average Rake Fullness of Shoreline Control Sites (Blue) and Year 1 Endothall with Year 3 UV-Combination (Golden).

Note: Shorelines were not treated with UV in Combination Sites

a)

b)

Figure 24. Location of Mid-channel UV Combinations in Sites 10 (a) and Site 11 (b).

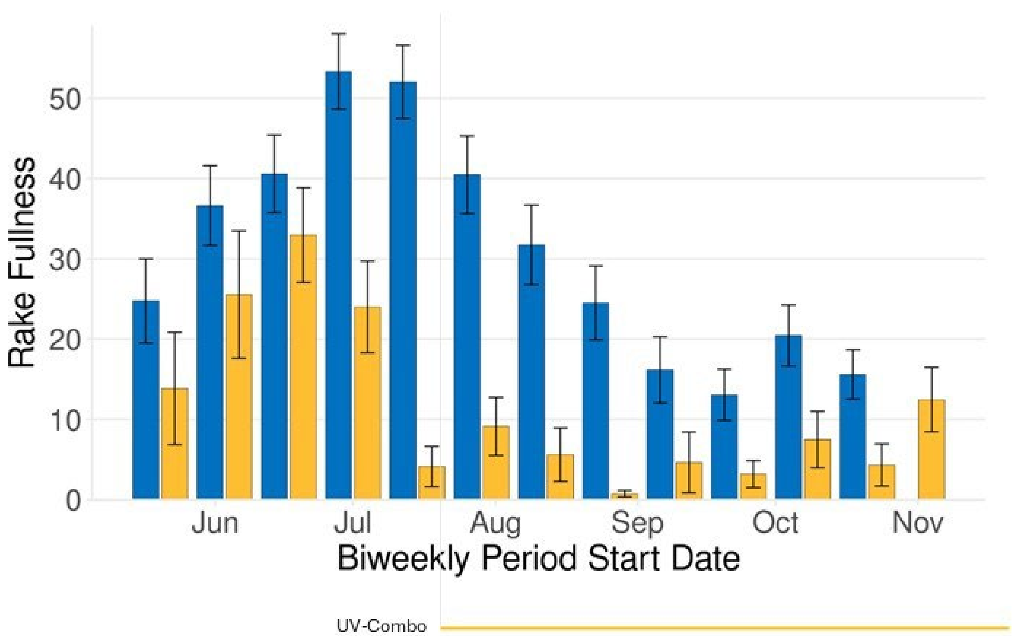


Figure 25. Average Rake Fullness of Mid-channel Control Sites (Blue) and Year 1 Endothall-only with Year 3 UV-Combination. Line Indicates Approximate Range of Assessments Following End of First Treatment.

Group B Areas

In addition to the mid-channel UV treatment as part of Group A combinations, Sites 10 and 11 also received a complexity of Group B treatments. In Site 10, there were two bottom barrier areas and two expanded DASH areas from Year 2 (**Figure 26)**. The northern barrier in Site 10 received a sequential treatment with DASH following removal of the northern barrier. Site 11 had one bottom barrier and two DASH areas.

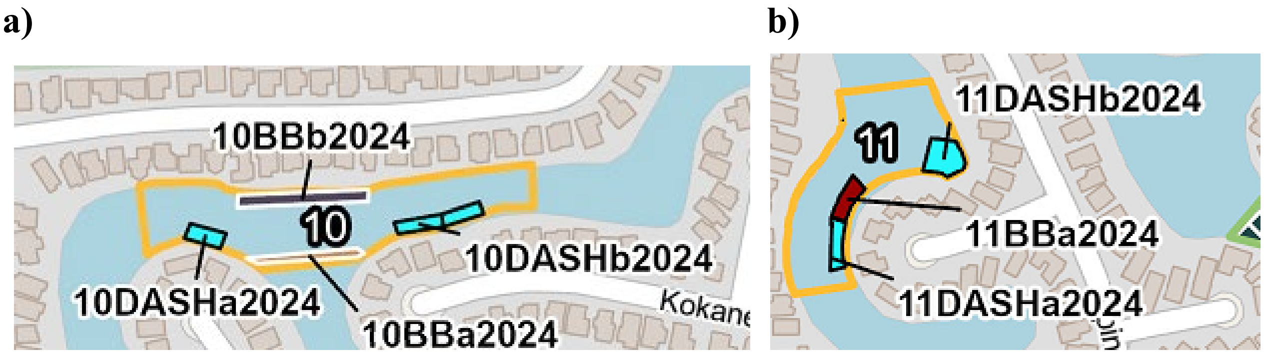


Figure 26. Location of Group B Methods in Site 10 (a) and Site 11 (b).

Given the widespread application of Group A UV-light and multiple Group B treatments in Sites 10 and 11, essentially the entirety of both sites were treated throughout the peak summer season. Rake fullness was generally less than 10 to 20% in the combined treated areas compared to control sites and continued to end of season. (**Figure 27**).

Following removal of the bottom barriers, fullness was on the order of 10 to 15% with a great deal of variation in Site 10. A sequential DASH treatment occurred in the northern bottom barrier area following removal and resulted in end of season rake fullness of ~5%. Following removal of the bottom barrier in Site 11, fullness was on the order of 0 to 5%.

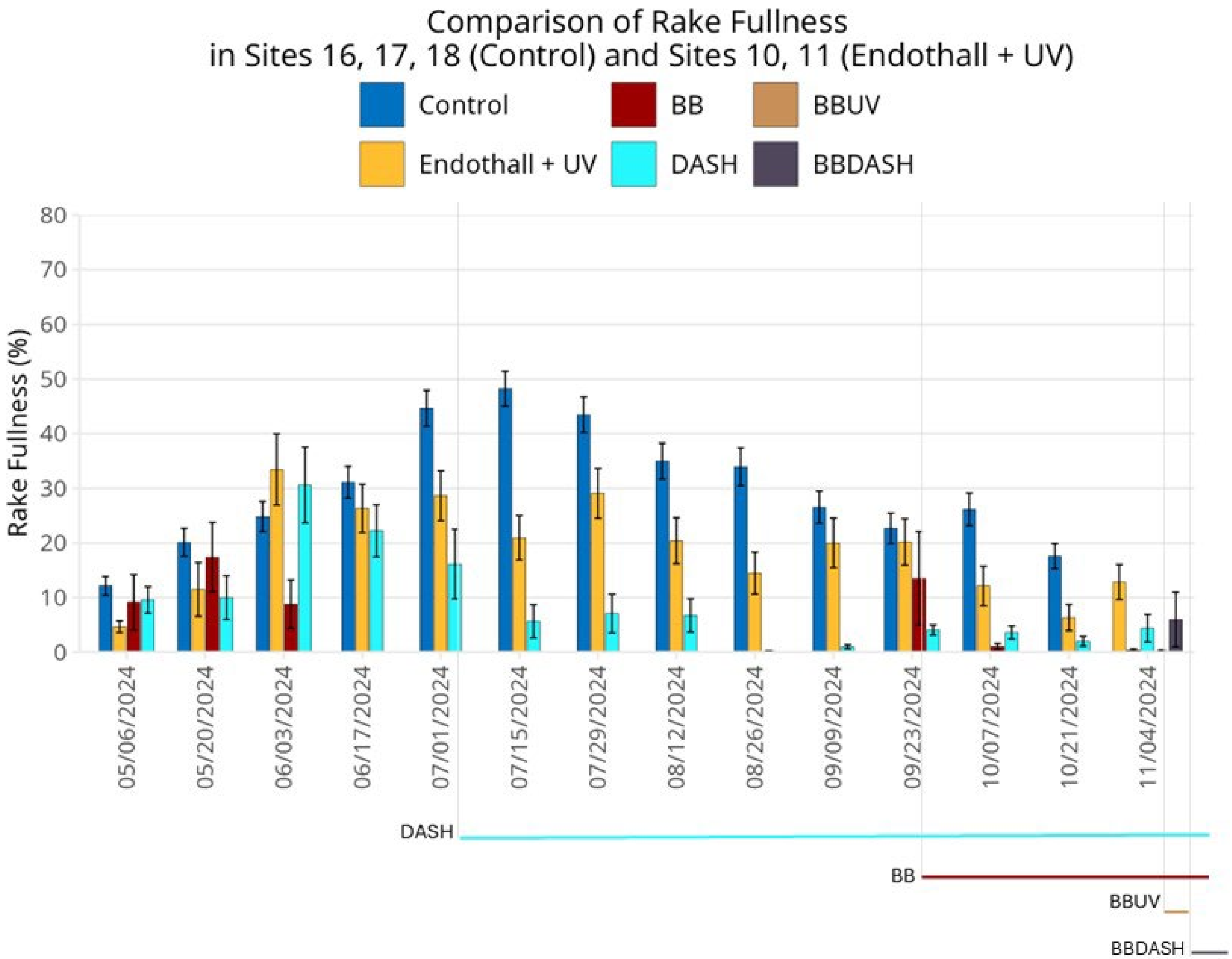


Figure 27. Average Rake Fullness of Control Sites (Blue) and Endothall-Combination Site-wide (Golden), Bottom Barrier (Dark Red), DASH (Aquamarine), and Sequential DASH following Barrier Removal (Brown). Lines Indicates Approximate Range of Assessments Following End of First Treatment.

Relative Abundance

The relative abundance of Eurasian Watermilfoil was similar to or greater in site-wide areas (golden bars in **Figure 28**) compared to controls (blue bars). Results in Figure 28 do not differentiate between shoreline and mid-channel samples. In Year 1, Endothall was only applied to the shoreline areas and, in Years 2 and 3, shoreline areas were inundated that were dry in Year 1. Additionally, the UV-combination treatments only occur mid-channel and, as seen in Figure 25, this has tremendous impact on the rake fullness results collected in those areas. The abundance of Curlyleaf Pondweed far exceeded that of controls by approximately double. This was the case for both shoreline and mid-channel samples. In general, the abundance of Eurasian Watermilfoil was roughly half compared to controls. Following the removal of the bottom barriers in Sites 10 and 11, the abundance of all AIP was at or near 20% with end season sequential DASH resulting in similar levels. Results of DASH treatments were again highly variable with few differences in relative abundances compared to site-wide samples. Sequential UV treatments following bottom barrier removal were successful on Coontail and Curlyleaf Pondweed using UV, but no difference to site-wide for Eurasian Watermilfoil.

Native plant species in the Endothall + UV sites was highly variable and ranged from non-detect up to ~20% in a DASH area in Site 11.

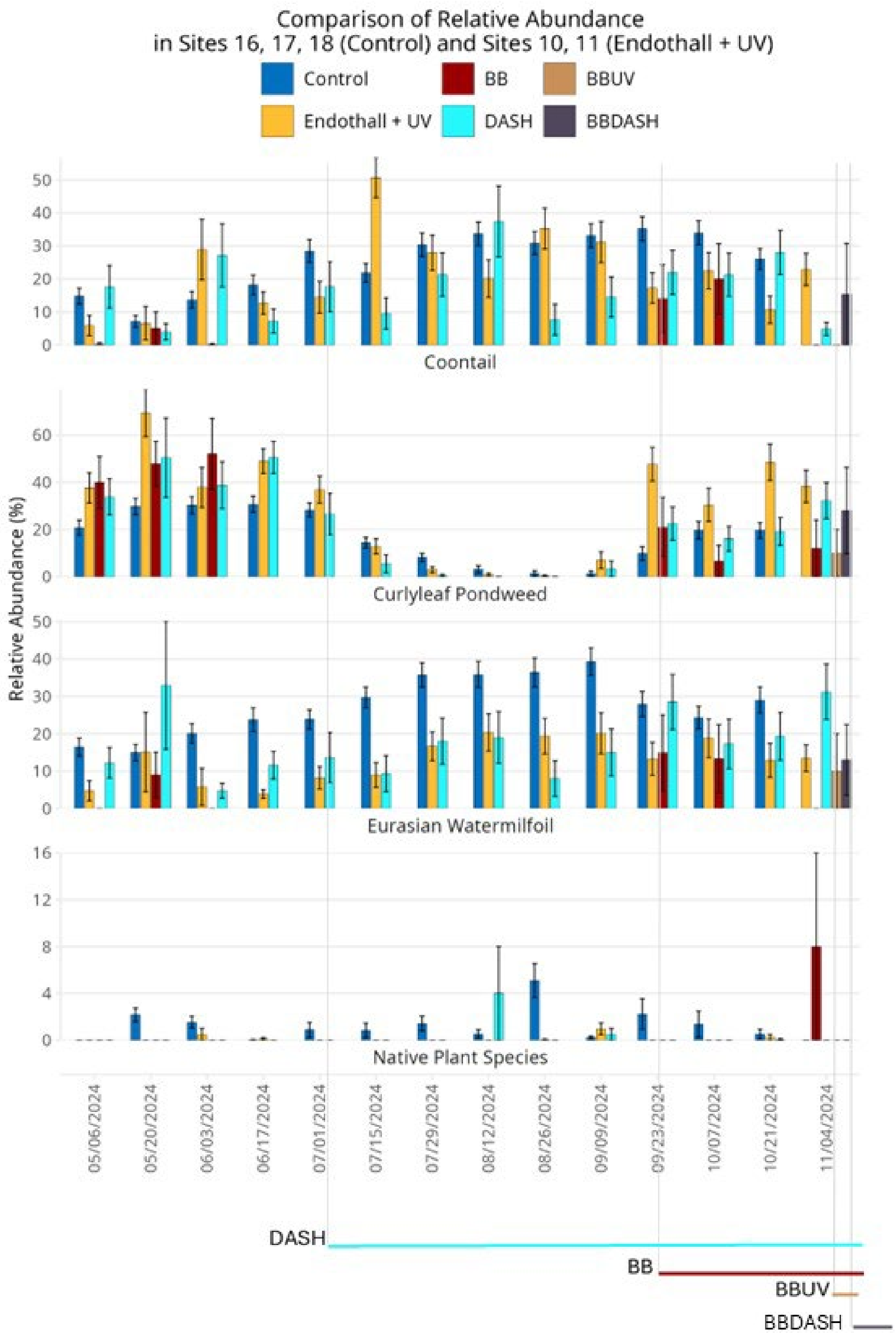


Figure 28. Average Species Relative Abundance of Control Sites (Blue) and Endothall-Combination Site-wide (Golden), Bottom Barrier (Dark Red), DASH (Aquamarine), and Sequential DASH following Barrier Removal (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Note variable scale on y-axis

Frequency of Occurrence

Frequency of occurrence of Eurasian Watermilfoil was maintained near 40% for most of the season (golden bars in Figure 29) compared to near 80% in controls (blue bars). Occurrence of Coontail was highly variable and occurrence of curlyleaf pond weed was often equal to or greater than controls. Bottom barriers reduced the occurrence of Curlyleaf Pondweed and Eurasian Watermilfoil but less so for Coontail compared to site-wide. Sequential UV and DASH treatments were highly variable for all AIP, but notably nearly 80% occurrence of Curlyleaf Pondweed by end of season, greater than site-wide.

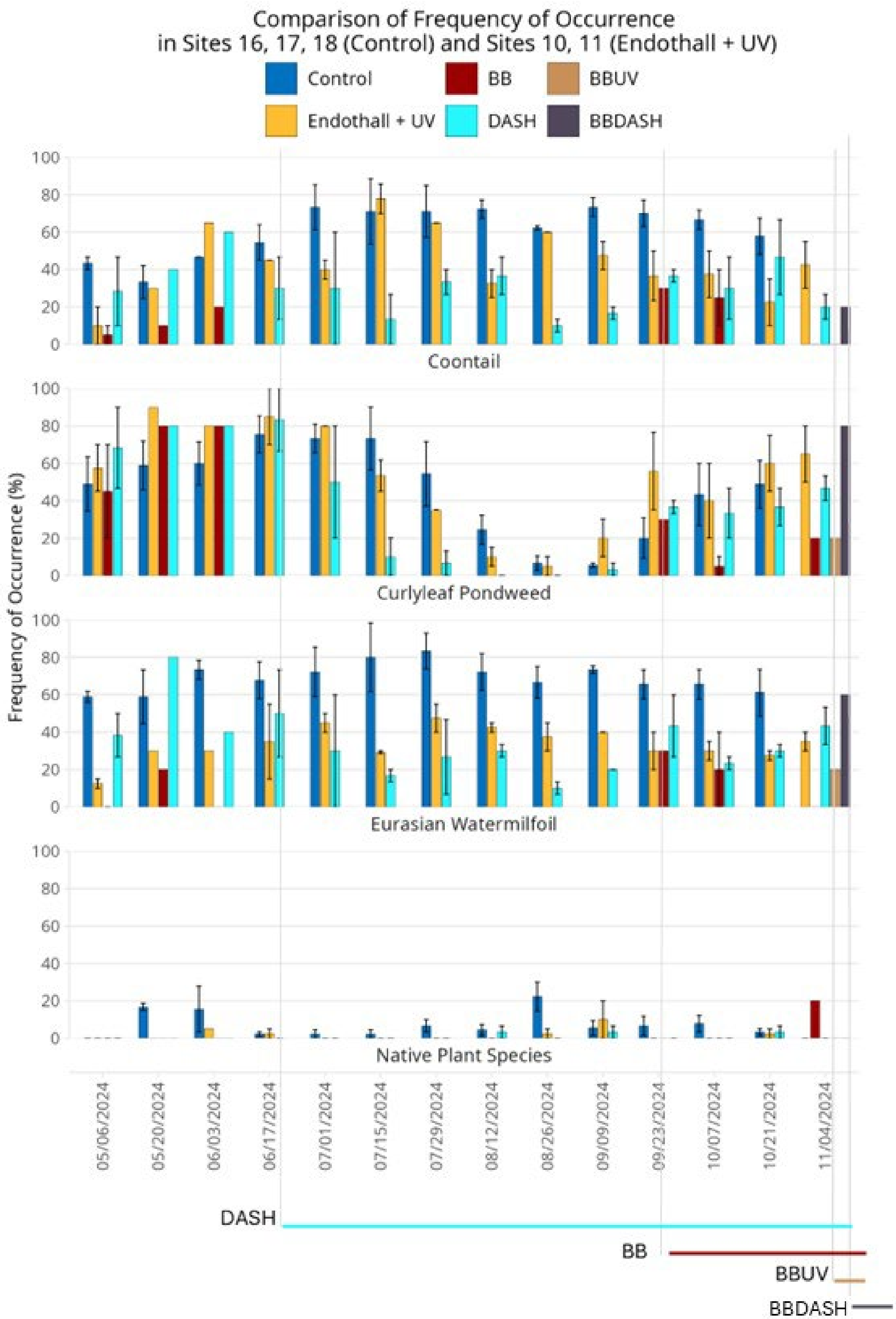


Figure 29. Average Species Frequency of Control Sites (Blue) and Endothall-Combination Site-wide (Golden), Bottom Barrier (Dark Red), DASH (Aquamarine), and Sequential DASH following Barrier Removal (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Triclopyr + UV Sites with Group B Areas

Triclopyr + UV sites included Sites 12, 13, and 14 that were treated in Year 1. Group B methods in Year 3 included one each of DASH and bottom barriers in Sites 13 and 14 with no UV or Group B treatments in Site 12.

Hydroacoustic Scans

Biovolume

In Year 3, biovolume measured in Triclopyr + UV sites of the Main Lagoon during peak summer months (July [following the start of UV treatments] to September) ranged widely from 13 to 41% (**Figure 30**). Average biovolume in the controls in the Main Lagoon over the same time period was 48%. Overall, there was 42% less biovolume in the Main Lagoon Triclopyr + UV sites compared to controls. On a site-by-site basis, Site 14 had the greatest difference in biovolume compared to controls at 52% lower.

Vessel Hull Clearance

All CMT sites (including controls in the Main Lagoon and Lake Tallac) had VHC levels equal to or greater than 3 feet in May, August, and November with the exception of Site 27 at 2.9 feet in August (Figure 3).

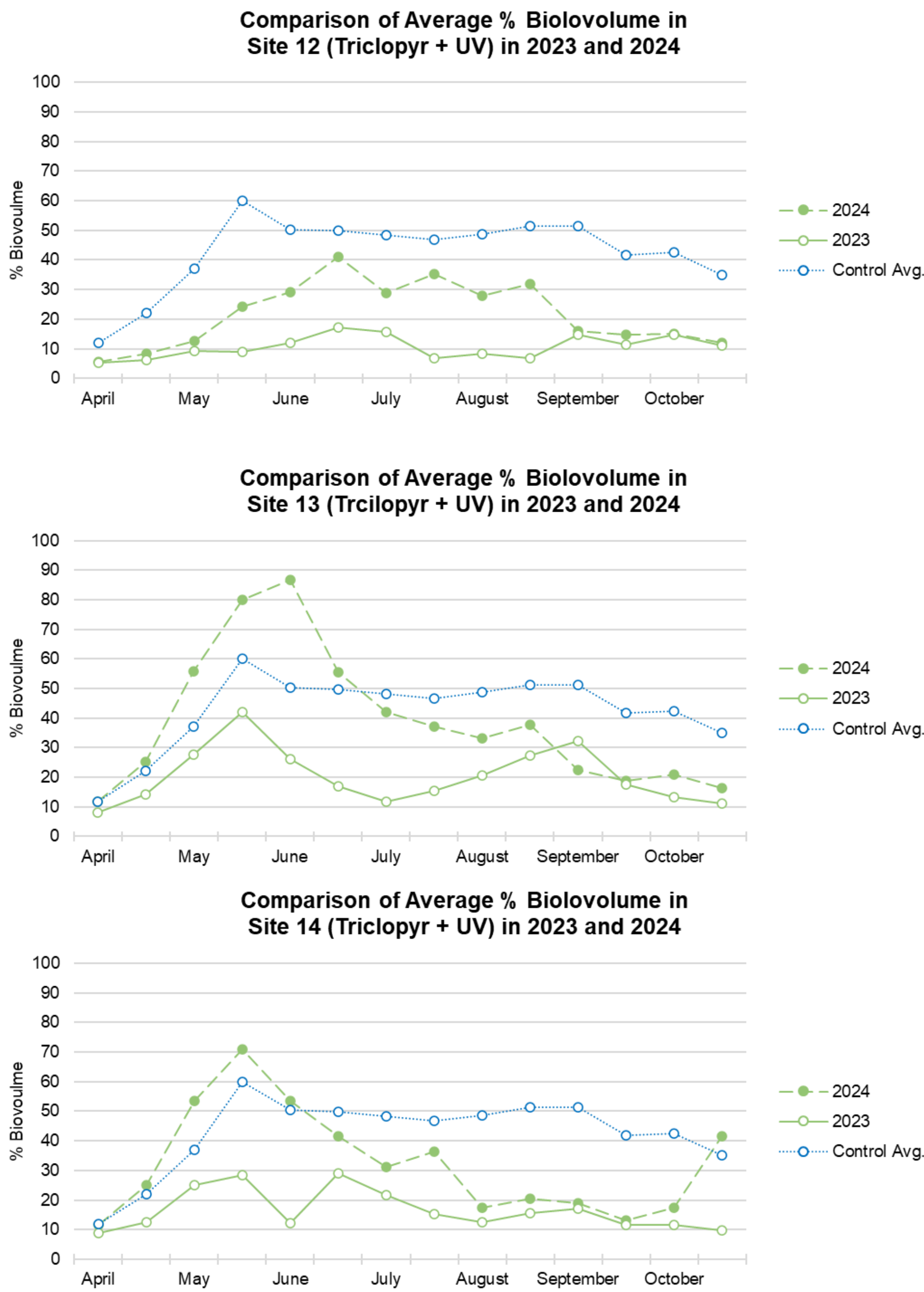


Figure 30. Average Percent Biovolume in Control Sites (Blue; 2024 data) and Sites12 (no UV in Year 3), 13, and 14 in 2023 and 2024 (open and closed light green circles, respectively).

SOURCE: TKPOA

Note: all control sites were harvested throughout the summer

Point Sampling

The schedule for all Group B methods can be found in Tables 1 through 3. Note that for all the metrics described below, the dates in figures represents the first day of a two-week period because all sites could not be assessed within the same week.

Rake Fullness

Using rake fullness as the metric, sustained site-wide (non-Group B/NA) control of aquatic weeds was not observed along the shorelines (where Group A Triclopyr was applied in Year 1 but no UV treatments) during the peak summer months (green bars in **Figure 31**) compared to control (blue bars). It should be noted that due substantially higher water depth, the areas of shoreline assessed in Year 3 were not inundated in Year 1 when Triclopyr treatments occurred. Site 12 was discontinued in Year 3. **Figure 32** illustrates the location of the mid-channel UV treatments that occurred as part of the combinations. In these areas, rake fullness was around 10 to 20% compared to mid-channel areas in control site at over 50% (**Figure 33)**.

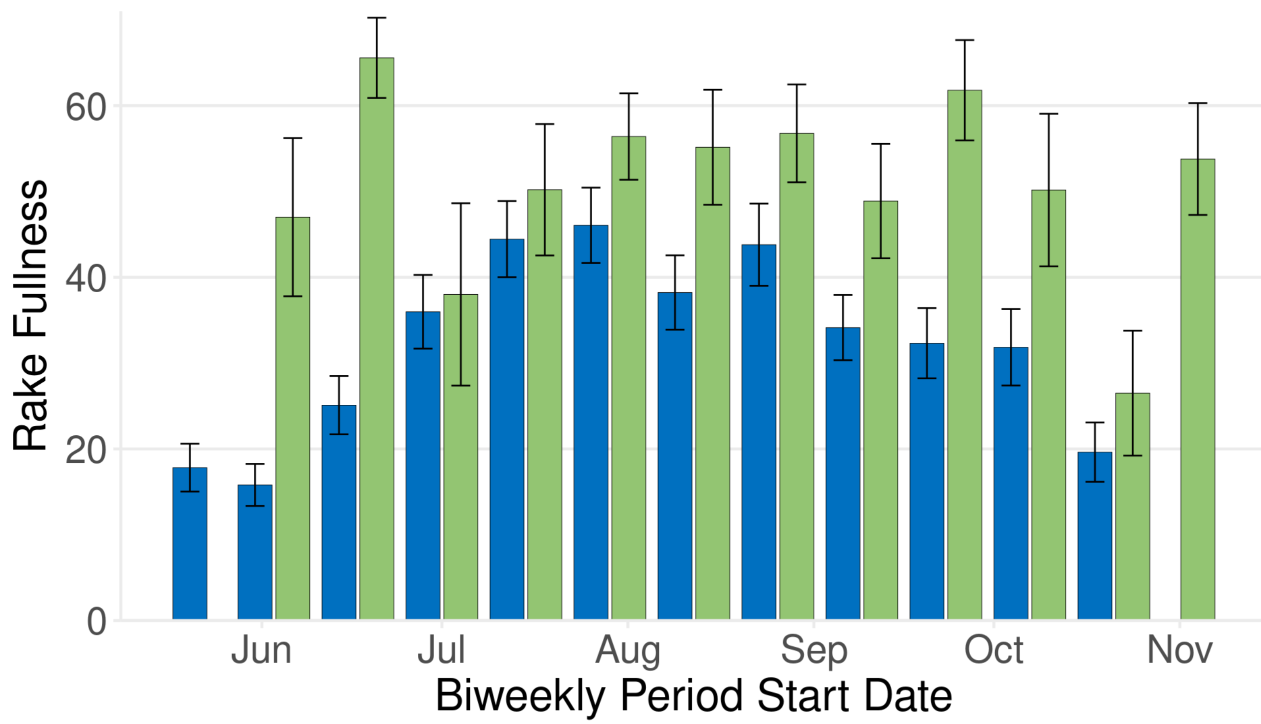


Figure 31. Average Rake Fullness of Shoreline Control Sites (Blue) and Year 1 Triclopyr with Year 3 UV-Combination (Green).

Note: Shorelines were not treated with UV in Combination Sites

a)

b)

Figure 32. Location of Mid-channel UV Combinations in Sites 13 (a) and Site 14 (b)

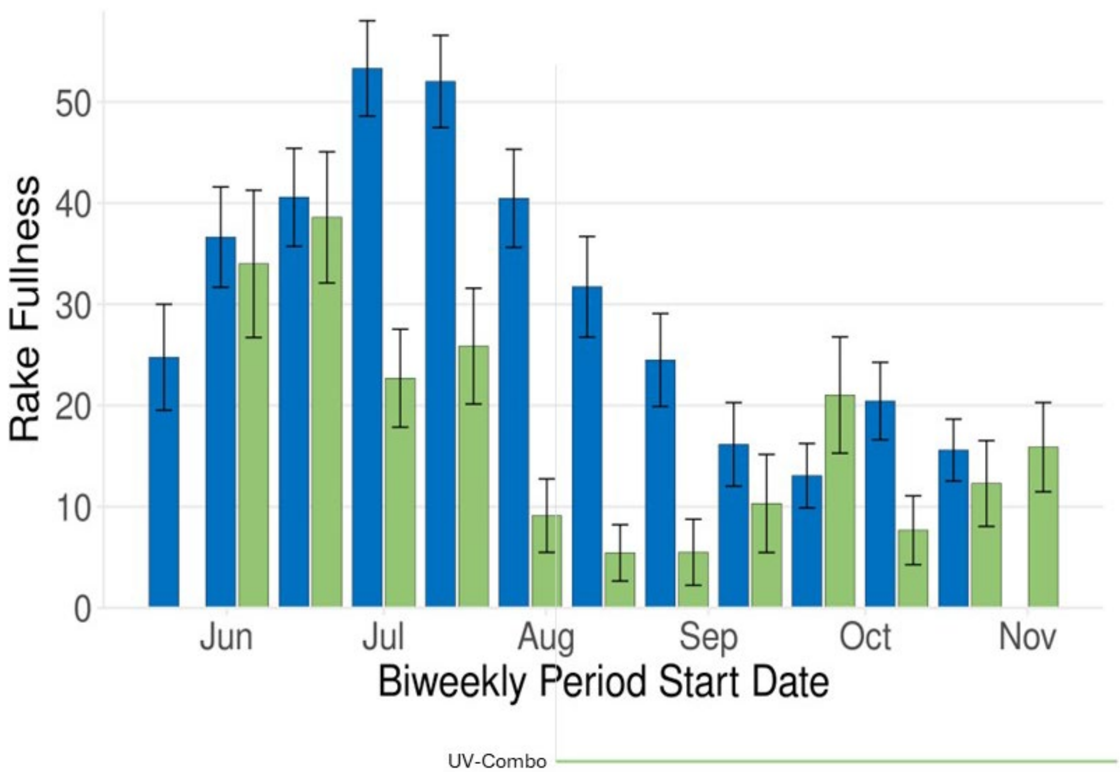


Figure 33. Average Rake Fullness of Mid-channel Control Sites (Blue) and Year 1 Triclopyr-only with Year 3 UV-Combination. Line Indicates Approximate Range of Assessments Following End of First Treatment.

Group B Areas

In addition to the mid-channel UV treatment as part of Group A combinations, Sites 13 and 14 also received Group B treatments. In both Sites 13 and 14 there were each one DASH and one barrier (**Figure 34**).

a) Site 13

b) Site 14

Figure 34. Location of Group B Methods in Site 13 (a) and Site 14 (b).

Given the widespread application of Group A UV-light and multiple Group B treatments in Sites 13 and 14, essentially the entirety of both sites were treated throughout the peak summer season. Rake fullness was generally less than 10 to 30% in the combined treated areas compared to control sites and continued to end of season. Looking exclusively at mid-channel results, where Group A UV-light was applied, rake fullness was at or near 10% throughout the peak summer season, very similar to the Endothall + UV results (**Figure 35**).

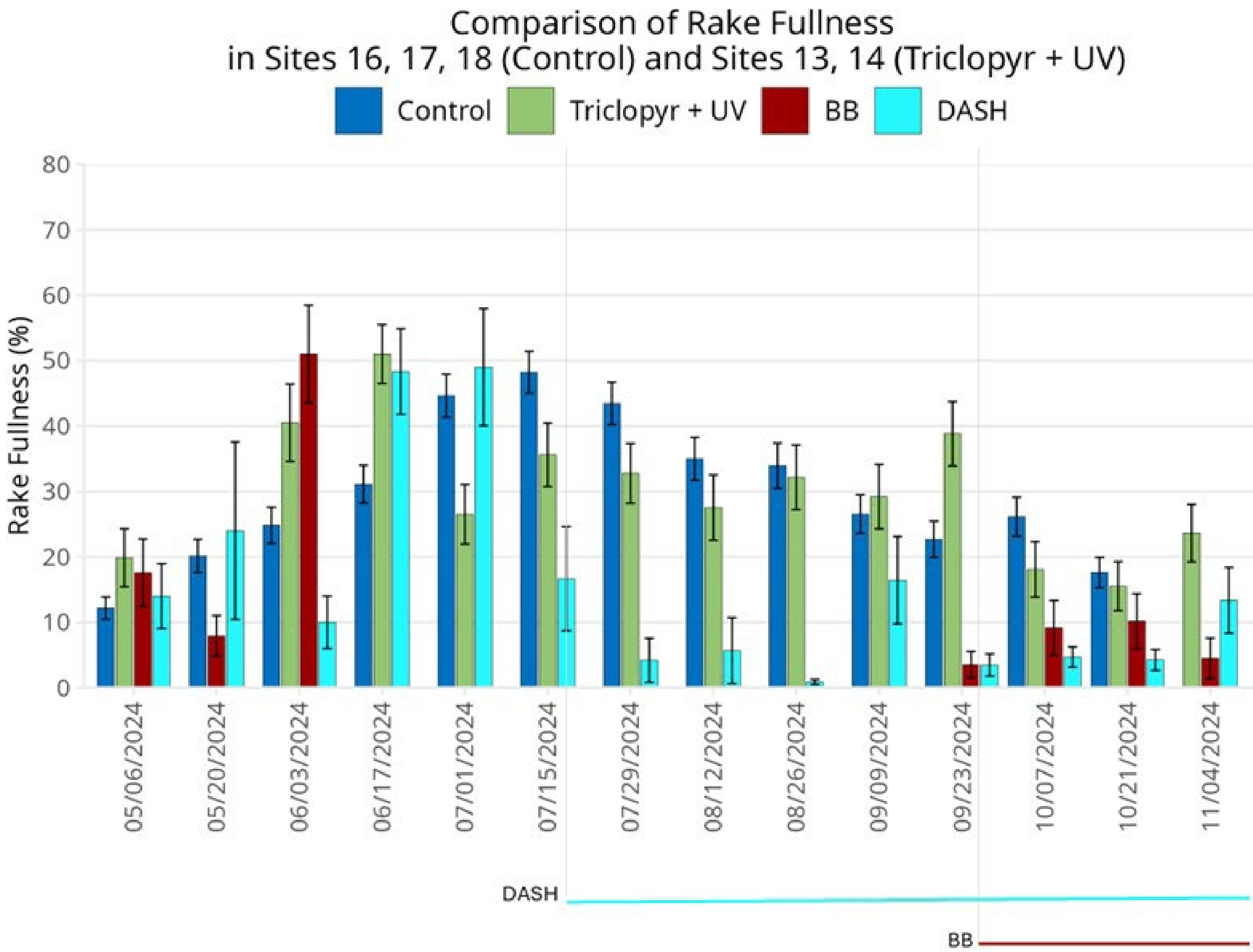


Figure 35. Average Rake Fullness of Control Sites (Blue) and Triclopyr-Combination Site-wide (Green), Bottom Barrier (Dark Red), and DASH (Aquamarine). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Relative Abundance

Using the relative abundance metric, sustained control of Eurasian Watermilfoil was observed throughout the season (green bars in **Figure 36**) compared to controls (blue bars), particularly in Site 14. The relative abundance of target AIP following DASH was highly variable in all Triclopyr + UV sites. Two Group B methods were utilized: bottom barriers and DASH. In general, one of the bottom barriers was most effective in reducing the abundance of Curlyleaf Pondweed in Site 13 (compared to the very high abundance site-wide (up to 50%). Results were more variable in Site 14. DASH was again highly variable in both sites, particularly for Coontail.

The relative abundance of native plant species was less than 4% throughout the season with a couple of anomalous results from DASH sites on the order of 7 to 20%.

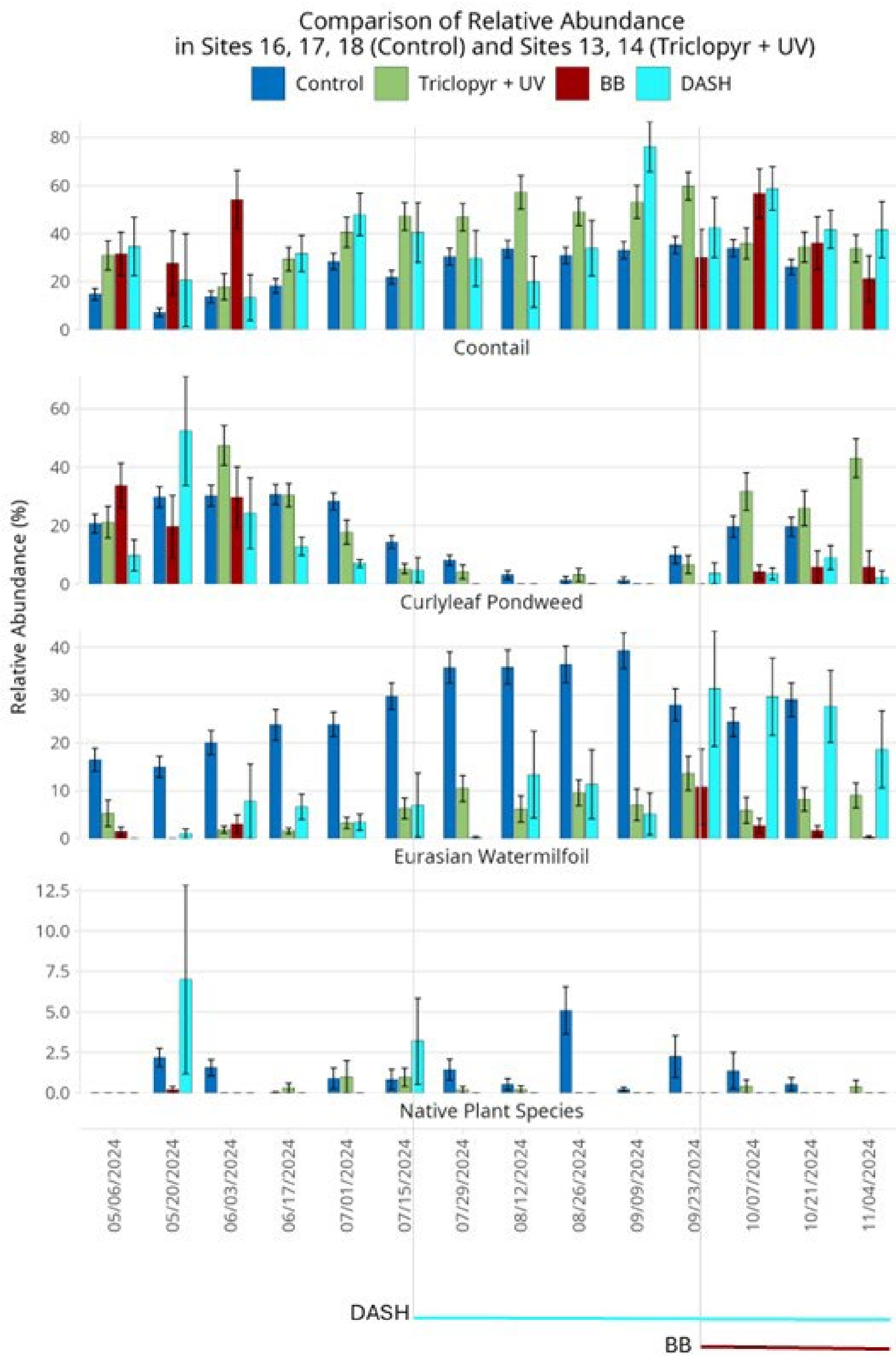


Figure 36. Average Relative Abundance of Control Sites (Blue) and Triclopyr-Combination Site-wide (Green), Bottom Barrier (Dark Red), and DASH (Aquamarine). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Note variable scale on y-axis

Frequency of Occurrence

Frequency of occurrence of Eurasian Watermilfoil was maintained near 20% for much of the season (green bars in **Figure 37**) compared to controls (blue bars). This was somewhat expected given the known selectivity of Triclopyr for this species. A similar pattern was observed in the Triclopyr-only sites (see Figure 17); however, when samples are separated by shoreline (where Triclopyr was applied in Year 1) versus mid-channel (where UV-combination treatments occurred in Year 3), the occurrence of Eurasian Watermilfoil diminishes greatly in the mid-channel areas, presumable due to the UV-combination treatments. As also expected, there were no discernible decreases in the occurrence of Coontail.

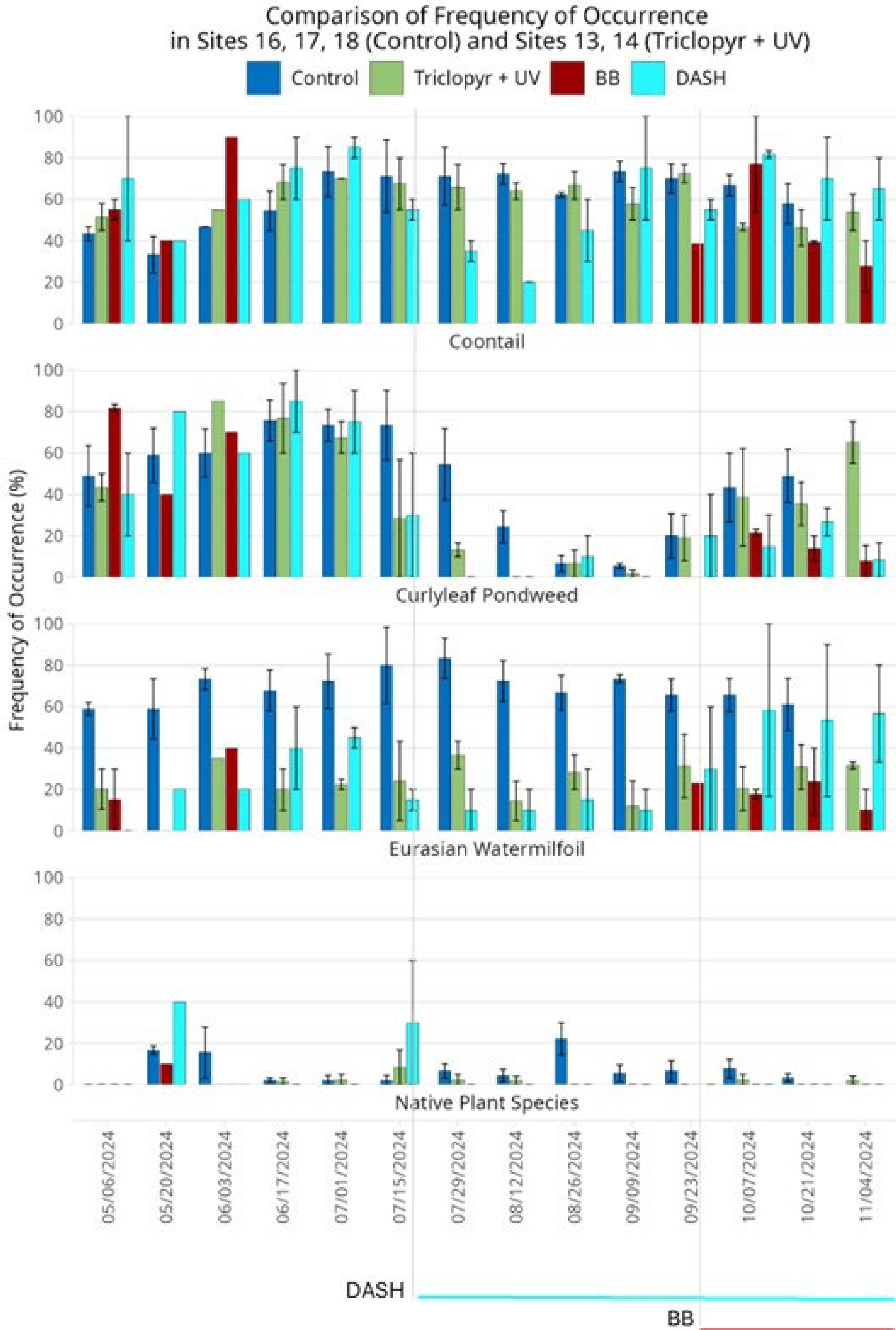


Figure 37. Average Species Frequency of Occurrence of Control Sites (Blue) and Triclopyr-Combination Site-wide (Green), Bottom Barrier (Dark Red), and DASH (Aquamarine). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

LFA Sites with Group B Areas

LFA sites included Sites 25, 26, and 27. Group B treatments were only implemented in Site 26 in Year 3 and included two DASH areas, two bottom barrier areas and one UV-spot. Sequential DASH treatments followed the removal of both bottom barriers.

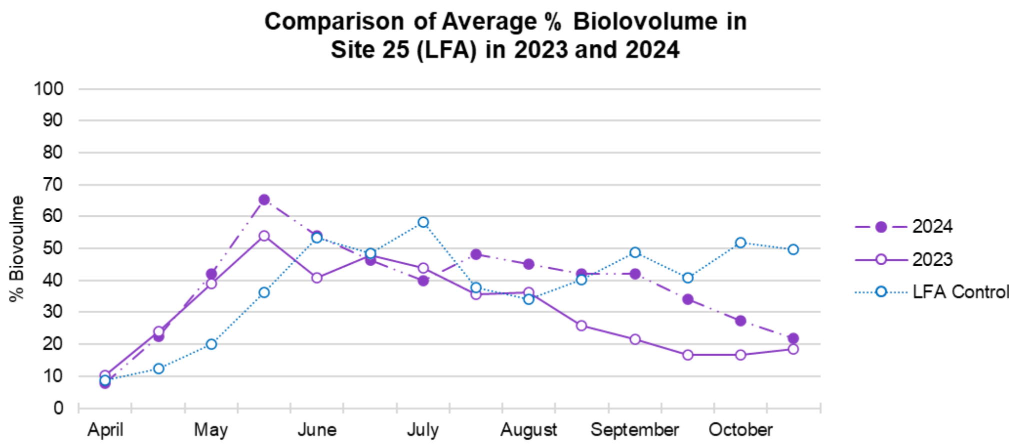
Hydroacoustic Scans

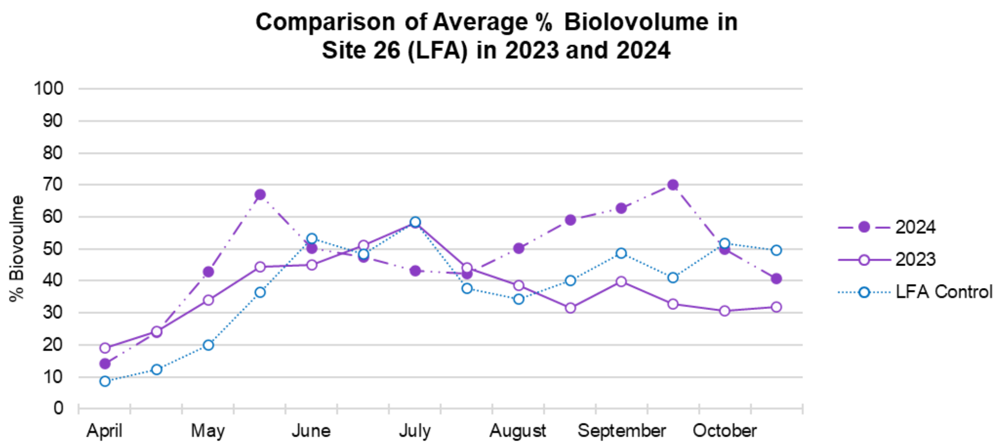
Biovolume

In Year 3, biovolume measured in LFA Site 26 of the Main Lagoon during peak summer months (July to September) ranged widely from 42 to 70% (**Figure 38**). Average biovolume in the controls in the Main Lagoon over the same time period was 48%. Overall, there was 12% more biovolume in the Main Lagoon LFA Site 26 compared to controls. Biovolume measured in LFA Site 25 ranged from 34 to 48%. Overall, there was 15% less biovolume in LFA Site 25 compared to controls.

Vessel Hull Clearance

All CMT sites (including controls in the Main Lagoon and Lake Tallac) had VHC levels equal to or greater than 3 feet in May, August, and November with the exception of Site 27 at 2.9 feet in August (Figure 3).





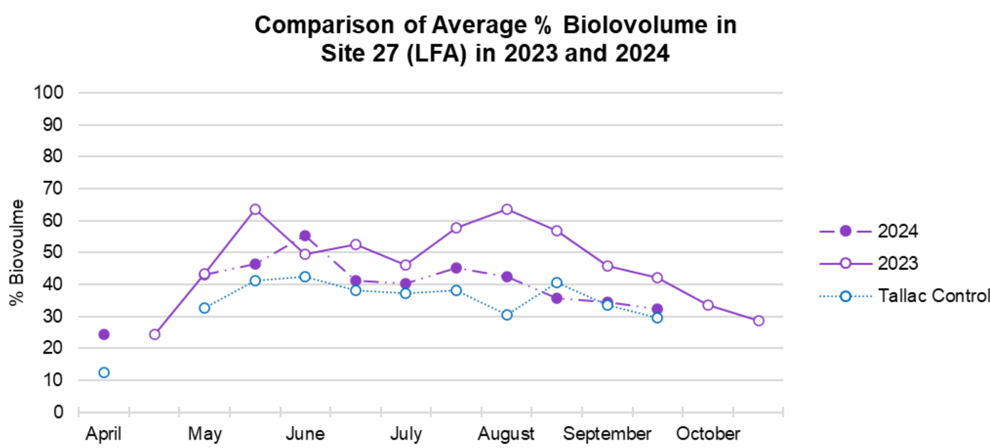


Figure 38. Average Percent Biovolume in LFA Control Site 7 and Sites 25 and 26 (top two panels; blue; 2024 data) and LFA Control Site 27 (Tallac Control; blue; 2024 data) and Site 27 (third panel) in 2023 and 2024 (open and closed purple circles, respectively).

SOURCE: TKPOA

Note: all control sites were harvested throughout the summer

Point Sampling

The schedule for all Group B methods can be found in Tables 1 through 3. Note that for all the metrics described below, the dates in figures represents the first day of a two-week period because all sites could not be assessed within the same week.

Rake Fullness

Using rake fullness as the metric, sustained control of aquatic weeds was not observed in LFA Site 26 (purple bars in **Figure 39**) compared to controls (blue bars) with little difference between them (range of ~20% to 50% fullness). In fact, fullness was often greater in site-wide samples (up to 50%) compared to controls. There were limited number of visits to LFA Site 25 but fullness was on the order of 10% site-wide compared to near 50% in control sites (16, 17, 18) and ~45% in LFA control Site 27 mid-summer.

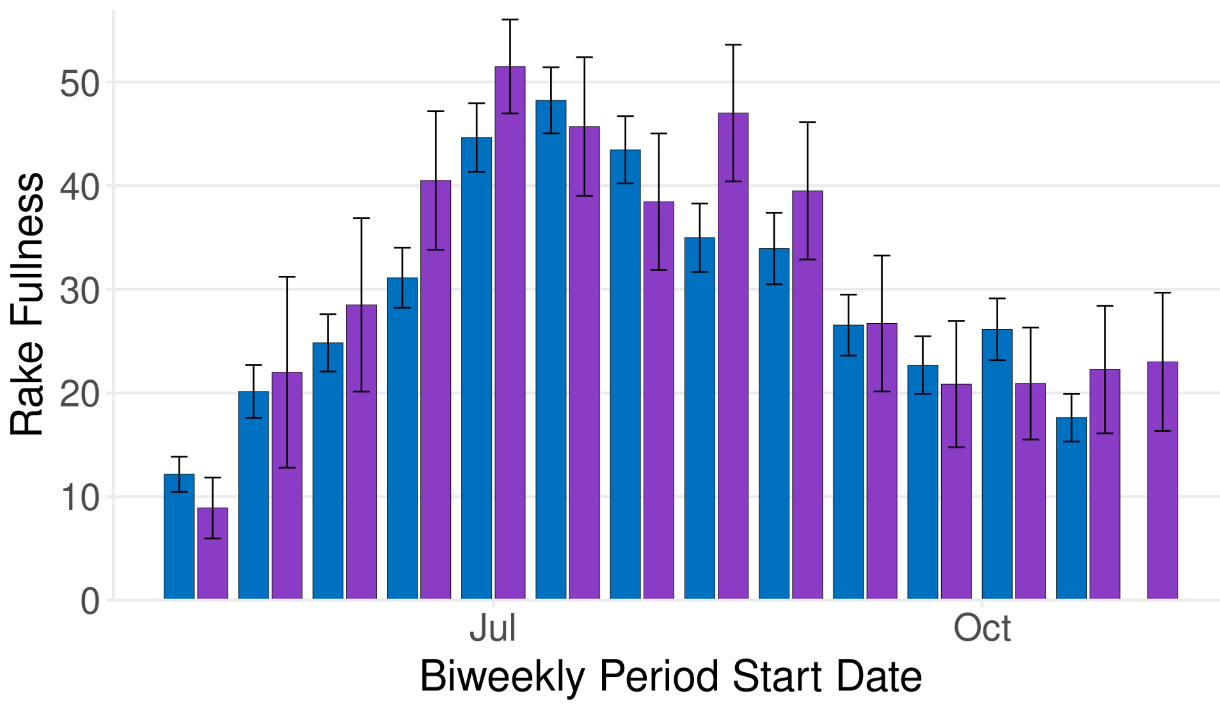


Figure 39. Average Rake Fullness of the Control Sites (Blue) and Year 3 LFA Site-wide (Purple) (combined mid-channel and shoreline).

Group B Areas

LFA Site 26 received all Group B treatments in Year 3 and included UV-light, two bottom barriers and two DASH areas (**Figure 40**). No Group B methods were implemented in Site 25 or Site 27.

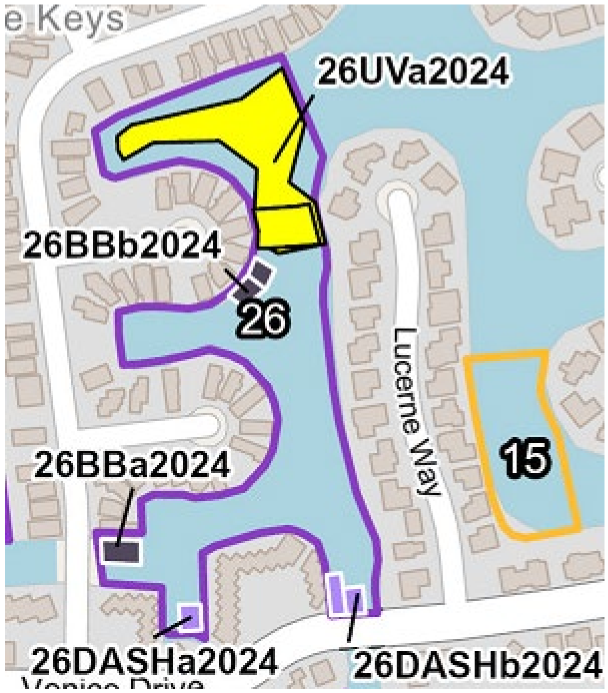


Figure 40. Location of Group B Methods in Site 26.

Bottom barrier results were variable and, generally, not substantially lower than site-wide upon initial removal. There were two sequential DASH treatments in Site 26 following the removal of bottom barriers, both utilizing DASH. There was an initial reduction in rake fullness to less than 5% with a slight increase to 10% by end of season. Results of DASH treatments in Site 26 were somewhat variable but rake fullness was generally half that of site-wide values. The relatively large UV-spot treatment in Site 26 resulted in rake fullness at 20% or less throughout the season, compared with 20-50% site-wide.

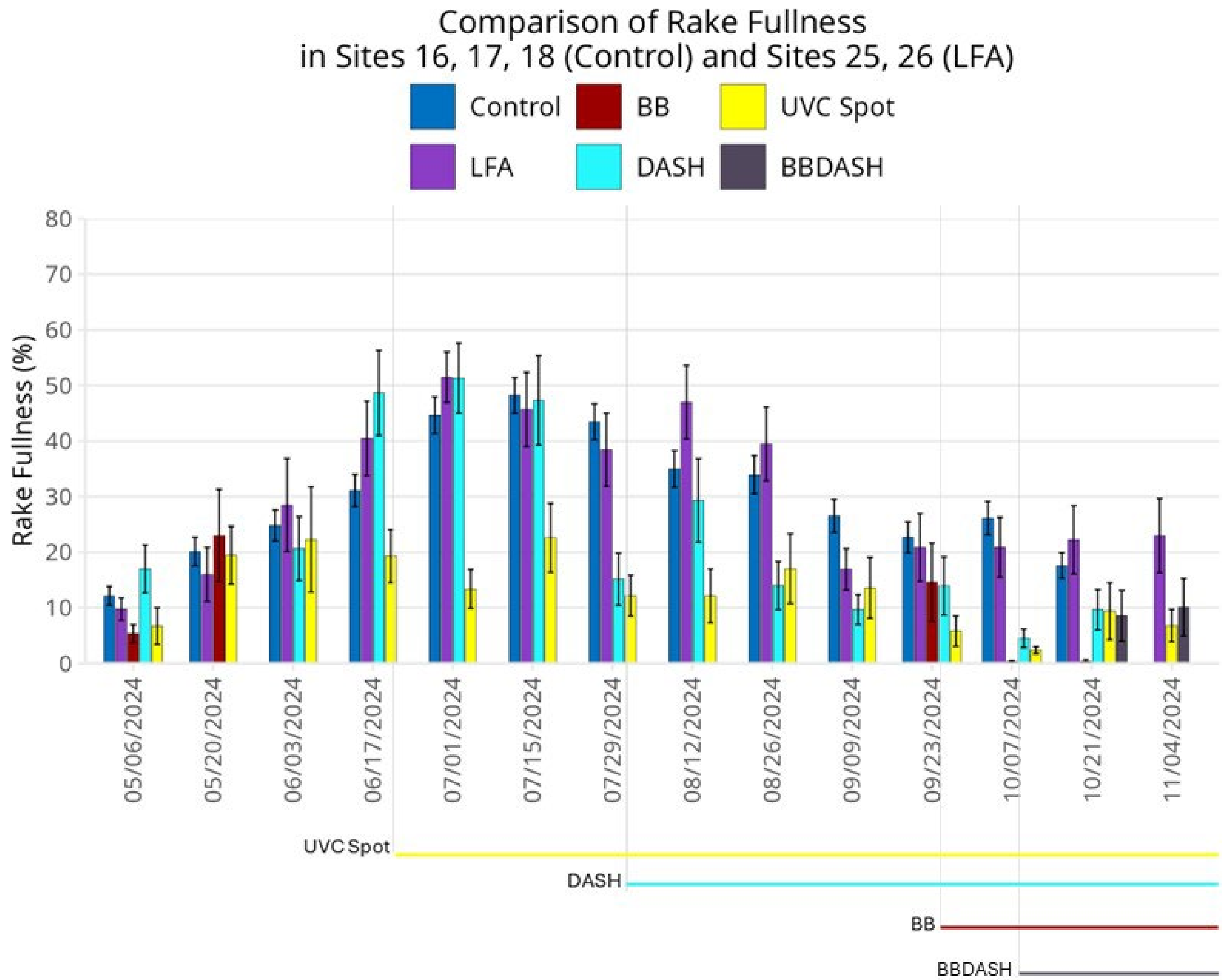


Figure 41. Average Rake Fullness of Control Sites (Blue) and LFA-only Site-wide (Purple), Bottom Barrier (Dark Red), DASH (Aquamarine), UV-spot (Yellow), and Sequential DASH following Barrier Removal (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Relative Abundance

The relative abundance of all AIP were generally equal to or greater site-wide (purple bars in **Figure 42**) compared to controls (blue bars). Bottom barriers reduce the abundance of all AIP; however, sequential DASH treatments had mixed results for the three AIP, with the greatest reductions in Curlyleaf Pondweed. Similar to other sites, the UV-spot treatments were quite variable with abundances of AIP being similar to site-wide by end of season. It should be noted; however, that relative abundance reflects the relative number of times a species is observed on rake, thus if two stems of two species are observed, they are equally recorded as 50%. Rake fullness data provide a better understanding of how much plant material is controlled by the various Group B method.

Native plant species in the LFA sites was highly variable and ranged from non-detect up to ~12% in Site 27 (Lake Tallac) but generally ~3% in Site 26.

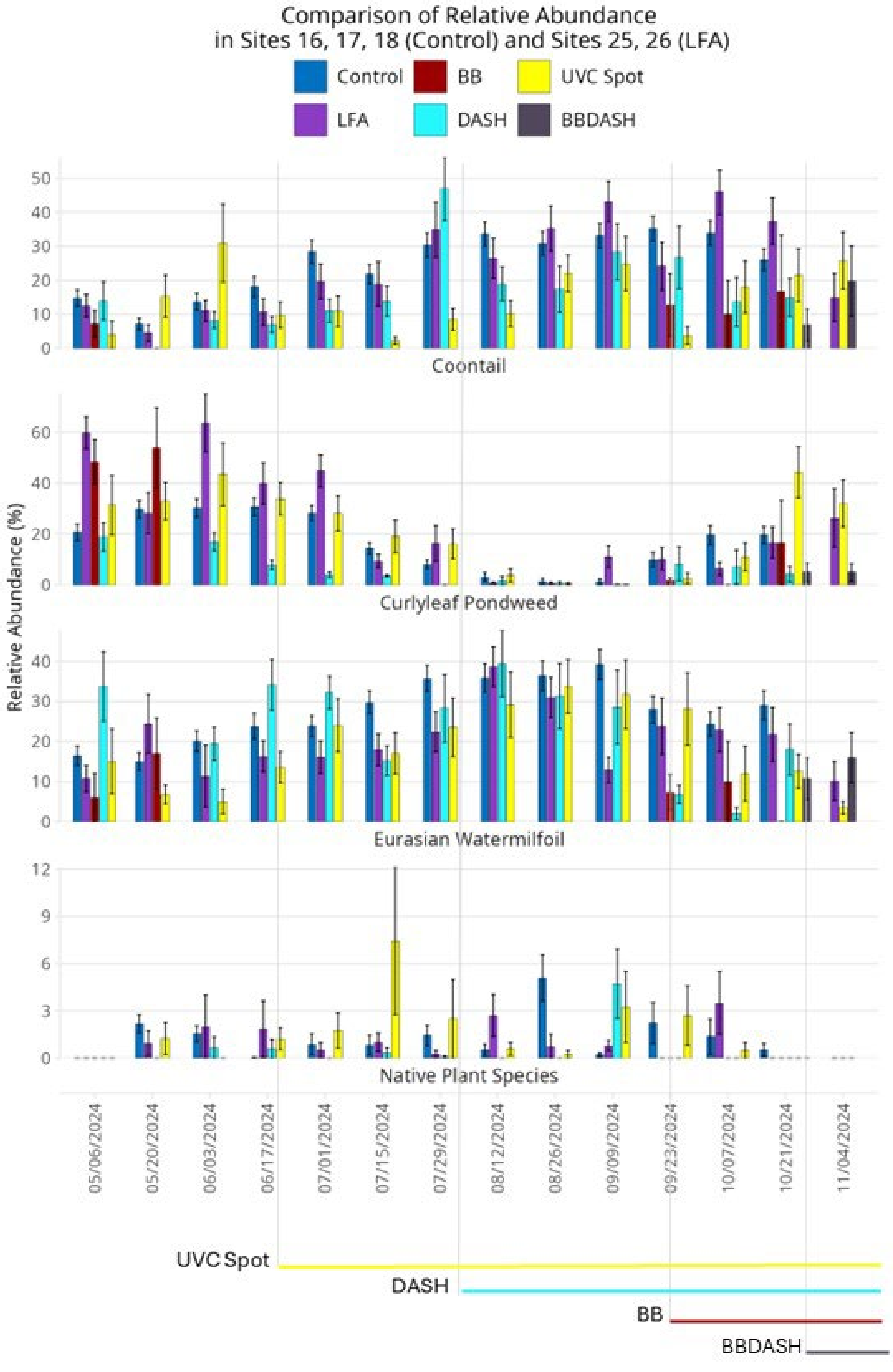


Figure 42. Average Relative Abundance of Control Sites (Blue) and LFA-only Site-wide (Purple), Bottom Barrier (Dark Red), DASH (Aquamarine), UV-spot (Yellow), and Sequential DASH following Barrier Removal (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Note variable scale on y-axis

Frequency of Occurrence

Using frequency of occurrence as the metric, sustained control of AIP was not observed in Site 26 (purple bars in **Figure 43**) compared with controls (blue bars). In fact, the occurrence of AIP was frequently similar to or higher than controls. Similar to relative abundance, the effectiveness of Group B methods was highly variable across all methods but also between replicated methods. Following the removal of bottom barrier "a", a sequential DASH reduced the average occurrence of AIP to approximately half that of the controls and site-wide. UV-spot treatments were quite variable but most effective in reducing the occurrence of Coontail compared to site-wide.

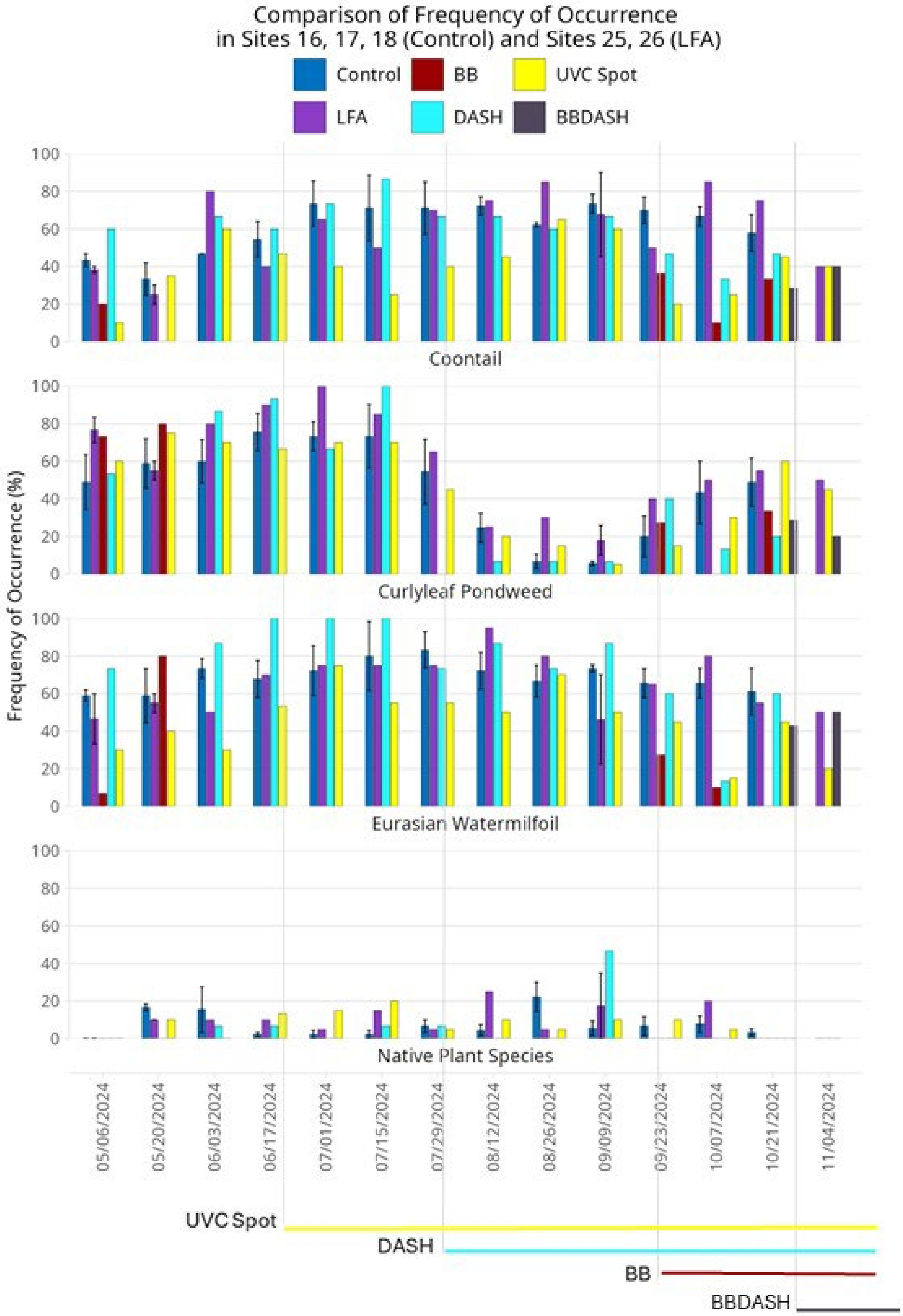


Figure 43. Average Species Frequency of Control Sites (Blue) and LFA-only Site-wide (Purple), Bottom Barrier (Dark Red), DASH (Aquamarine), UV-spot (Yellow), and Sequential DASH following Barrier Removal (Brown). Lines Indicate Approximate Range of Assessments Following End of First Treatment.

Note variable scale on y-axis

Fresh Weight

There were 225 fresh weight samples collected over the season from nine (9) Project sites representing controls, Endothall-only, Triclopyr-only, LFA, and Triclopyr + UV. The samples represented all rake fullness ratings (except 0) described in Table 5. The number of rakes from each rating category ranged from 30 to 66. There was a strong and positive correlation between the rake fullness ratings and wet weight ($r = 0.836$, $n=225$, $p<0.001$) (**Figure 44**).

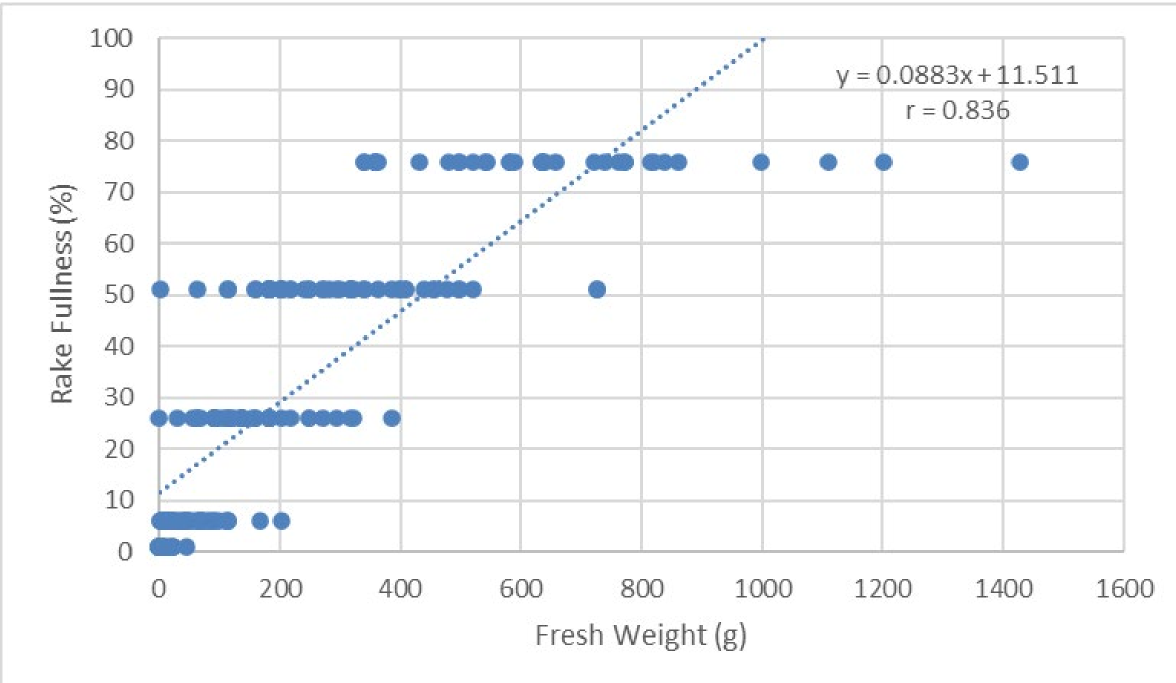


Figure 44. Correlation between Fresh Weight (g) and Rake Fullness (%) of all Aquatic Plants across the CMT Project in 2024.

Summary

This summary is grouped according to the type of treatment received in 2022 (similar to above), followed by a focus on Group B outcomes.

Endothall-only Sites

- Based on hydroacoustic scans during peak summer months (July to September), there was an average of 48% less biovolume in the Endothall-only sites compared to controls, with Site 2 having the greatest difference at 54% lower than controls.

- Vessel hull clearance >3 feet was achieved in all Endothall-only sites; however, it should be noted that overall water depth was substantially greater in Year 3 than Year 1 and Year 2 due to differences in annual weather conditions.

- While rake fullness does not provide species-specific information, it is insightful in understanding the overall changes in plant material resulting from Group B methods. Of the Group B methods in

Endothall-only sites DASH and UV-spot treatments were the most successful in keeping plant material low. That is, Group B methods generally had rake fullness less than 10% compared to control sites. On average, the site-wide rake fullness was on the order of 20 to 35%, still higher than the Group B areas.

Triclopyr-only Sites

- Based on hydroacoustic scans during peak summer months (July to September), there was an average of 25% less biovolume in the Triclopyr-only sites compared to controls, with Site 9 having the greatest difference at 46% lower than controls.

- Vessel hull clearance >3 feet was achieved in all Triclopyr-only sites; however, it should be noted that overall water depth was substantially greater in Year 3 than Year 1 or Year 2.

- While rake fullness does not provide species-specific information, it is insightful in understanding the overall changes in plant material resulting from Group B methods. Of the Group B methods in Triclopyr-only sites all Group B treatments maintain relatively low plant material, on the order of near zero to 20%. On average, the site-wide rake fullness was on the order of 30 to 40%, still higher than the Group B areas.

- The very high selectivity of Triclopyr for Eurasian Watermilfoil strongly influences all metrics evaluated here, resulting in lower rake fullness, relative abundance, and frequency of occurrence. Conversely, Triclopyr has no known efficacy against Coontail. Its effects on Curlyleaf Pondweed strongly suggest some level of control. That is, for mid-channel relative abundance (which was treated in Year 1), there appears to be sustained control of Curlyleaf Pondweed compared to controls. This trend is less clear in shoreline samples which, given the very high water in Year 3, would not have been treated in Year 1. Additionally, total turion counts were less mid-channel in Year 3 compared to shoreline samples.

UV-only Sites

- Based on hydroacoustic scans during peak summer months (July to September), there was an average of 52% less biovolume in the UV-only sites compared to controls, with Site 22 having the greatest difference at 65% lower than controls.

- Vessel hull clearance >3 feet was achieved in all UV-only sites; however, it should be noted that overall water depth was substantially greater in Year 3 than Year 1 or Year 2.

- Rake fullness was dramatically different between mid-channel and shoreline samples as expected since shorelines are not generally treated with UV.

- In general, the number of turions observed in the mid-channel of UV-only sites were generally less than half compared to control sites.

Endothall + UV Sites

- Based on hydroacoustic scans during peak summer months (July to September), there was an average of 60% less biovolume in the Endothall + UV sites compared to controls, with Site 10 having the greatest difference at 60% lower than controls.

- Vessel hull clearance >3 feet was achieved in all Endothall + UV sites; however, it should be noted that overall water depth was substantially greater in Year 3 than Year 1 or Year 2.

- While rake fullness does not provide species-specific information, it is insightful in understanding the overall changes in plant material resulting from Group B methods. Results of Group B methods in Endothall + UV Combination sites were rather variable, however, DASH areas were less than 10% rake fullness to end of season and sequential UV-spot following the removal of the bottom barrier was very successful (less than 1%). On average, the site-wide rake fullness was also variable, ranging from less than 10% up to 35% over the season, still higher than Group B areas.

Triclopyr + UV Sites

- Based on hydroacoustic scans during peak summer months (July to September), there was an average of 44% less biovolume in the Triclopyr + UV sites compared to controls, with Site 14 having the greatest difference at 52% lower than controls.

- Vessel hull clearance >3 feet was achieved in all Triclopyr + UV sites; however, it should be noted that overall water depth was substantially greater in Year 3 than Year 1 or Year 2.

- While rake fullness does not provide species-specific information, it is insightful in understanding the overall changes in plant material resulting from Group B methods. Of the Group B methods in Triclopyr + UV Combination sites DASH performed well in keeping plant material low (less than 20%), but following the removal of bottom barriers, rake fullness remained less than 10%. On average, the site-wide rake fullness was on the order of 20 to 50%, so still higher than Group B areas.

LFA Sites

- Based on hydroacoustic scans during peak summer months (July to September), there was an average of 12% more biovolume in LFA Site 26 compared to controls and 15% less biovolume in LFA Site 25 compared to controls.

- Vessel hull clearance >3 feet was achieved in LFA Sites 25 and 26; however, it should be noted that overall water depth was substantially greater in Year 3 than Year 1 or Year 2.

- While rake fullness does not provide species-specific information, it is insightful in understanding the overall changes in plant material resulting from Group B methods. Of the Group B methods in LFA Site 26, UV-spot performed well in keeping plant material low (less than 5 to 15%) through end of season. This is compared to site-wide and control fullness values around 40%. DASH also performed well with less than 15% through much of the season. In general, bottom barriers performed well while in place, but following removal, vegetation rather quickly moved into the sites. One bottom barrier had nearly 20% rake fullness following removal (similar to site-wide and controls) and received sequential DASH treatments, resulting in approximately 5% rake fullness. Looking at relative abundance, there was no clear pattern of one AIP moving into the Group B areas, no matter the treatment.

Native Plant Species

The relative abundance of native plant species in all CMT sites, including control sites, was generally low (<10%) in the Main Lagoon and highest in Lake Tallac (~30%). However, the frequency of occurrence was quite high (~40% to 80% in the spring), suggesting the potential for a robust and diverse native plant community in the absence of AIP. Canadian waterweed (*Elodea canadensis*) was the most abundant and frequently occurring native plant in the Main Lagoon. Other common native species include Richardson's pondweed (*Potamogeton richardsonii*), naiad (*Najas* sp.), and muskgrass (*Chara* sp., a macroalgae). Watershield (*Brasenia schreberi*) was the most abundant and frequently occurring native plant species in Lake Tallac. Watershield is a 2B.3 California Rare Plant, "2B" meaning the plant species is rare, threatened, or endangered in California but common elsewhere and "3" meaning more information is needed to assign the plant to another higher or lower rank (CNPS 2025).

Group B Treatments

UV-Spot

UV-spot treatments occurred in six sites, ranging from 13,702 sq ft up to 49,851 sq. ft. and comprising from 18% to nearly 60% of the Group A site. UV-spot treatments were the largest in terms of sq. ft. compared to other Group B methods (**Table 7**).

With few exceptions, UV-spot treatments maintained low rake fullness throughout the season in all sites utilizing this Group B method. This includes the sequential bottom barrier to UV-spot area in Site 8 where rake fullness was maintained at less than half of site-wide to end of season. UV-spot treatments in LFA Site 26 appear to be most effective in reducing Coontail during the summer with diminished reductions in relative abundance over time. Perhaps the overall very high biovolume in Site 26 decreases the efficacy of this approach. In general, UV-spot maintained low relative abundance of Coontail and Eurasian Watermilfoil. For Curlyleaf Pondweed, however, relative abundance was generally greater in all UV-spot treatment areas compared to site-wide and controls. The same trend was not observed in UV-only sites.

DASH

DASH treatments occurred in nine sites (five sites with one or two DASH areas) ranging from 1,247 sq. ft. to 8,746 sq. ft. and comprising from just 0.8% to 9.1% of the Group A site. For Site 26, the two DASH areas were just 0.8% and 1.6% of the overall site. Of all Group B methods, DASH was the most variable in terms of all metrics assessed, likely due to the relatively small area and the, oftentimes, very dense surrounding vegetation capable of either floating (e.g., unrooted Coontail) or adjacent canopy simply occupying the open space.

Bottom Barrier

Bottom barrier treatments occurred in nine sites (two sites with two bottom barrier areas) ranging from 2,538 sq. ft. to 7,439 sq. ft. and comprising from 1.3% to 9.2% of the Group A site.

Macrophytes were assessed prior to the placement of barriers, then one to four times depending on timing and the implementation of sequential UV-spot or DASH treatments. No plant assessments occurred while the barriers were in place. Using rake fullness as the metric, bottom barriers were generally effective at reducing plant biomass; however, in many instances Coontail was the most frequently occurring species to quickly occupy the relatively small treatment sites. In addition to the movement of Coontail fragments (and likely others), the plant canopy likely moved into the otherwise unoccupied space and this plant material was captured on the rakes. It should be noted that bottom barriers represent a very small proportion of the overall site, for example in Site 26 bottom barriers were 1.4% and 1.5% of the overall site.

TABLE 7
SUMMARY OF YEAR 3 NON-HERBICIDE GROUP A AND GROUP B METHODS

CMT Year 3 Group A, B **Type Treatments**	**Number of Group A, B Areas Treated in 2024**	**Net Acres Treated in 2024 [a]**
Bottom Barriers	9	0.9
DASH (Includes 4 Sequential Treatments)	20	1.77
UV-C Spot (Includes 2 Sequential Treatments)	8	4
UV-C Only	3	2.3
UV-C Combo	5	3.12
LFA	3	12.9
Total Group B Areas Treated in 2024	**48**	**24.99**

NOTES:
[a] UV-C and DASH treatments were repeated within the same areas.

Considerations and Recommendations

Fresh Weight

The fresh weight of a subset of samples was highly correlated with the more subjective rake fullness evaluation. Intermittent use of fresh weight measurement may be helpful in understanding where crew assessments may become challenging to separate, particularly in the mid-level categories of rake fullness. Some accepted scoring approaches use as few as four categories compared to the six used in the CMT Project (IDNR 2018). Evaluation of this more simplistic approach should be considered. Regardless of number of categories, individual rakes still provide details of occurrence and relative abundance which cannot readily be achieved through hydroacoustic scans without an increased level of effort and disruption in the workflow during data collection. Fresh weight measurements merely remove some of the subjectivity and provide more defensible measurement which can be more easily statistically evaluated.

Monitoring Level of Effort

One of the objectives of the Project was to increase the frequency and abundance of native aquatic plant species relative to AIP. The overall analysis of this objective will be covered in the synoptic report that looks at all three years of the CMT Project. Looking forward, collecting sufficient information to evaluate this objective must also be in balance with available resources. For the CMT Project, a minimum of 30 rakes per site were collected. To answer the question of how many rake samples are needed to determine when all species have been captured, a species accumulation curve was quickly developed for Site 19. This site was selected because it had the highest diversity of aquatic plants, including bladderwort, which was not commonly found, even in Lake Tallac. It was found that in that site (on 5/29/2024), using that date and site, it took 13 rakes to find all six species. This is in contrast to, for example, Control Site 16 in the Main Lagoon, where a mere three rakes were needed to find all three recorded species on a certain date during the peak summer season. To be clear, this does not factor in Group B methods which will require a more focused assessment based on treatment size.

Calculating the number of rakes samples needed to detect all species in an area/site is only one criterion to determine the minimum number of rake samples per area. Other criteria include the accuracy of rake fullness and relative abundance evaluations. The growth of aquatic macrophytes is inherently "patchy" and greatly influenced by variations in habitat, including but not limited to depth (e.g., shoreline versus mid-channel), light availability, and sediment type. Only when habitat characteristics are consistent and not substantially different can we rely on a calculated/estimated minimum number of rake samples.

Aside from the number of rakes per site, the timing is also a critical piece of the monitoring level of effort, in particular, to assess Curlyleaf Pondweed turion production and subsequent sprouting. Early spring growth followed by turion formation is a life history pattern unique among the *Potamogeton* species. Further unique to *P. crispus* (curlyleaf) is the subsequent late summer/fall emergence from some turions. Assessing these patterns across treatment areas (as well as controls) will be critical in managing this species in the Tahoe Keys Lagoons and preventing further spread within the Keys and to the greater Lake Tahoe. At a minimum, assessments in the spring and fall should capture turion production and sprouting. This spring/fall turion pattern was clearly observed across the CMT Project sites in 2024, regardless of treatment (**Figure 45**) and should strongly factor into future monitoring protocols and assessment of management approaches.

a)

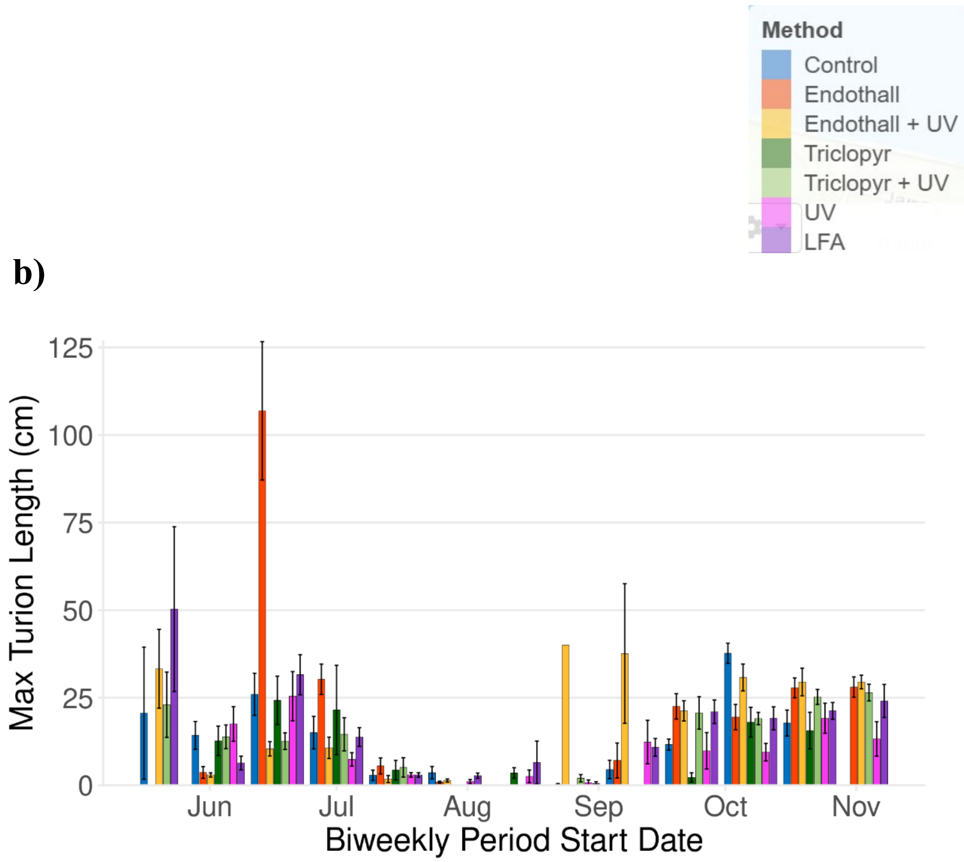


Figure 45. Total Number of Turions (a) and Average Turion Length, cm (b) over all CMT Project Sites.

Water Levels

Due to dramatic snowmelt, in some sites water levels were approximately 4 feet deeper mid-site in Year 2 compared to Year 1 and an additional 2 feet deeper (or more) in Year 3. This deeper water resulted in reduced light penetration and lower water column temperatures which, combined, deterred plant growth. For herbicide and combination sites in Year 1, this further means that exposed shorelines in Year 1 did not receive Year 1 treatments. Increased water levels also expanded the habitat for plant establishment. Lastly, the extreme differences in water depth between years have revealed some questions about the applicability of the various metrics for assessing year to year efficacy.

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