

INTEGRATED MANAGEMENT PLAN FOR AQUATIC WEEDS FOR THE TAHOE KEYS LAGOONS

PREPARED PURSUANT TO
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION
BOARD ORDER NO. R6T-2014-0059

Prepared by
Tahoe Keys Property Owners Association



UPDATE
JANUARY 2026

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1.0 INTRODUCTION

In accordance with its Waste Discharge Requirements (WDR) (Lahontan Regional Water Quality Control Board, Board Order No. R6T-2014-0059, issued July 17, 2014) (Lahontan 2014), Tahoe Keys Property Owners Association's (TKPOA) Integrated Management Plan (IMP) applies an integrated pest management approach to aquatic weed control by combining sound ecological principles and research of new technology with proven methods for aquatic plant control. Annually, TKPOA has completed and submitted an update of its IMP to Lahontan. This is the tenth update to the IMP.

To learn more about the history of the IMP development, the location, ecology and hydrology of the Tahoe Keys Lagoons, the aquatic invasive species (AIS) of concern, and the WDR-approved methods of plant control (along with their advantages and disadvantages), please refer to the first IMP submitted to Lahontan (TKPOA 2017e).

1.1 IMP GOALS AND OBJECTIVES

For reference, the goals and objectives of TKPOA's IMP, as established by its WDR (Lahontan 2014), are as follows:

Goal 1: Fulfill the objectives named in the 2014 WDR.

WDR Objectives:

- Eliminate the spreading of AIS from the Tahoe Keys to the greater Lake Tahoe.
- Enhance the overall water quality of the Keys Lagoons thereby improving Lake Tahoe water quality and associated clarity.
- Reduce habitat for non-native fish and enhance habitat for native fish in the Keys Lagoons.
- Restore and maintain established beneficial recreational uses, including water contact safety in the Keys Lagoons and commercial uses within neighboring Marina.
- Implement a combination of cost-effective control measures that are feasible for long-term management of aquatic invasive plants (AIP).

Goal 2: Continue to refine existing methods of aquatic plant control and to research new, safe, cost-effective methods to control aquatic invasive plants. Use established objective criteria to evaluate these methods and propose effective, feasible methods for inclusion in updates to the IMP.

Objectives in support of Goal 2:

- Identify and confirm safety and success of new and novel aquatic invasive plant control methods by reviewing scientific literature and reports of these methods used under similar settings and operational conditions.
- Conduct and evaluate small-scale demonstrations of localized control methods in defined areas of the Keys Lagoons. These small-scale demonstrations may include

methods not specified as control measures in the WDR but will be conducted under the appropriate authorization of permits issued by the Lahontan Board.

These goals and objectives provide the basis for the IMP activities undertaken to date, and for the activities planned for 2026.

2.0 AQUATIC WEED CONTROL ACTIVITIES IN 2025

The following section summarizes WDR-approved weed control activities. WDR-approved indicates the activity is included in TKPOA's 2014 WDR that TKPOA may undertake without additional consultation or permitting with Lahontan. The WDR-approved activities undertaken by TKPOA in 2025 include mechanical harvesting, fragment containment, and bottom barriers. The WDR also directs TKPOA to employ best management practice (BMP) measures to limit the spread of viable plant fragments during aquatic weed harvest operations.

As the Control Methods Test (CMT) concluded at the end of 2024, activities in 2025 focused on the continuation of non-chemical treatment methods, including ultraviolet light (UV-C), Diver Assisted Suction Harvesting (DASH), and Laminar Flow Aeration (LFA). These activities were conducted under the CMT authorization issued by the Lahontan Regional Water Quality Control Board (Order No. R6T-2022-0004; NPDES No. CA6202201) and were not implemented pursuant to the WDR. These methods are also discussed below.

Discussion includes the purpose of the activity, duration of the activity, location of the activity, and effectiveness of the activity. Effectiveness is considered in relation to the understood purpose of the activity and in relation to the success criteria established by TKPOA with the 2017 IMP (TKPOA 2017e).

2.1 HARVESTING

Since the 1970's, harvesting has been the primary method to maintain navigable waterways and other beneficial uses such as contact and non-contact water recreation. One of the primary objectives of the harvesting is to maintain a minimum of 3 ft of vessel hull clearance in the channels to minimize the potential for weeds to be transported from the lagoons into Lake Tahoe by watercraft.

2.1.1. Mechanical Harvesting Implementation 2025

TKPOA initiated harvesting operations in mid-June 2025 and continued harvesting through October 2025. Figures 1 and 2 outline the harvesting zone maps for the 2025 season. During the season, TKPOA operated four mechanical harvesters, as well as up to four skimming vessels. Two Weedoo vessels were repaired and brought back into service late in the season. One of the Weedoo vessels, the "Aquaharvester", was tested around boat docks, slips, and in shoreline areas. The second, "Tigercat", is an electric skimming boat that trailed behind the Aquaharvester and collected the fragments made from the cutting machine.

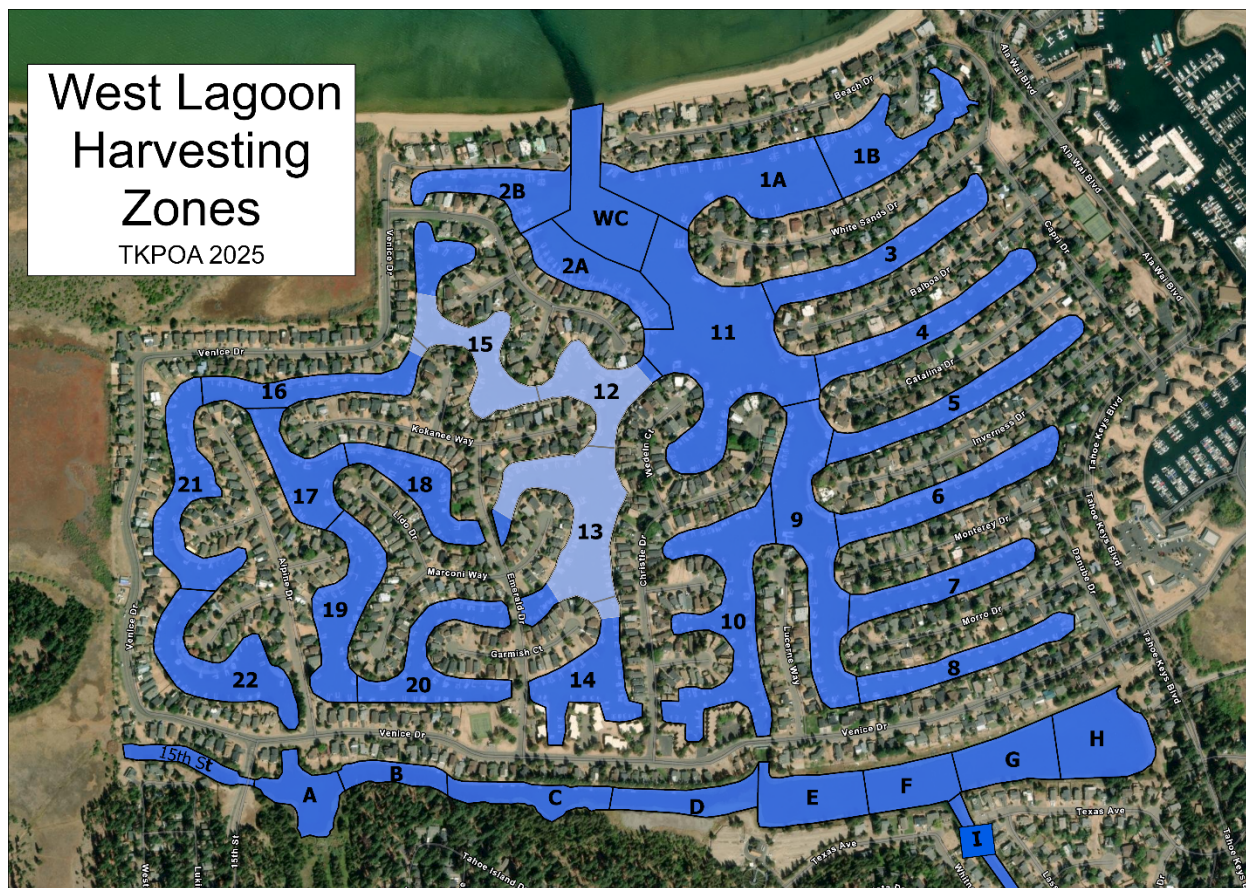


Figure 1. West Lagoon Harvesting Zones. Light color in zones 12, 13, 14 and 15 represents approximate UV-C treatment areas.



Figure 2. East Lagoon Harvesting Zones.

2.1.2. Mechanical Harvesting Effectiveness for 2025

The total amount of biovolume removed from the Tahoe Keys West Lagoon, East Lagoon and Lake Tallac via harvesting in 2025 was 1,007 tons. The skimmers following the harvesters removed an additional 193 tons (outlined in section 2.2.3) bringing the total amount of biovolume removed to 1,200 tons.

Figure 3 displays tons of plant material harvested by month since 2022 and Figure 4 displays harvesting totals (not including skimming contributions) from 2020 to 2025. Figure 5 shows the amount of weeds removed per location around the Lagoons in 2025. Overall, the number of tons harvested significantly increased in 2025 compared to previous years. On average, August

seems to be when peak biomass removal occurs, usually around 25% of total biomass for the season. In 2025, 30% of the total weeds harvested were in August followed by 25% of the total weeds harvested in September. In 2022, to meet the requirements of the CMT permit, turbidity curtains placed throughout the West Lagoon affected harvesting operations in the beginning of the season, which is why 52% of total weeds were harvested in October.

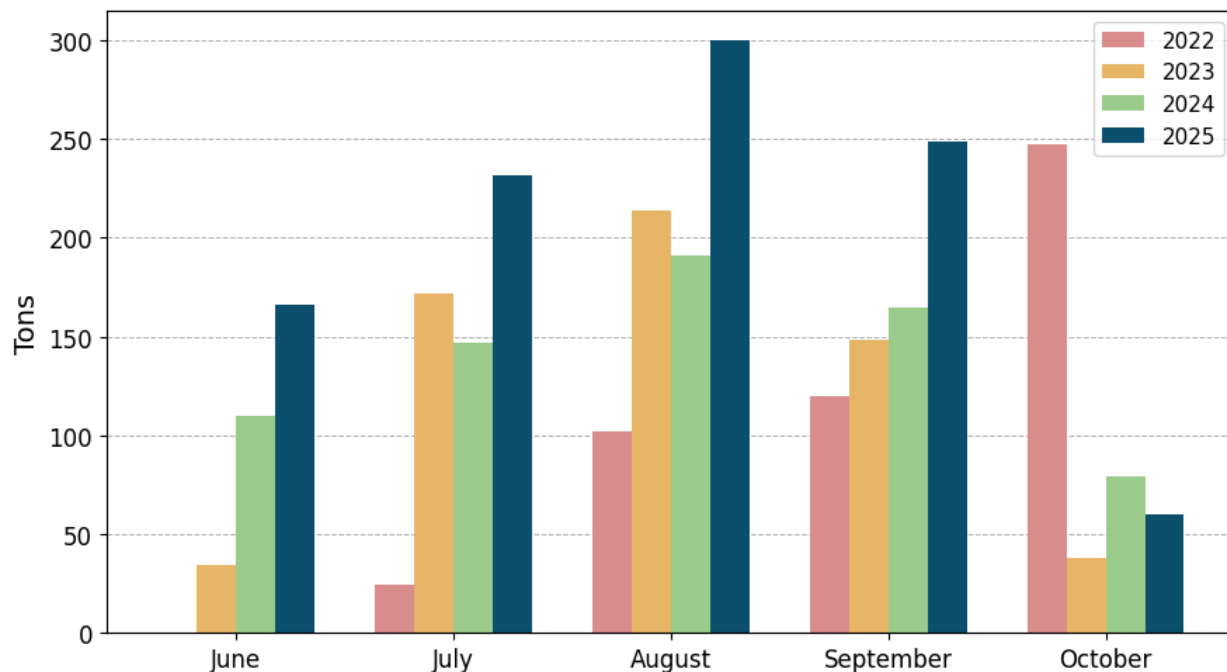


Figure 3. Tons of plant material harvested by month since 2022.

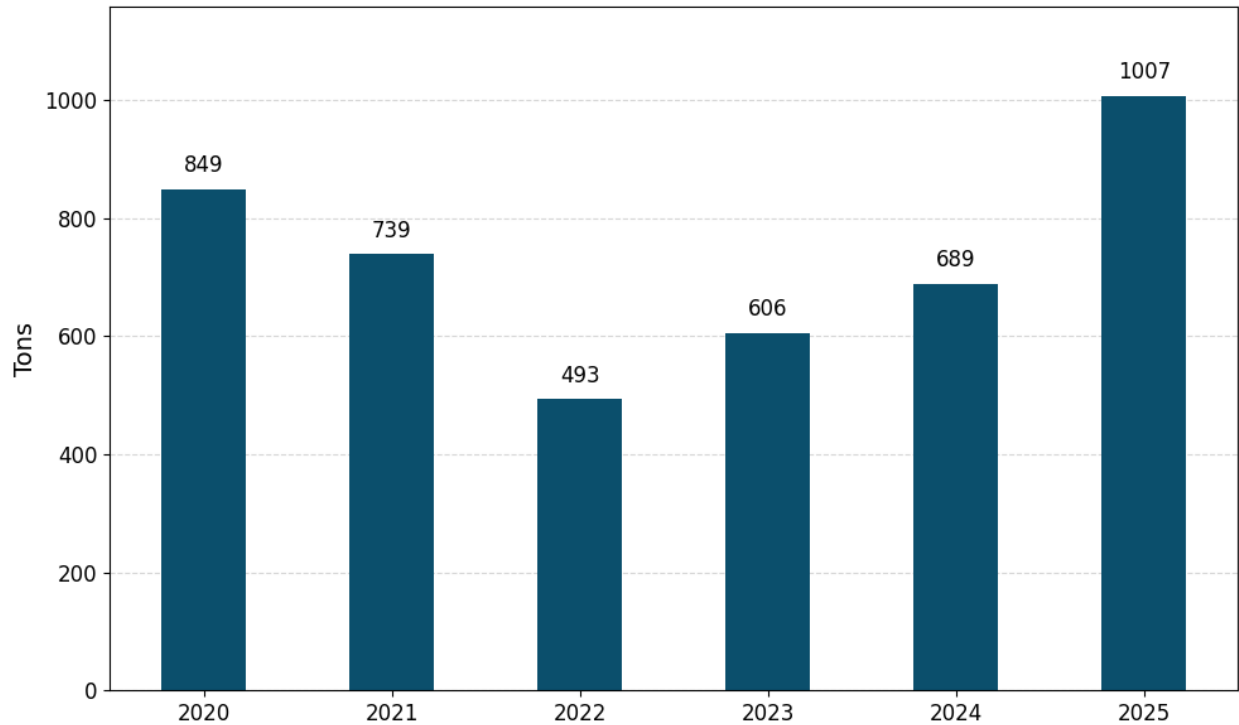


Figure 4. Tons of plant material harvested by year since 2020.

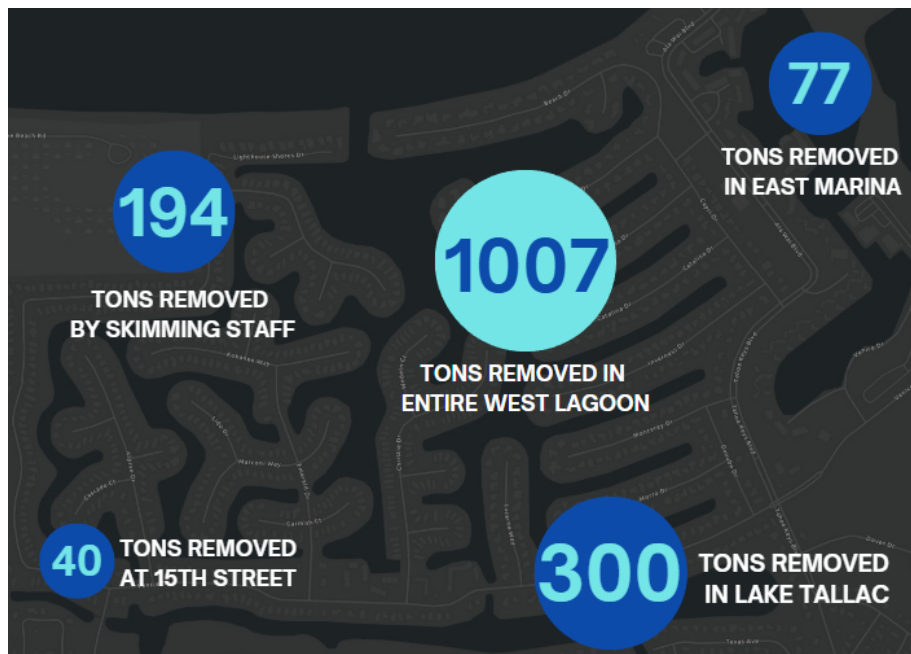


Figure 5. Harvested amounts in tons removed from the West Lagoon, East Marina, 15th St Lagoon, and Lake Tallac as well as tons removed via skimming staff in 2025.

The 2025 harvesting season marked a record-breaking accomplishment in the total volume of aquatic weeds removed from the waterways, exceeding last year's total by 40%. The 'pre-CMT' harvesting department had both staffing and harvester maintenance issues, and by learning from those trials, 'post-CMT' harvesting methods were greatly improved. During the CMT (2022-2024), there were a significant amount of areas that were not allowed to be harvested, in order to analyse biovolume percent in the treatment areas without bias. Therefore, 2025 was the first time in 3 years that the entirety of the Tahoe Keys waterways were open for harvesters to reach.

2.1.3. Vessel Hull Clearance Plant Height

To demonstrate compliance with the 2014 WDR objectives' success criteria related to navigation and recreational use, average aquatic plant height data for each lagoon are reported in this section. This data is used to evaluate whether sufficient vessel hull clearance (VHC), as identified in the 2017 TKPOA IMP update, is being maintained and to assess the effectiveness of aquatic plant management activities. A benchmark of 3 ft from surface to plant canopy was used as an indicator of potential VHC and was subsequently applied in the CMT to help evaluate treatment effectiveness. Therefore, each graph shown in Figures 6, 7, and 8 includes a reference line representing the minimum of 3 ft depth to plant for VHC. For average water depth and depth to plant data broken down by zones for each lagoon refer to Appendix B. The zones within each lagoon are shown in Figure 23.

VHC was calculated using data from hydroacoustic scanning described in section 3.2. The scans provide depth to top of plant canopy and depth to lagoon bottom values along the scan track. These numbers are averaged and plotted on graphs. With dense weed growth, depth to lagoon bottom values become inaccurate as the transducer has difficulty scanning all the way through the plant mass. The water column depth values on these graphs are therefore an estimation and water level should be checked against established staff gauges for accurate depth readings. Depth to top of plant canopy has not shown signs of inconsistency and can be considered true value.

Across all three lagoons, average depth to plant measured from the water surface remained above the 3 ft benchmark during the 2025 monitoring period, supporting navigation and recreational use objectives identified in the IMP. In the West Lagoon, average depth to plant ranged from 6.97 ft to 9.07 ft between June and October. In the East Lagoon and Lake Tallac, average depth to plant was greatest in June and October and shallowest in August, indicating mid-season increases in plant height and possibly limited harvesting, though still over the 3 ft VHC throughout the monitoring period. Harvesting is an effective control method to maintain this recreational access criteria.

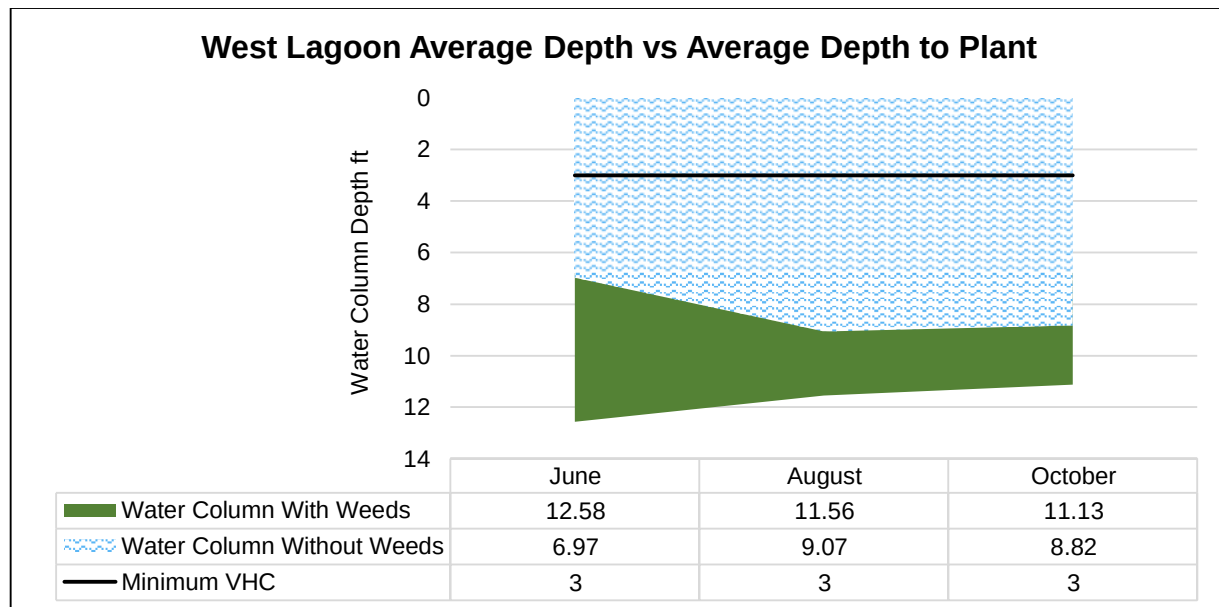


Figure 6. West Lagoon average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

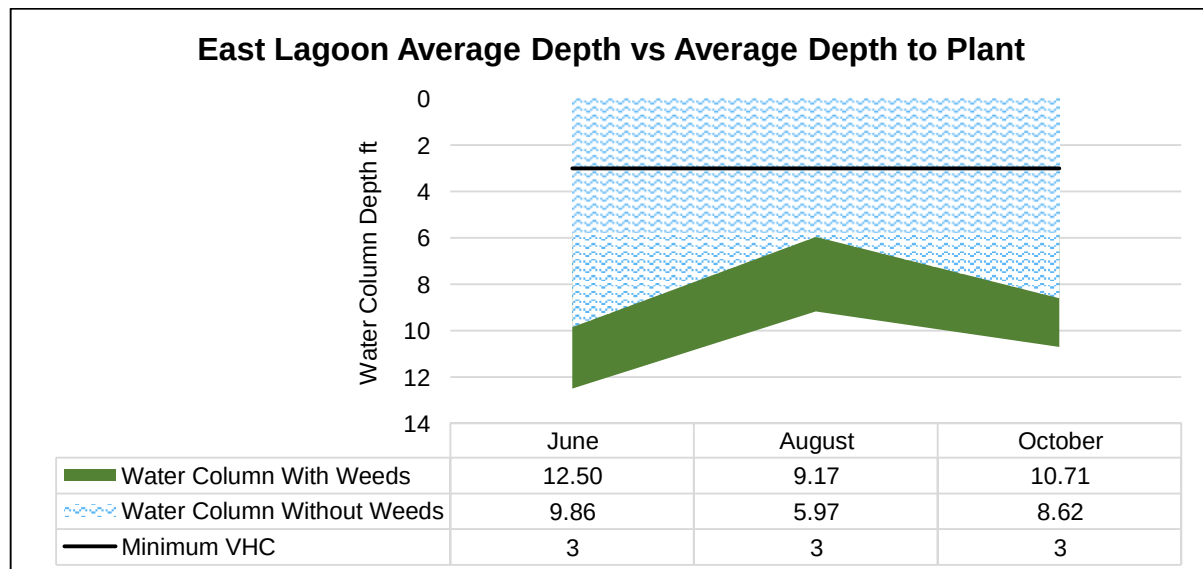


Figure 7. East Lagoon average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

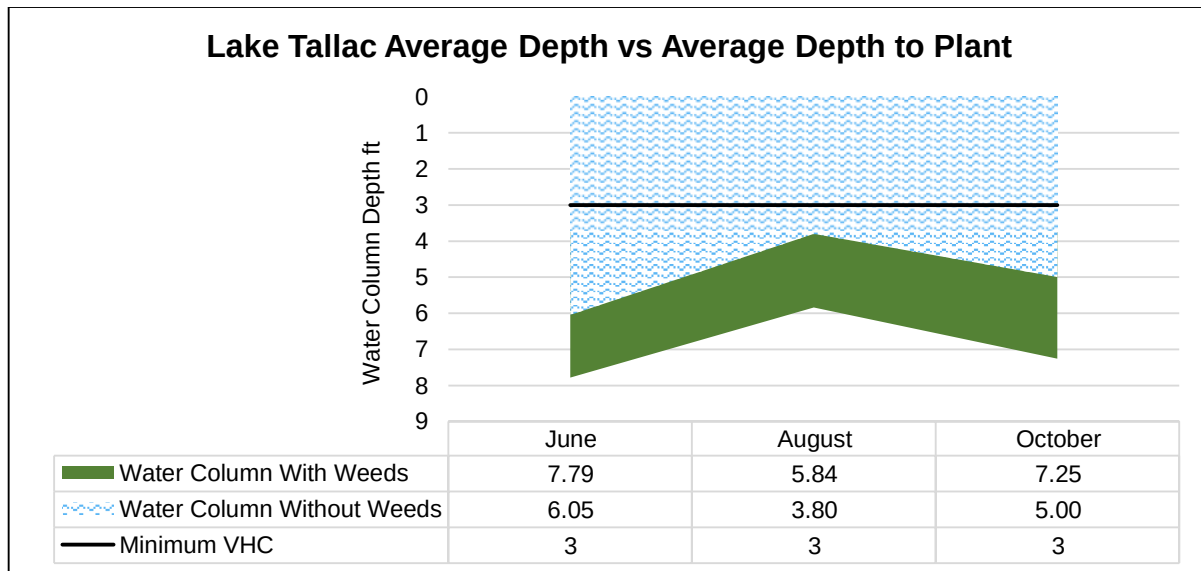


Figure 8. Lake Tallac average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

2.1.4. Weed Disposal / TKPOA Corporation Yard

Since 2023, TKPOA has had an agreement with South Tahoe Refuse (STR) for disposing harvested weeds using their services. As a result, harvested aquatic weeds are no longer placed on the ground to dry at the former TKPOA Corporation Yard off Dover Drive, but are delivered directly to STR after being off-loaded from the harvesters.

2.2 FRAGMENT CONTAINMENT

There are currently three methods for containment both in the channels and throughout the West and East Lagoons: bubble curtains, boat back-up station and skimming. Each method has unique advantages and applications tailored to keep fragments from spreading into Lake Tahoe. In Lake Tallac, physical screening has been installed to prevent fragments from spreading to Pope Marsh.

2.2.1. Bubble Curtains

Bubble curtains are an innovative technique used to create a physical barrier of bubbles in the water column to contain fragments within the West and East Lagoons and stop them from spreading into Lake Tahoe. In 2018, with funding support from The League to Save Lake Tahoe (LTSLT), divers hired by TKPOA installed the West Channel bubble curtain. Since the initiation of the program, TKPOA has installed a second line, creating a 'double bubble curtain', and has continually monitored and enhanced the operations of the bubble curtain. Refer to Appendix A for a full history of bubble curtains in the Tahoe Keys Lagoons.

2.2.1.1. West Channel Bubble Curtains

The layout of the West Channel bubble curtains was modified in 2024 to streamline the air demand. Continuing issues with compressors malfunctioning due to electrical constraints led TKPOA to hire a dive contractor to redesign the underwater bubble curtain layout. Almost quadruple the necessary length of bubble tubing was found in the channel which, along with irregular splicing of segments, made the system inefficient. The redesign and installation reduced the total number of segments for each bubble curtain to two lines, which allowed for a single compressor to be able to adequately supply the four air lines now in service.

In 2025, TKPOA has been able to maintain the 24/7 operations with no disruption except for brief interruptions associated with scheduled efficacy monitoring described in section 2.2.1.2. An OTTO monitoring system was installed in May 2025 to provide real-time operational oversight, and a maintenance contract with the manufacturer supported consistent performance. High exhaust air temperature remains a consistent issue. Heat will lead to premature wear on a motor so methods to reduce the exhaust temperature while maintaining needed air pressure are being evaluated. Noise continues to be an issue with neighbors but further solutions to reduce noise will increase heat inside the housing. Until the temperature can be managed, noise will remain a problem. Large sailboat keels and deep boat propellers damage the lines occasionally. The curtains remain operational when this occurs, and divers are sent out quickly for repair. In addition, weeds build up and lay over the airlines causing obstructions. Divers spent about 1 week removing weeds, unplugging air holes, resealing lines, and brushing off bottom barriers to ensure proper function of the bubble curtains.

2.2.1.2. Bubble Curtain Effectiveness for 2025

In 2024, the methodology of efficacy monitoring shifted. A new standard operating procedure (SOP) was written by our consulting lead scientist, Dr. Lars Anderson, and approved by the bubble curtain committee. Monitoring was done once in the peak boating season and once at lower use conditions to account for differences in boat traffic. Transects were surveyed across both the lagoon (inside) and Lake Tahoe (outside) sides of the East and West Channel bubble curtains while the system was operational and again following a 72-hour shutdown period. Each fragment was typed, weighed, counted and measured.

In 2025, we modified the transects to reach into the corner pockets of the bubble curtain where fragment accumulation was visually observed (Figure 10). Due to the transfer of responsibility of the East Channel bubble curtain to Suntex Marina, 2025 efficacy monitoring was only done on the West Channel. Results indicate that during peak summer use, aquatic plant fragments were largely retained on the lagoon side when the curtain was operational. When the curtain was off, fragment distribution was more evenly spread, with a greater proportion detected on the Lake Tahoe side. Fall monitoring (low use conditions) showed similar trends but with reduced fragment volumes. These findings suggest the bubble curtain is functioning as intended, though additional years of data are required to confirm long-term efficacy (Figure 9).

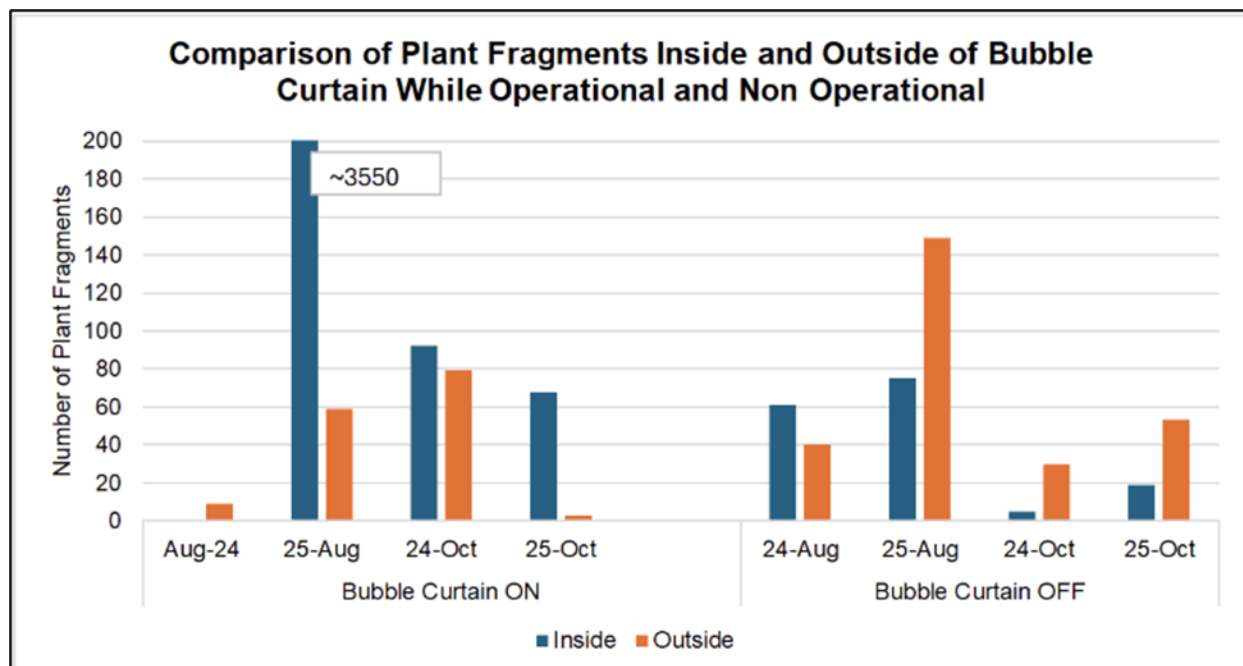


Figure 9. Comparison of plant fragments inside and outside of bubble curtain while operational and non-operational from the Bubble Curtain Efficacy Study in 2025.

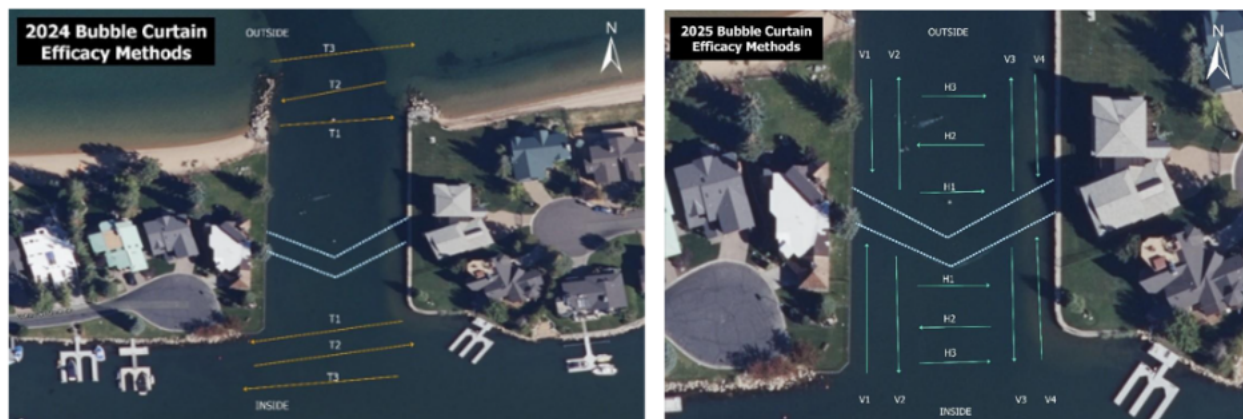


Figure 10. Transects surveyed in the 2024 and 2025 Bubble Curtain Efficacy Study, before and after modifications of transects.

2.2.2. Boat Back Up Station

The Boat Back-Up Station involved placing visible signage (Figure 12) for boaters exiting the West Lagoon to place their boats in reverse before entering Lake Tahoe proper. It was expanded in 2025 placing signage in two more locations around the West Channel (Figure 11). This method aimed to encourage boaters from the side channels to utilize the boat back up station as they might be inclined to bypass it based on their angle of entry to the channel mouth. The new messaging also included progressive severity in wording to promote better compliance with environmental best practices among boat operators. The TKPOA Boat Back-

Up Station is a recurring, seasonal installation. Refer to Appendix A for a full history of the Boat Back-Up Station in the Tahoe Keys Lagoons.

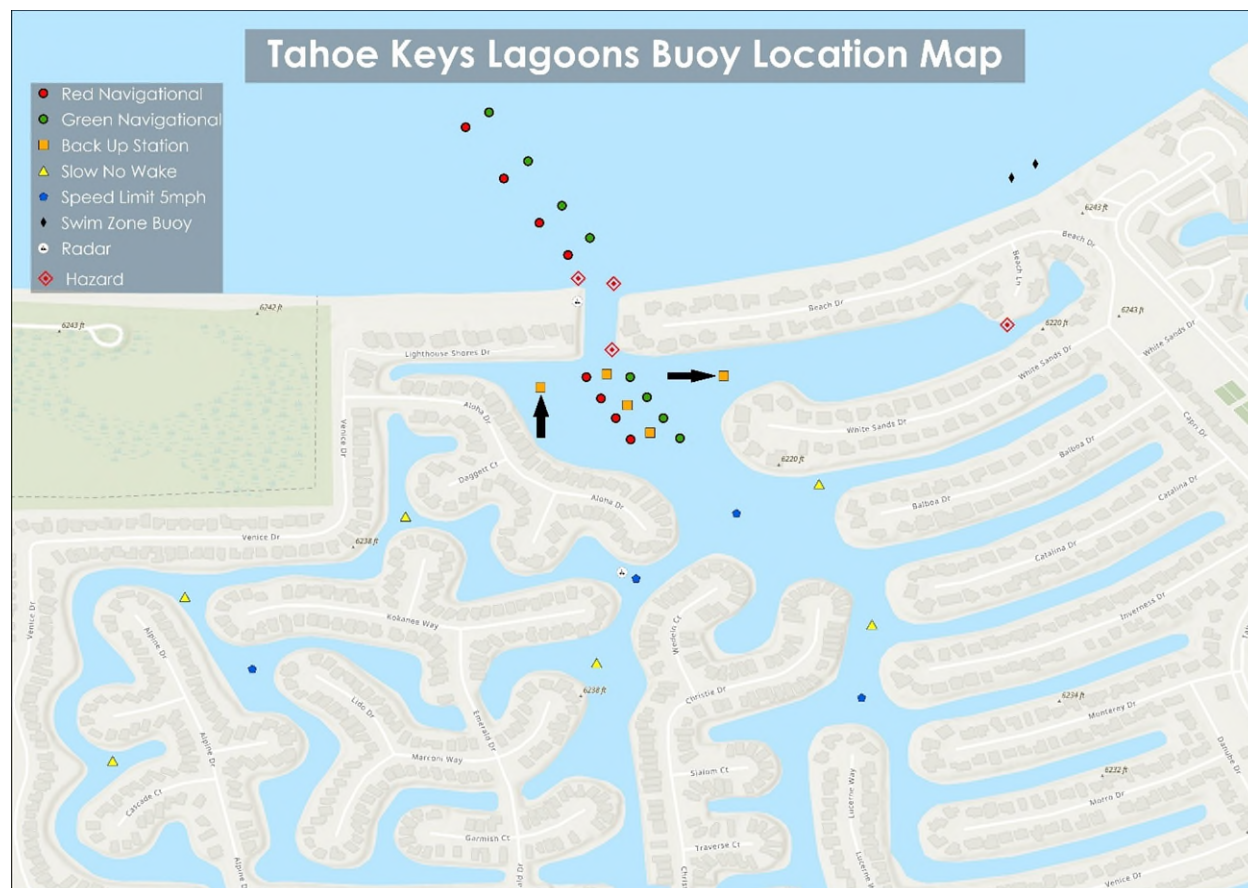


Figure 11. The expanded TKPOA Boat Back Up Station. Black arrows indicate new signage for 2025.

2.2.2.1. 2025 Implementation and Effectiveness

The buoys and directional signage were installed in the West Channel in May 2025 and removed late October 2025. For the 2025 season, TKPOA stationed a skimming vessel at the channel entrance five days a week to remove fragments that get dislodged from boat propellers and encourage all boaters to use the Boat Back-Up Station. The majority of boaters used the Boat Back-Up Station without needing prompting from stationed water quality staff. Homeowners are continuing to take more responsibility and ownership of the Boat Back-Up Station by encouraging others to adhere to it.



Figure 12. Boat Back-Up Station signage.

2.2.3. Skimming

Skimming targeted surface-level containment using specialized ‘dock boats’ and crew members using nets and rakes to collect floating fragments, which prevents AIS dispersion within the lagoons as well as into Lake Tahoe.

2.2.3.1. 2025 Implementation and Effectiveness

In 2025, TKPOA continued the more strategic skimming schedule (implemented in 2024) from mid-June through October 31st to follow one day behind the harvesters in the West Lagoon and East Lagoon. This allowed time for the fragments to clump and rise to the surface giving the skimming team better groupings to collect. This proactive approach led to the successful collection of 193 tons of weeds, representing 19% of the total weed removal this season. Skimming efforts focused on shallow shorelines and removing any flowering Eurasian watermilfoil that harvesting is unable to reach. Figure 13 shows the amount of weeds removed using the skimming method since 2020. Due to the installation of turbidity curtains in the West Lagoon to comply with the CMT permit, skimming was limited in 2022.

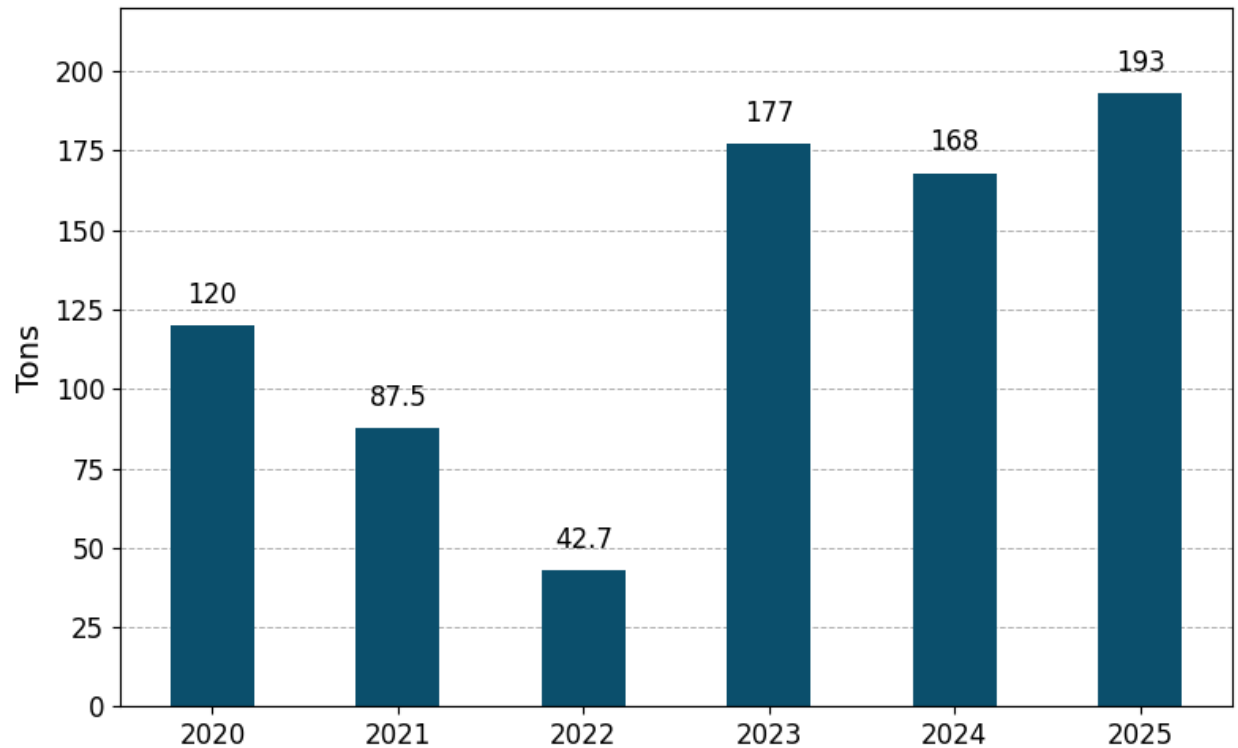


Figure 13. Total amount of weeds removed via skimming 2020-2025.

2.2.4. Additional Containment Activities

The Lake Tallac to Pope Marsh connection was identified as an urgent containment point. In 2025, a custom screen system was fabricated and installed to prevent fragment transport from Lake Tallac through a culvert into the 15th St. Lagoon (Figure 14). A removable grate was later installed across the top to prevent any animals or fragments from moving up and over the screens to ensure a secure barrier. In collaboration with Tahoe Regional Planning Agency (TRPA), Tahoe Resource Conservation District (TRCD), and the United States Forest Service (USFS), screening at the weir from the 15th St Lagoon into Pope Marsh was also updated to a similar barrier. This two-screening system isolate the 15th St. Lagoon and inhibits flowing fragments from causing further infestation. This isolation is aimed to bolster future AIS eradication efforts and ultimately provide a 2-step barrier system preventing the spread of AIS into Pope Marsh. Both screening systems are checked weekly for blockages or damage.



Figure 14. The 15th Street screening system.

2.3 BOTTOM BARRIERS

Bottom barriers are a physical control method used in the Tahoe Keys Lagoons since 2010 to manage AIS by blocking sunlight, thus inhibiting photosynthesis and plant growth. These barriers consist of benthic mats that are laid directly on the lagoon bed. This strategy is used throughout the Tahoe Basin as part of AIS management methods. Refer to Appendix A for a full history of bottom barriers in the Tahoe Keys Lagoons.

2.3.1.1. Bottom Barrier Implementation 2025

In 2025, TKPOA reintroduced the Bottom Barrier Program which encouraged homeowners to install bottom barriers around their dock space. Independently contracted divers worked directly with each homeowner who signed up to determine the optimal size and placement based on individual property needs. Homeowners reported the size, type, and area of bottom barriers to Waterways staff to manage and keep track of the program enforcing permit compliance with size of covered areas and materials used.

2.3.1.2. Bottom Barrier Effectiveness

In 2025, 25 homeowners installed bottom barriers around their dock space totaling more than 14,000 sq ft throughout the lagoons. Figure 15 shows bottom barrier locations. Installation was within the May through June window and removal occurred at the end of October and early November. The bottom barrier materials were 5ft x 10ft modular panels heavily weighted with metal anchors. The barriers were not staked down nor was there any loose material such as rocks used. There were no reports of lifting or maintenance needed once in place. After removal, inspection of what was underneath showed decomposing material with no signs of living plants.



Figure 15. Map of bottom barrier locations installed in 2025.

Bottom barriers require sufficient time to be effective, making early season implementation ideal. With the current installation rate, it takes about one month to install one acre. If scaled up and more barriers were placed down at the beginning of the season, there would not be enough time for proper inhibition if barriers needed to be removed before winter as is the current practice. It is advisable to leave the barriers in place with potential removal one year later. There are also considerations regarding maintenance and burial issues as well as material cost and longevity of the barriers themselves. Under the current permit allowances of a maximum of five acres per year it would take a minimum of 22 years to cover the West Lagoon alone if bottom barriers were the only method used.

2.4 CMT PERMITTED CONTROL METHODS

2.4.1. Laminar Flow Aeration

LFA systems were first introduced in the Tahoe Keys Lagoons in 2018. The implementation was part of an experimental project aimed at improving water quality and reducing organic sediment layers in sections of the West Lagoon. In 2022, as part of the CMT Group A methods, LFA was expanded from one site to three sites and tested in combination with other CMT methods. Based on results from the Draft Final CMT Report submitted by Tahoe Keys Property

Owners Association (Anderson, 2025), as well as the Tahoe Keys Lagoons Water Quality Improvements Project, Nutrients Existing Conditions Report (EMKO, 2025a), LFA was discontinued in the West Lagoon. For 2025, one site in Lake Tallac remained in operation (Figure 18). Refer to Appendix A for a full history of the LFA project in the Tahoe Keys Lagoons.

2.4.1.1. 2025 Implementation

In 2025, TKPOA operated LFA in one location in the Lake Tallac Lagoon that was installed in December 2022 (now known as Site D, see Figure 29).

Multiple methods to measure organic sediment layer thickness have been evaluated starting in 2023. No consistent method has been found to accurately account for the thickness or composition of the organic sediment layer. Continued testing will be needed.

2.4.1.2. LFA Effectiveness

After 6 years at the longest-running site (Site 10A and 10B, see Figure 29), there was no measurable change in the organic sediment layer. There was no evidence to suggest that these systems effectively reduce plant growth or organic sediment accumulation. In fact, evidence to suggest that the LFA converts nutrients to a more readily available form is most likely occurring (EMKO, 2025a). Visual observations of denser plant growth around aerators support this.

2.4.2. Ultraviolet Light (UV-C)

UV-C treatment was first introduced experimentally in Lake Tahoe at Lakeside Marina and Beach as part of an innovative strategy to control AIS (see <https://tahoekeysweeds.org/current-lake-wide-efforts/>). Starting in 2020, these trials aimed to explore the effectiveness of UV-C light in disrupting plant growth as a non-chemical AIS treatment method. The treatment specifically targets the DNA of plants, preventing reproduction and growth, thus offering a potentially sustainable solution to manage invasive species and maintain ecosystem health in the lagoons. It became a Group A method in 2022 as part of the CMT and due to its effectiveness in mid channel areas, was used in 2025 targeting curlyleaf pondweed ‘hotspots’ (Figures 16 and 17). For a full history of UV-C use, refer to Appendix A.

2.4.2.1. UV-C Treatments Conducted in 2025

The 2024 mid-season (July) curlyleaf pondweed composition map (Figure 16) shows a series of ‘hotspots’ in the central and western part of the West Lagoon. In 2025, approximately 6.9 acres were treated three times (totaling 20.7 acres) with UV-C between May 5th to October 23rd, targeting the curlyleaf pondweed ‘hotspots’ that were identified in 2024. These ‘hotspots’ are shown within the blue oval area in Figure 16. This group of ‘hotspots’ was selected because it represented the greatest risk of spreading and fragment generation closest to the West Channel. Also see Figure 1, which identifies the specific zones within the West Lagoon where UV was deployed in 2025. Figure 17 shows the mid-season curlyleaf pondweed composition in 2025, indicating that by July the UV-C treatments had reduced the area and number of ‘hotspots’ in the target area.



Figure 16. Curlyleaf pondweed 2024 mid-season composition map used to identify curlyleaf pondweed 'hotspots'. Blue oval indicates area targeted for 2025 UV-C treatments.



Figure 17. Curlyleaf pondweed mid-2025 season composition map used to identify curlyleaf pondweed 'hotspots'.



Figure 18. Map of DASH, UV-C, and LFA treatment areas in 2025.

2.4.2.2. UV-C Effectiveness

UV-C was shown to be effective in reducing AIS abundance and at sustaining control during the CMT in the years following herbicide treatment and in stand-alone treatments in areas where herbicide was not used. If treatment occurs based on the curlyleaf pondweed growth cycle, it could be used to address recently sprouted turions and prevent subsequent growth. Due to the size and maneuverability of the UV-C boats, this treatment method is most effective in mid channel areas, as near shore AIS abundance was not controlled using UV-C during the CMT. Physical features like docks, support pilings, and boats moored at the docks made it difficult for the UV-C boats to access near shore areas, as did environmental factors like water levels, near shore bottom terrain and inclement weather.

In 2025, UV monitoring and data collection was conducted through a TRPA funded science team from Environmental Science Associates (ESA). Data and results will be published at a future date from these outside groups. Once made available, copies of these reports can be found on TKPOA's water quality website (keysweedsmanagement.org).

2.4.3. Diver Assisted Suction Harvesting

DASH is a precise, non-chemical method for controlling aquatic weeds in the Tahoe Keys Lagoons. This technique involves divers manually removing AIS from the lagoon floor, which

are then suctioned to the surface and removed. Introduced in the Tahoe Keys as a selective and minimal-impact approach, DASH targets specific areas heavily affected by AIS as well as hard to get places for other non-chemical methods, like underneath docks. DASH can also be species-specific, allowing divers to remove AIS while leaving native aquatic plants in place. This method was established as part of the Group B Methods within the CMT and continued in 2025.

2.4.3.1. DASH Implementation 2025

DASH was utilized in 2025 and aligned with the UV-C treatments. Where UV-C could be applied mid-channel at curlyleaf pondweed ‘hotspots’, DASH treatment was located on the adjacent shoreline in hard-to-reach areas (under docks, boats, shallow water) (Figure 18). The total area of DASH treatment sites was 146,844 sq ft or 3.3 acres and with almost two treatments over the same area, a total of 6 acres was covered. Certified divers from Hiuga Diving Company, which is licensed by the California Contractors State License Board (CSLB License No. 1011839) hand-pulled target weeds from the bottom of the lagoons at the treatment sites and directed them towards a suction generating flow system. The suction system was used to transport the weeds into a container onto the boat at the surface. The divers identified which species of weeds were pulled and estimated a percentage of each from the total load.

2.4.3.2. DASH Effectiveness

In 2025, a total of 50,954 lbs of AIS was removed via DASH. Species percentage was mostly Eurasian watermilfoil (~80%) since the sites were along the shoreline, followed by curlyleaf pondweed (~10%), and coontail and elodia with similar amounts (~5%) (Figure 19).

The maximum square footage that one dive team can cover in a day is 2,500-3,000 sqft. The growing season for plants extends from May to the end of October. It is estimated that the maximum acreage that a single dive crew can manage in a season is eight acres total, but it should be noted that each area would require repeated DASH to be most effective. If DASH was focused along only the shorelines in the west lagoon at a total of 45 acres, it would take a minimum of six years to treat with only a single pass and one dive team.

DASH is an effective method at physically removing turions, the reproductive structures of curlyleaf pondweed, which enable the plant to survive through winter and regenerate in the spring. This should have compounding effects in preventing future population growth.

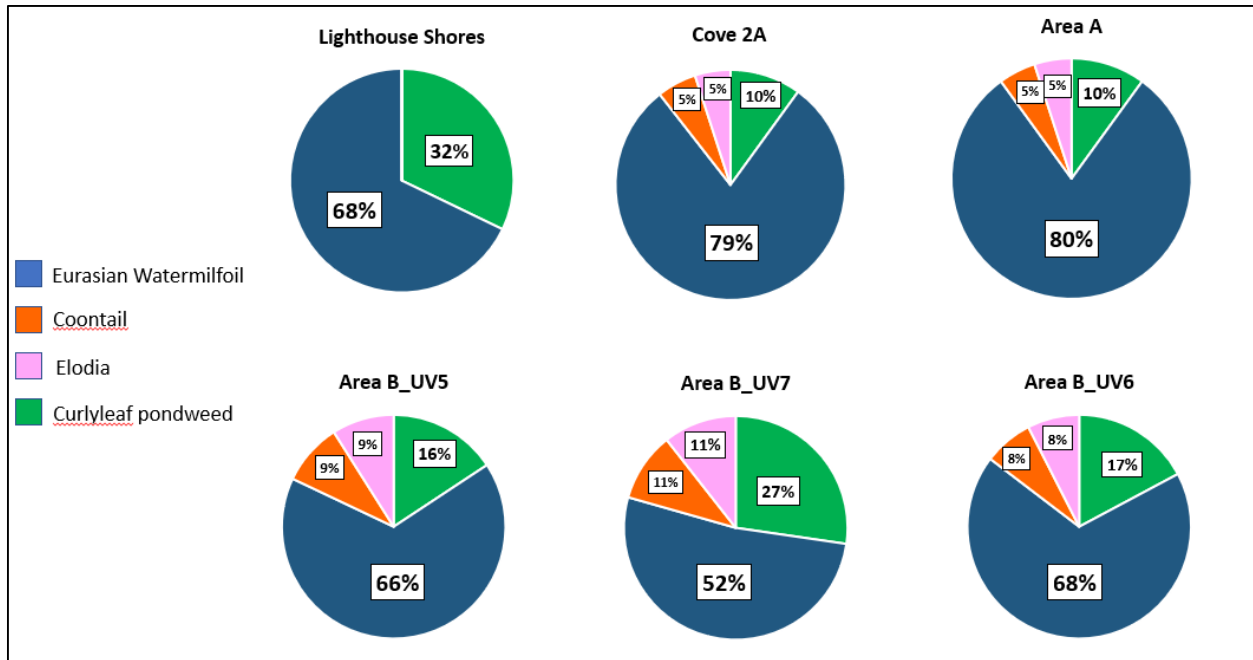


Figure 19. Species percentage harvested via DASH.

3.0 DATA COLLECTION AND MONITORING

Since 2015, TKPOA has conducted a variety of routine surveys to monitor the spread of aquatic weeds in the Keys Lagoons as well as to comply with its WDR. These routine surveys include the following:

- Annual Macrophyte Survey –conducted in late June/early July
- Water Quality Sampling –conducted monthly beginning in June
- Hydroacoustic Scans – conducted twice monthly beginning in late May
- Algae Monitoring – conducted after the first visual identification of algae presence

3.1 MACROPHYTE SURVEY

The information below summarizes some of the key details from the 2025 Macrophyte Survey Report prepared by Sierra Ecosystem Associates (SEA) in accordance with Lahontan Board Order No. R6T-2014-0059 and submitted to Lahontan in January of 2026. Please refer to the 2025 Macrophyte Survey Report for additional information and details (TKPOA, 2025a).

The 2025 point-intercept survey was conducted over the course of five days: July 7 - July 11, 2025. During the survey, a total of 647 points were sampled throughout the Keys Lagoons, including the East Lagoon (113 points), West Lagoon (436 points), and Lake Tallac (98 points). The survey data showed that curlyleaf pondweed, Eurasian watermilfoil, and the native but nuisance species coontail remain the most prevalent aquatic plants in the waterways of the Keys Lagoons.

In the East Lagoon, curlyleaf pondweed and Eurasian watermilfoil continued to dominate shallow areas, while coontail remained most prevalent in deeper waters. The frequency of occurrence for Eurasian watermilfoil increased to 48% in 2025, which means that Eurasian watermilfoil fragments were present in 48% of the 113 point-intercept samples obtained in the East Lagoon. The frequency of occurrence for Eurasian watermilfoil in 2025 is a continuation of an upward trend observed since 2023. Curlyleaf pondweed showed moderate year-to-year variability, with its frequency of occurrence decreasing slightly from 52% of the 107 point-intercept samples in 2024 to 45% of the 113 point-intercept samples in 2025, while still maintaining a strong competitive presence in shallow areas. Coontail occurrence also declined from 71% of the 107 point-intercept samples in 2024 to 67% of the 113 point-intercept samples in 2025, though it remains the dominant species overall in deeper areas.

In the West Lagoon, curlyleaf pondweed remained the most prevalent species with a frequency of occurrence of 64% of the 436 point-intercept samples, only decreasing only slightly from 66% of the 489 point-intercept samples in 2024, but still reflecting its sustained expansion since 2015. Eurasian watermilfoil continued its rebound, following declines observed in 2022-2023, with its frequency of occurrence increasing to 58% of the 436 point-intercept samples in 2025. Frequency of occurrence for coontail declined from 56% of the 489 point-intercept samples in 2024 to 51% of the 436 point-intercept samples in 2025.

Lake Tallac's ecosystem remains dominated by coontail, with a 94% frequency of occurrence in 2025. Eurasian watermilfoil increased substantially to 56% of the 98 point-intercept samples, marking a notable rise since 2023. Curlyleaf pondweed also showed a significant increase in Lake Tallac, reaching a 38% frequency of occurrence, the highest recorded in Lake Tallac. In contrast, watershield declined from 53% in 2023 to 19% in 2025.

Overall, the survey underscores the dynamic shifts in aquatic plant populations within the lagoons, with curlyleaf pondweed notably expanding its presence, potentially displacing other species as well as a resurgence in Eurasian watermilfoil. Additional details such as frequency of occurrence data and percent composition maps can be found in the 2025 Macrophyte Survey Report (TKPOA, 2025a).

3.2 HYDROACOUSTIC SCANS

The application of hydroacoustic technology in the Tahoe Keys began in 2015 as part of TKPOA's efforts to develop an IMP for aquatic weed control. Traditional methods of plant monitoring, such as manual surveys and visual observations, proved to be time-consuming, labor-intensive, and limited in spatial accuracy. Hydroacoustic scanning emerged as a superior alternative, enabling the TKPOA to obtain precise measurements of biovolume, plant canopy height, and the extent of aquatic vegetation across the lagoons.

Lowrance sonar technology operates by emitting sound waves that penetrate the water column and interact with underwater objects, such as aquatic plants. The reflected sound waves are analyzed to produce detailed maps and three-dimensional representations of the submerged vegetation. This data allows for a comprehensive understanding of plant distribution, growth patterns, and density, which are critical for evaluating the effectiveness of invasive plant control methods and identifying high-priority treatment areas. Refer to Appendix A for a full history of the use of hydroacoustic scans in the Tahoe Keys Lagoons.

3.2.1. 2025 Implementation

In addition to collecting biovolume data on plant material harvested, TKPOA collected biovolume data within the water column using hydroacoustic scans. The percent biovolume data depicts the percentage of the water column taken up by vegetation. Twice-monthly scans were performed in the West Lagoon, Lake Tallac, East Lagoon and Lake Tahoe Offshore Zone. This data was overlapped with macrophyte survey data (TKPOA, 2025a) to establish 'hotspots' of certain key species to better implement previously mentioned control methods (Figure 17). Figure 20 shows scans taken in June, August and October 2023-2025 to show beginning, middle and end of season biovolume heat maps in the West Lagoon and Lake Tallac. Figure 21 shows scans taken in the same months for the East Lagoon. Figure 22 shows scans taken in the same months for the Lake Tahoe Offshore Zone.

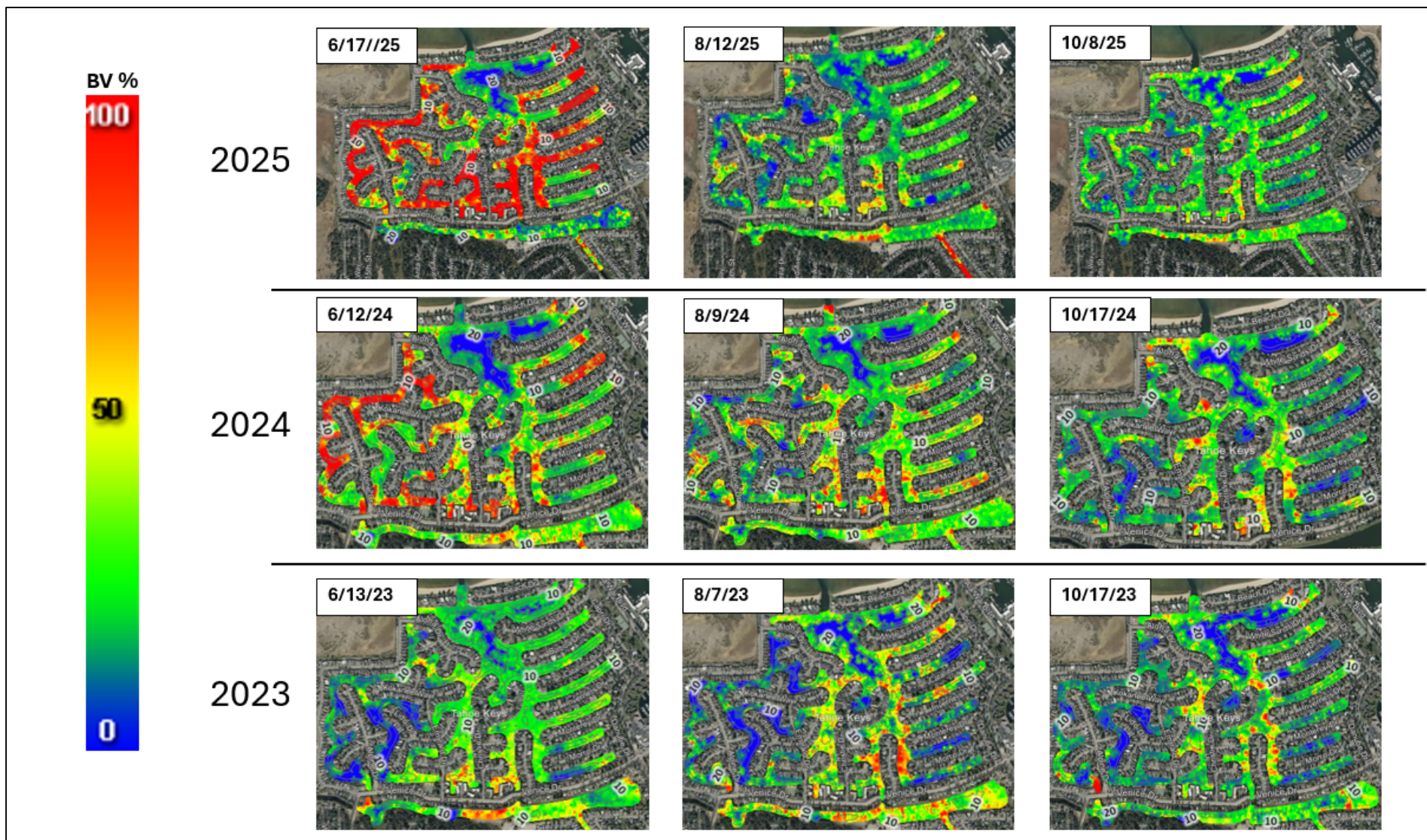


Figure 20. Hydroacoustic scans of the West Lagoon and Lake Tallac from June, August and October of 2025, 2024, and 2023.

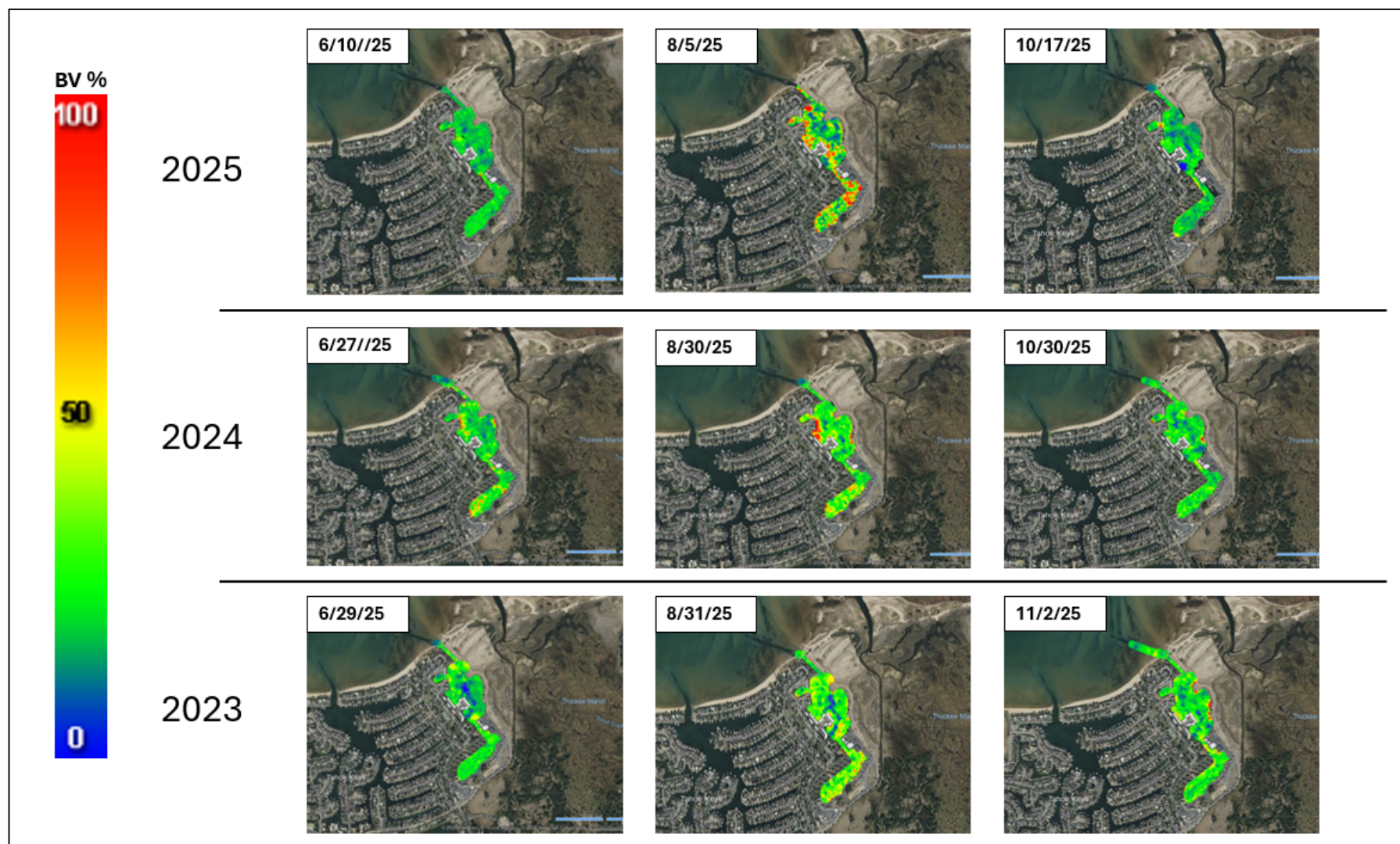


Figure 21. Hydroacoustic scans of the East Lagoon from June, August and October of 2025, 2024, and 2023.

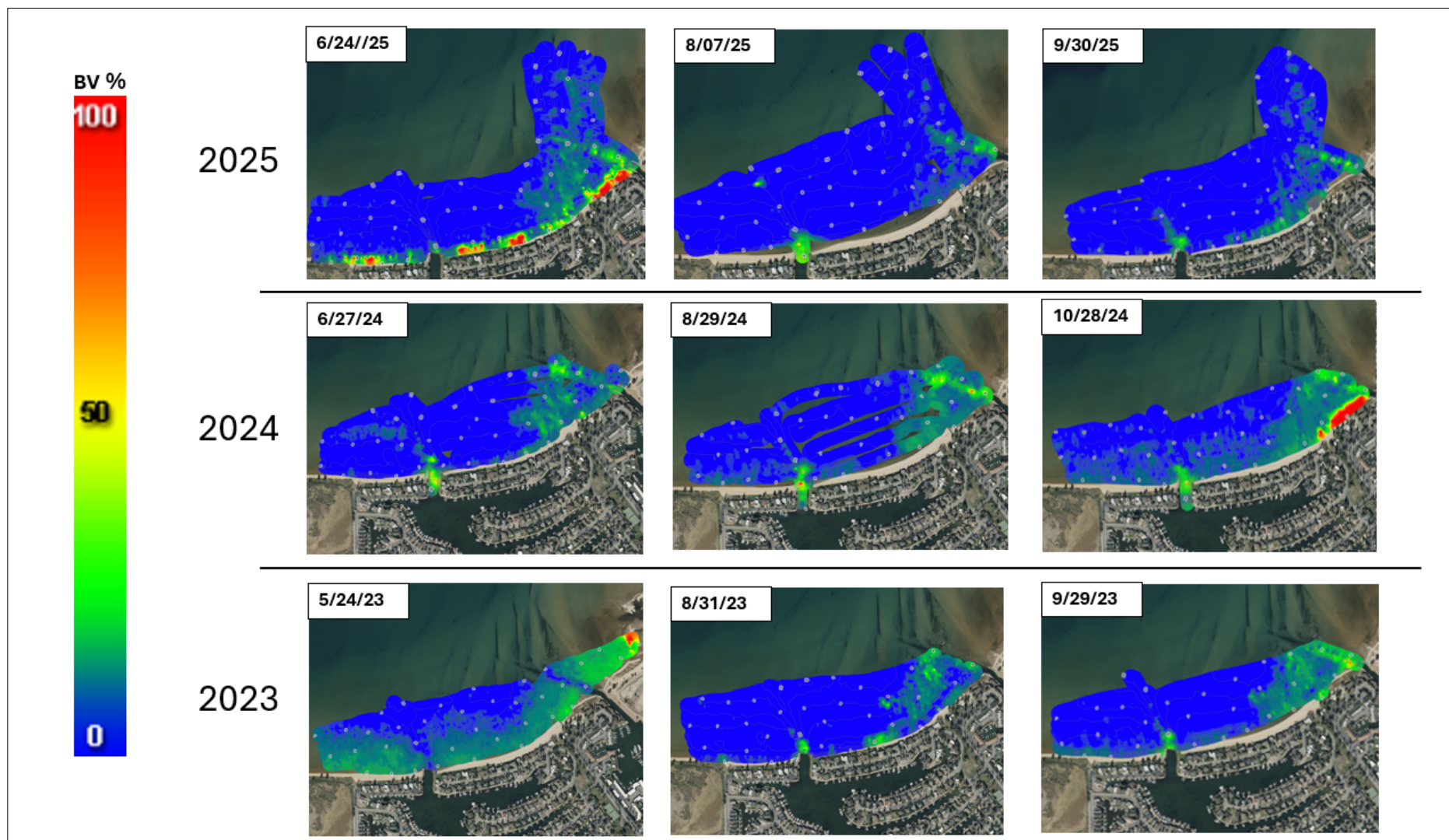


Figure 22. Hydroacoustic scans of the Lake Tahoe from May/June, August and September/October of 2025, 2024, and 2023.

In 2025, a new zone map was created to better identify the locations around the lagoons. This map will be used going forward for all future planning and composition determinations of lagoon characteristics (Figure 23). Figure 24, 25, and 26 display percent biovolume data scanned within the water column and grouped in accordance with these zones.



Figure 23. Tahoe Keys Lagoons zone map created in 2025 for consistent identification and grouping of lagoon areas used in planning and percent biovolume analyses.

3.2.1.1. West Lagoon % Biovolume

Percent biovolume in the West Lagoon in 2025 exhibited an early season peak followed by a decline and stabilization that corresponds with the timing of harvesting activities (mid-June – October). Biovolume percent increased from mid-May to mid-June, with Zones B, C, D, and E reaching peak values of approximately 70-80%, while Zone A peaked at lower levels (40-45%). From August through September, during continued effective harvesting operations, biovolume values converged across zones and remained relatively stable, ranging between 20-35% through the end of the monitoring period in October. Lower percent biovolume in Zone A is influenced by greater water depth relative to other zones, as percent biovolume derived from hydroacoustic surveys represents the proportion of the water column occupied by vegetation. Therefore, in deeper areas, vegetation occupies a smaller fraction of the total water column, resulting in lower percent biovolume value. Deeper waters also reduce the amount of light at bottom depths, limiting plant growth.

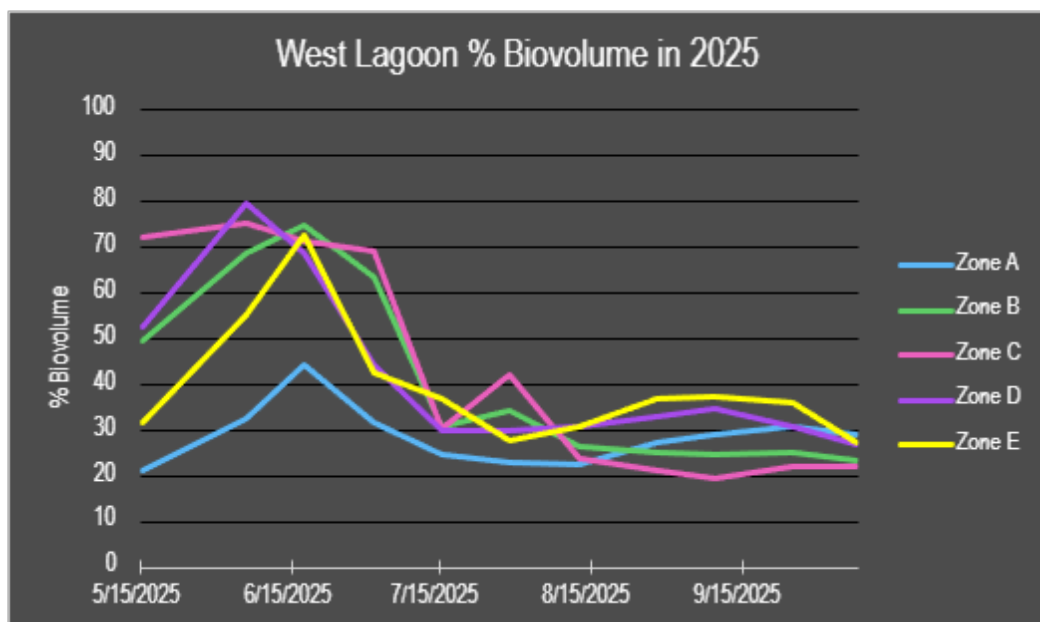


Figure 24. Percent biovolume in the West Lagoon during 2025, grouped by lagoon management zones (Zone A-E).

3.2.1.2. Lake Tallac % Biovolume

Percent biovolume in Lake Tallac showed clear spatial and seasonal patterns related to water depth, management activities and seasonal plant growth. Biovolume increased from mid-May and peaked in July, with the Middle Zone exhibiting the highest values at 65-70%, consistent with its shallower depth and the presence of LFA (LFA has been shown to support macrophyte growth under certain conditions– see Section 2.4.1.2, above). The East and West Zones, which are generally deeper, had lower percent biovolume throughout the season, typically ranging between 20-35 %. The spike in mid-July reflects peak macrophyte growth and a brief increase in biovolume during mid to late August coincide with the sole harvester being taken out of Lake Tallac to harvest the 15th street lagoon between August 18th to August 22nd.

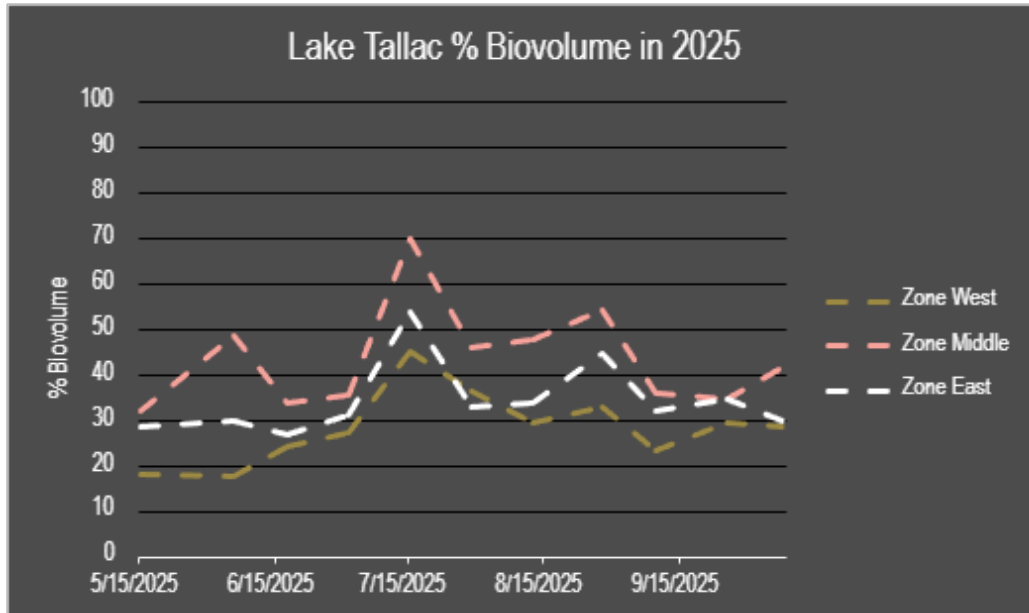


Figure 25. Percent biovolume in Lake Tallac during 2025, grouped by lagoon management zones (Zone West, Middle and East).

3.2.1.3. East Lagoon % Biovolume

Percent biovolume in the East Lagoon ranged between 15% to 45% with two distinct increases observed. The two spikes in percent biovolume align with periods of limited harvesting coverage and peak seasonal growth. The first increase between late June and mid-July, when percent biovolume rose from 18-25% to 25-40%, coincided with peak macrophyte growth and limited harvesting presence, with the only harvesting occurring on July 9, 2025. The second spike occurred in late July, when percent biovolume rose more substantially with Zones 1,2 and 4 peaking at 30-45%. This coincides with a period of peak macrophyte growth and just before the next harvesting window (July 30,2025 to August 4, 2025). With harvesting continuing through October, percent biovolume decreased and was maintained at lower values between 15-25% by September.

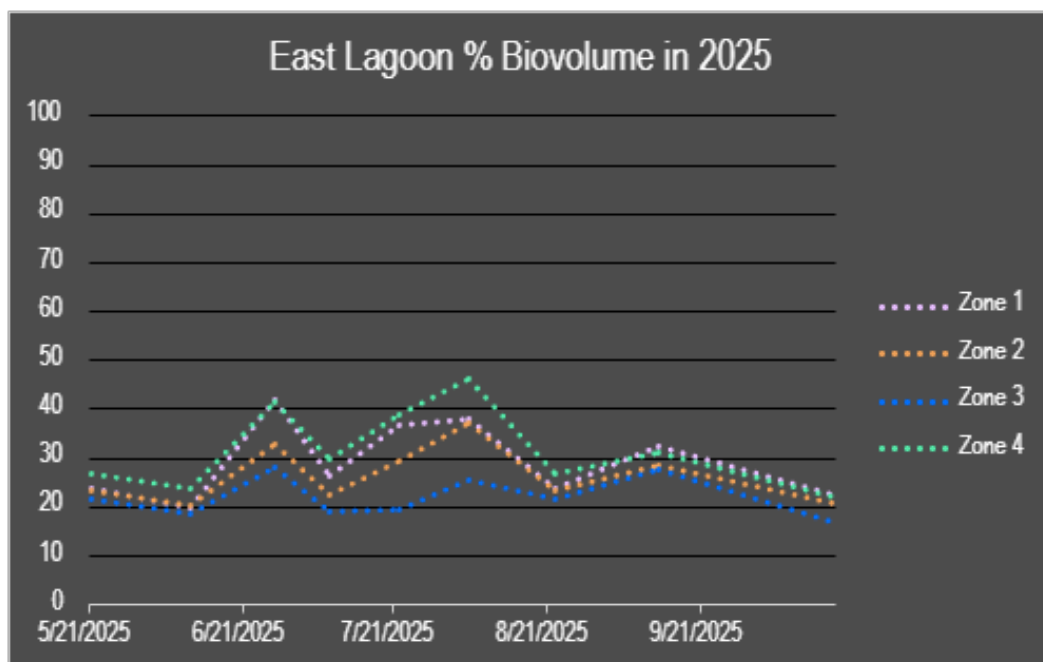


Figure 26. Percent biovolume in the East Lagoon during 2025, grouped by lagoon management zones (Zone 1-4).

3.3 ALGAL BLOOM MONITORING AND MANAGEMENT

TKPOA initiated systematic algal bloom monitoring in 2017 following the detection of harmful algal blooms (HABs) in the lagoons. Since then, monitoring activities have included visual inspections along with targeted sampling for cyanotoxins and laboratory analyses. More recently, evaluation of ultrasonic technology to control HABs has been performed (see section 3.3.1). These efforts aim to protect the public from HABs and develop strategies to mitigate their impacts. Refer to Appendix A for a full history of algal bloom monitoring and management in the Tahoe Keys Lagoons.

In 2025, monitoring and sampling differed from previous years due to budgetary constraints that limited routine laboratory analysis. Several alternative monitoring methods were evaluated such as the ‘stick test’, in which a wooden stick was submerged and inspected for green residue indicative of cyanobacterial presence (GWD Water, 2019). However, this method had mixed results, and more testing is needed to prove reliability. The use of in-house test kits was also evaluated. However, these kits did not analyze for the primary cyanotoxins historically identified in the lagoons (anatoxin-a and microcystin).

Therefore, 2025 cyanobacteria samples were based off visual cues in addition to the pre-holiday assessments per an agreement with the Lahontan Regional Water Quality Regional Control Board (Lahontan Water Board, 2025). When visual indicators of cyanobacteria were present, public advisory signage was installed in accordance with California HABs Program guidance using the established caution, warning, and danger advisory framework (California Cyanobacteria and Harmful Algal Bloom Program [CCHAB], 2019). Samples were also collected at these sites and sent to the lab for cyanotoxin analysis. Results in 2025 met the Caution

advisory level only. Advisory signage was removed once visual indicators were no longer observed, consistent with guidance provided by Lahontan staff.

3.3.1. 2025 Ultrasonic Units Implementation

In 2020, TKPOA began researching potential use of ultrasonic waves to manage algae within the Keys Lagoons. This concept was first proposed to TKPOA's Water Quality Committee (WQC) in 2018-2019 by TKPOA residents. According to current research, the use of ultrasound influences (i.e., reduces) the buoyancy of algae which plays a large role in algal metabolism resulting in its inability to obtain sufficient sunlight and nutrients. Most studies have been limited to laboratory data interpretation due to the complicated environmental conditions in the field (Park et al. 2017). TKPOA purchased two units in 2021 (Figure 27), with the intention of installation and testing during the peak of any cyanobacteria outbreaks.

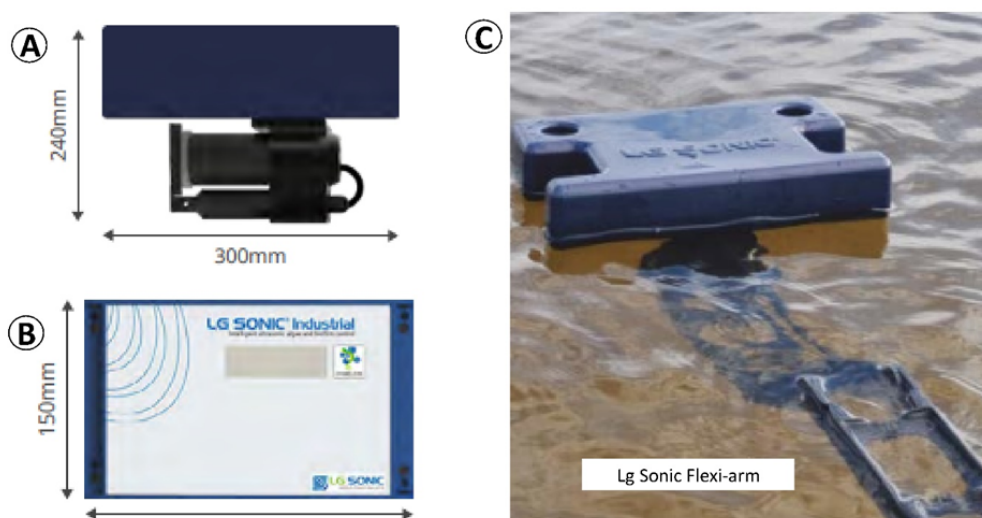


Figure 27. A. Transmitter unit attached to float B. Control Box C. Flexi-arm attachment

Two ultrasonic units were first installed in June 2023 on a dock in CMT Site 5 and CMT Site 13, which are both dead-end areas known to have frequent cyanobacteria blooms (Figure 28). Both units were removed in October 2023. They were reinstalled in June 2024 in the same sites for consistency and again removed in October 2024. In 2025, one unit was placed in Site LFAI instead of CMT Site 5 (now called Site 22B, see Figure 29). The purpose of this switch was because TKPOA has historical HABS data in Site LFAI to better compare before and after use of ultrasound technology. Another unit was continued in CMT Site 13 (now Site 20B, see Figure 29). Before use, the units were calibrated using factory settings as instructed by the equipment manual. The device was visually monitored throughout the season and HAB sampling occurred for analysis. The device was simple to install, unobtrusive, and will continue to be used in future seasons.



Figure 28. LG Sonic unit locations. In 2025, units were placed in Site 20B and Site LFAI.

3.3.1.1. Ultrasonic Effectiveness

In 2025, there was difficulty in maintaining a clear path for sonar emissions from the device due to large build-ups of weeds along the surface at the dead-end area of Site 20B. Even clearing a path weekly, it would immediately be blocked by large accumulations of weeds and debris. The unit in Site LFAI, which was attached to a homeowner's dock pole, also had problems staying in a fixed position due to stormy weather, boat traffic, and water level changes. Therefore, data from 2025 is not very reliable. Due to budget constraints, only 1-2 samples for HABs were taken this season, furthering the lack of data to confirm whether this technology has a significant impact on the formation of HABs. TKPOA will continue to use these ultrasonic units to obtain more data in years to come. To see full details on the installation, use and results from ultrasonic technology in the Tahoe Keys Lagoons, see Appendix C.

3.4 WATER QUALITY MONITORING

In 2016, TKPOA initiated the Baseline Water Quality Sampling Program, and has maintained the program annually. Water quality monitoring has included the use of YSI Pro DSS handheld devices as well as occasional water grab samples for nutrient composition analysis. Additional information on the Baseline Water Quality Sampling Program can be found in the 2016 and 2017 Baseline Water Quality Sampling Evaluation of the Tahoe Keys Lagoons (TKPOA 2017b, TKPOA 2018c). Water quality parameters measured were dissolved oxygen (DO), pH, electric conductivity (EC), turbidity, and temperature (Table 1).

Table 1. Water quality parameters measured with YSI Pro DSS handheld meter in 2025

Parameter	Units
Dissolved Oxygen (DO)	mg/L
pH	standard
Electrical Conductivity (EC)	μS/cm
Turbidity	NTU
Temperature	°C

3.4.1. 2025 Implementation and results

From 2022 to 2024, water quality monitoring occurred according to the CMT monitoring schedule. In 2025, the Baseline Water Quality Sampling/Monitoring Program that began in 2016 was resumed. The original program had 16 sites, but in 2025, 11 sites were added to include more areas of each lagoon. Figure 29 shows the monitoring and sampling locations around the lagoons. Water quality data was measured at surface, middle, and bottom depths of the water column. Nutrient samples were taken three times on June 23, September 9, and October 23 of 2025. Results for nutrients are reported in the Nonpoint Source (NPS) Annual Report submitted by TKPOA (2026) as part of the NPS component of the WDR. In addition to water quality monitoring and nutrient sampling, TKPOA continued its photosynthetically active radiation (PAR) monitoring, initiated in the CMT, on a monthly basis. Results are separated by water body; West Lagoon, East Lagoon, Tahoe, and Lake Tallac.



Figure 29. TKPOA Waterways Department sampling and monitoring locations for 2025.

3.4.1.1. Temperature

Water temperatures in 2025 align with long-standing thermal patterns observed in the Tahoe Keys Lagoons. Nearshore Lake Tahoe remained cooler and more stable, while the West Lagoon, East Lagoon and Lake Tallac exhibited warmer median temperatures across all depths (Figure 30). Lake Tahoe’s median was 18.2 °C, and most observations ranging between 16-20 °C, although early season minimum values were as low as 6.7 °C. In contrast, lagoon sites were consistently warmer. Lake Tallac exhibited the highest temperatures overall, with a median of 20.3 °C, and values up to 25.7 °C, which is most likely due to the strong groundwater influence. (EMKO, 2025b). Both the East and West lagoon had similar temperatures throughout the season both with a median of 20 °C. Temperature ranges within the West Lagoon ranged from 10.0 °C to 24.9 °C and the East Lagoon from 7.7 °C to 23.2 °C. Overall, lagoon waters remained 1-2 °C warmer on average than nearshore Lake Tahoe, likely due to longer residence times,

reduced wind-driven mixing, limited exchange of colder offshore waters and enhanced solar heat absorption associated with low water clarity and elevated biomass.

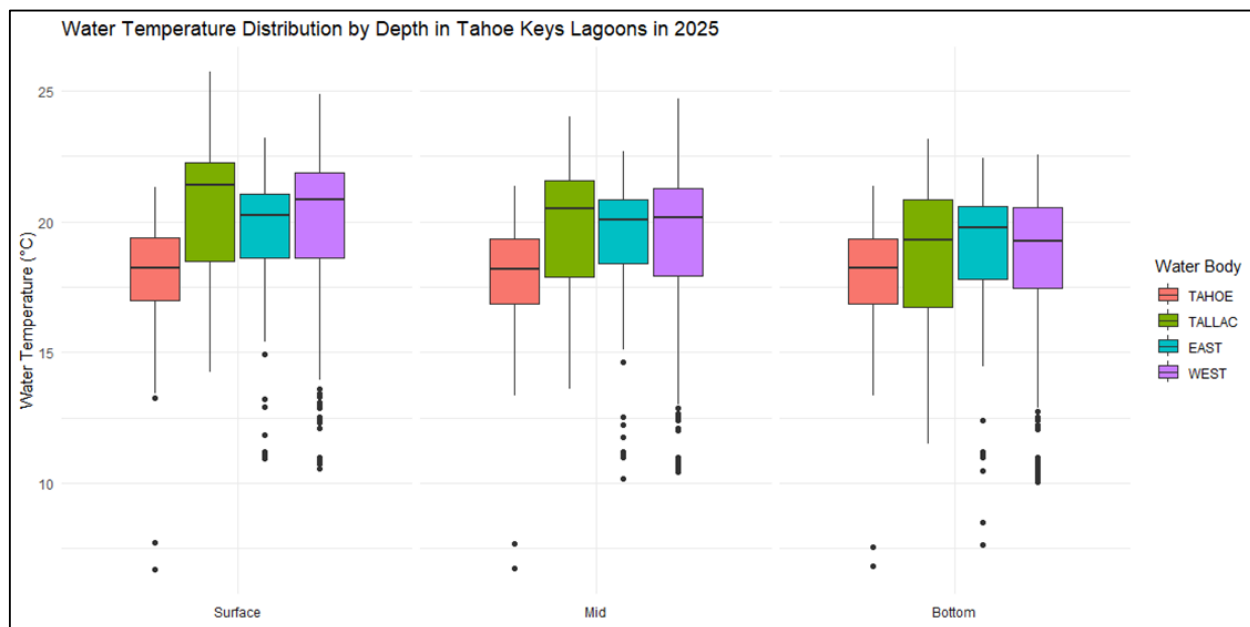


Figure 30. Distribution of water temperature (°C) collected at surface, mid, and bottom depths during the 2025 monitoring season summarized by water body (Lake Tahoe Shore Zone, Lake Tallac, East Lagoon, and West Lagoon). Boxplots represent the median, interquartile range, and observed range of values.

3.4.1.2. pH

PH conditions were generally consistent with recent years. Again, there were clear differences between Lake Tahoe and the Tahoe Keys Lagoons (Figure 31). Lake Tahoe maintained relatively stable pH values with a median of 7.90 and a range from 7.21 to 8.61, indicating lower biological influence. The Lagoons exhibited higher median pH values (8.06-8.63) and greater variability (6.67-10.08). The persistence of higher pH in the Tahoe Keys Lagoons is consistent with longer water residence times and increased productivity.

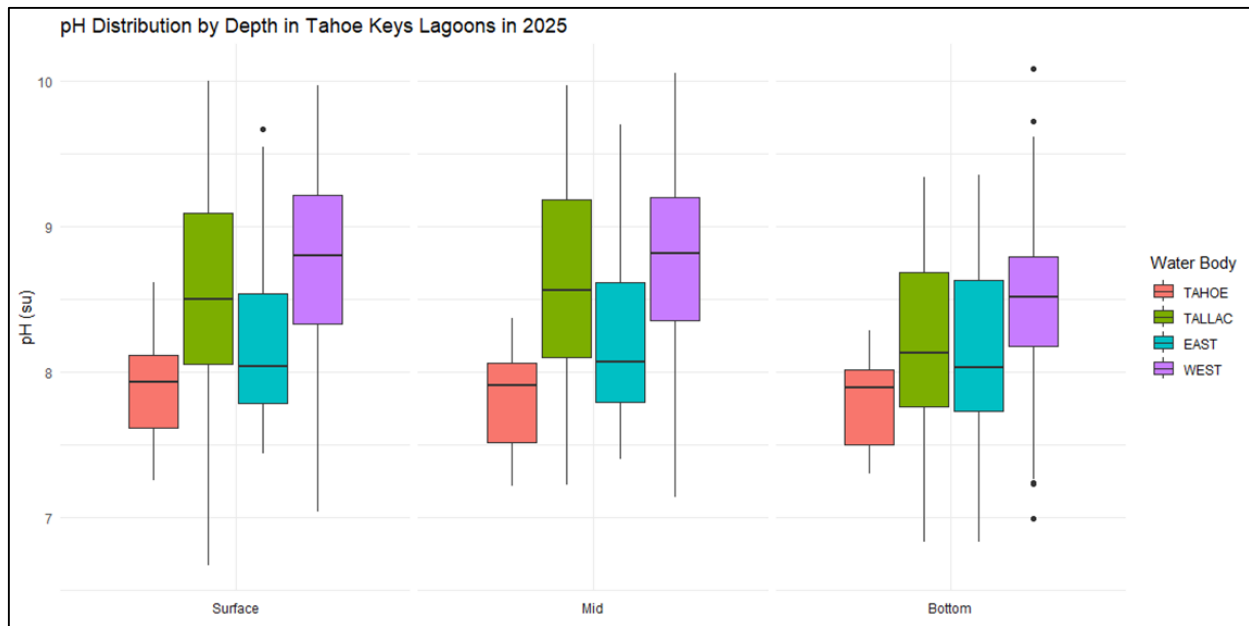


Figure 31. Distribution of pH collected at surface, mid, and bottom depths during the 2025 monitoring season summarized by water body (Lake Tahoe Shore Zone, Lake Tallac, East Lagoon, and West Lagoon). Boxplots represent the median, interquartile range, and observed range of values.

3.4.1.3. Electrical Conductivity

Electrical conductivity (EC) results reflect stable and recurring patterns documented in past years (Figure 32). Lake Tahoe continued to exhibit lower conductivity with a median of 98-100 $\mu\text{S}/\text{cm}$ and most values tightly clustered interquartile range (IQR) of 94.4-98.0 $\mu\text{S}/\text{cm}$ reflecting dilute conditions and strong exchange with offshore waters. Lake Tallac showed substantially elevated conductivity with a median of 352.5 $\mu\text{S}/\text{cm}$ (IQR 341.4-365.4 $\mu\text{S}/\text{cm}$). The East Lagoon displayed moderate conductivity with a median of 102.2 $\mu\text{S}/\text{cm}$ (IQR 96.6-106.5 $\mu\text{S}/\text{cm}$), while the West Lagoon exhibited higher and more variable values, with a median of 117.1 $\mu\text{S}/\text{cm}$ and a broader IQR of 106.7-136.6 $\mu\text{S}/\text{cm}$. Overall, the EC values and ranges in Lake Tahoe, the East Lagoon, and the West Lagoon are comparable. In contrast, the EC values in Lake Tallac are reflective of the water quality of the shallow groundwater that provides the primary inflow to Lake Tallac (EMKO, 2025b). These patterns that have been repeatably observed in prior monitoring years reflect differences in circulation and residence time among water bodies.

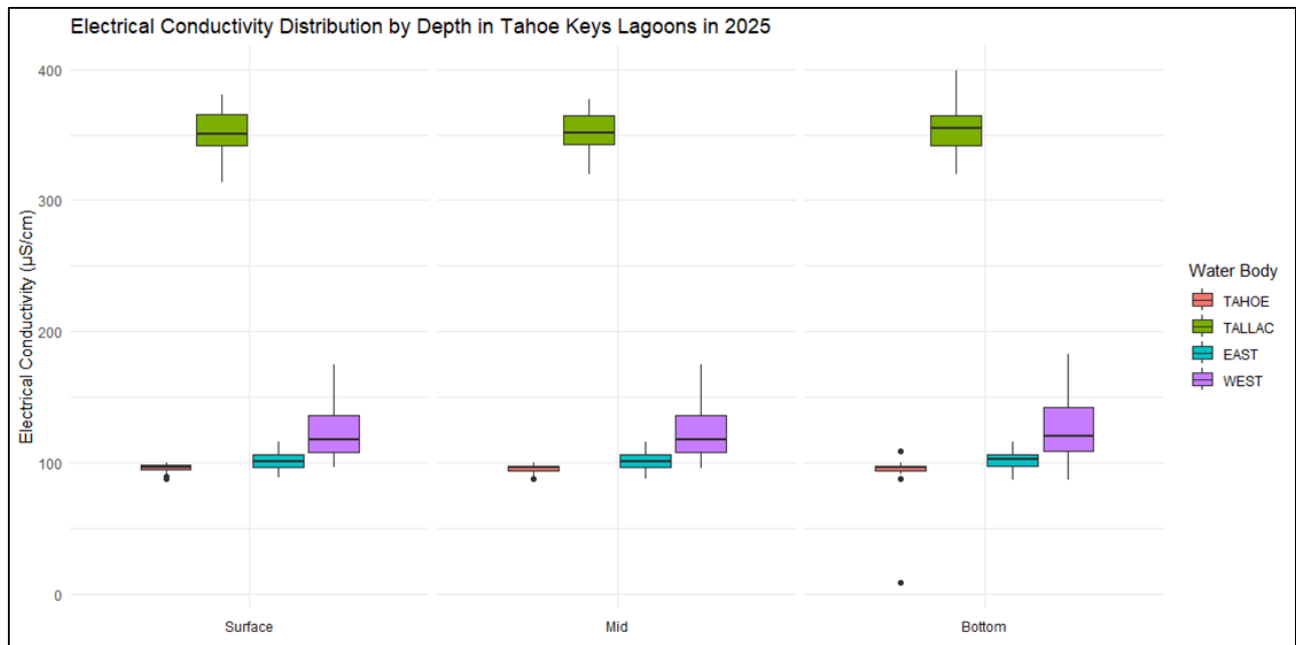


Figure 32. Distribution of electrical conductivity($\mu\text{S}/\text{cm}$) collected at surface, mid, and bottom depths during the 2025 monitoring season summarized by water body (Lake Tahoe Shore Zone, Lake Tallac, East Lagoon, and West Lagoon). Boxplots represent the median, interquartile range, and observed range of values.

3.4.1.4. Turbidity

Turbidity patterns in 2025 are consistent with conditions observed in previous years (Figure 33). Lake Tahoe continued to have low and stable turbidity with a median of 0.06 NTU and a narrow IQR of 0.00-0.22 NTU. Within the Tahoe Keys lagoons, the turbidity levels are generally relatively low compared with, for example, the drinking water maximum contaminant level of 5 NTU. At 5 NTU, any turbidity in the water is imperceptible. Except for a few measurements from the West Lagoon, the median values and upper IQR levels are all at or below 5 NTU.

Despite the low turbidity values, the lagoon water has appreciably reduced clarity. Turbidity is due to suspended solids in the water column that scatter light. Water clarity, on the other hand, can be significantly influenced by dissolved organic matter in the lagoon water. The dissolved organic matter is from the AIS, organic sediment layer, leaves, pine needles, and other biological material that is present within or enters the lagoons. The dissolved organic matter imparts the color to the water and absorbs light passing through the water, reducing the overall visibility.

Episodic physical disturbances, for example from boat traffic, harvesting, and monitoring operations, have the potential to cause substantial (e.g., greater than 25 to 50 NTU or more) increases in turbidity within the lagoons. Based on the data shown in Figure 33, however, any

such increases in turbidity are local and temporary, as they are generally not reflected in the upper ranges of the data shown.

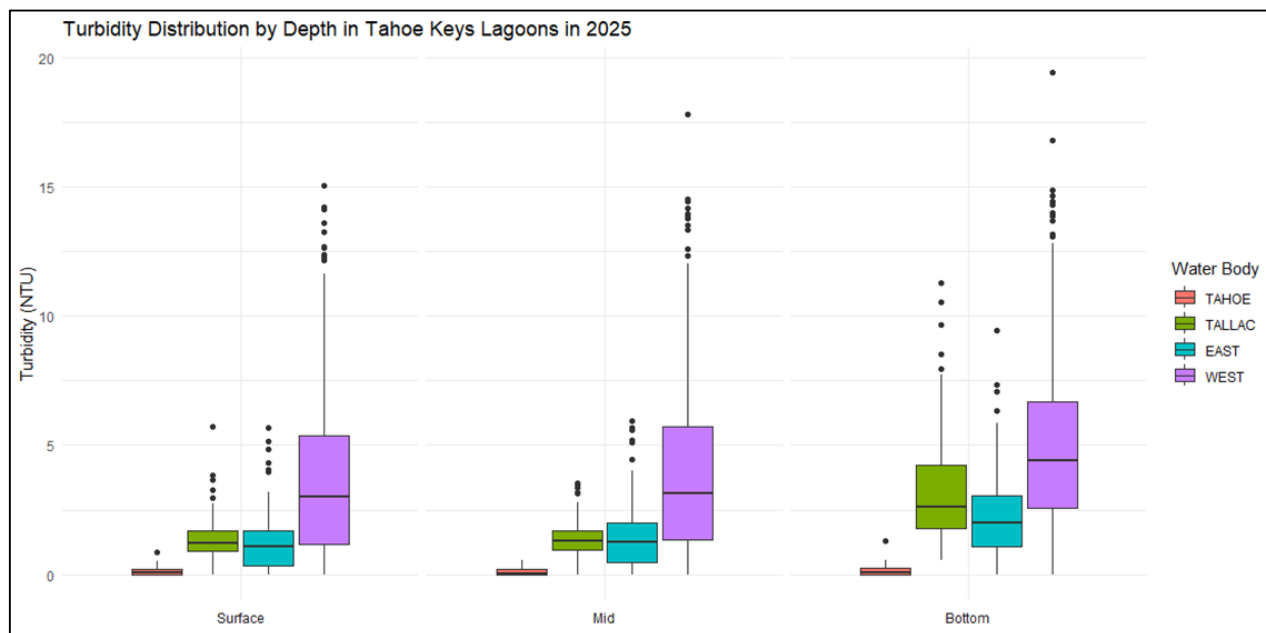


Figure 33. Distribution of turbidity (NTU) collected at surface, mid, and bottom depths during the 2025 monitoring season summarized by water body (Lake Tahoe Shore Zone, Lake Tallac, East Lagoon, and West Lagoon). Boxplots represent the median, interquartile range, and observed range of values.

3.4.1.5. Dissolved Oxygen

DO concentrations were consistently sufficient to support aquatic life in surface and mid-depth waters across all water bodies, with medians ranging from 7.8-8.4 mg/L. However, greater variability was observed at the bottom depth within the lagoon systems, particularly in Lake Tallac and the West Lagoon, where bottom waters occasionally declined below 5 mg/L (minimum values of 2.6 mg/L and 2.4 mg/L respectively) (Figure 34). These patterns are consistent with reduced circulation near the sediment-water interface, elevated organic matter, and higher biological oxygen demand in lagoon environments. Lake Tahoe maintained relatively stable DO across depths, reflecting stronger mixing and lower sediment influence.

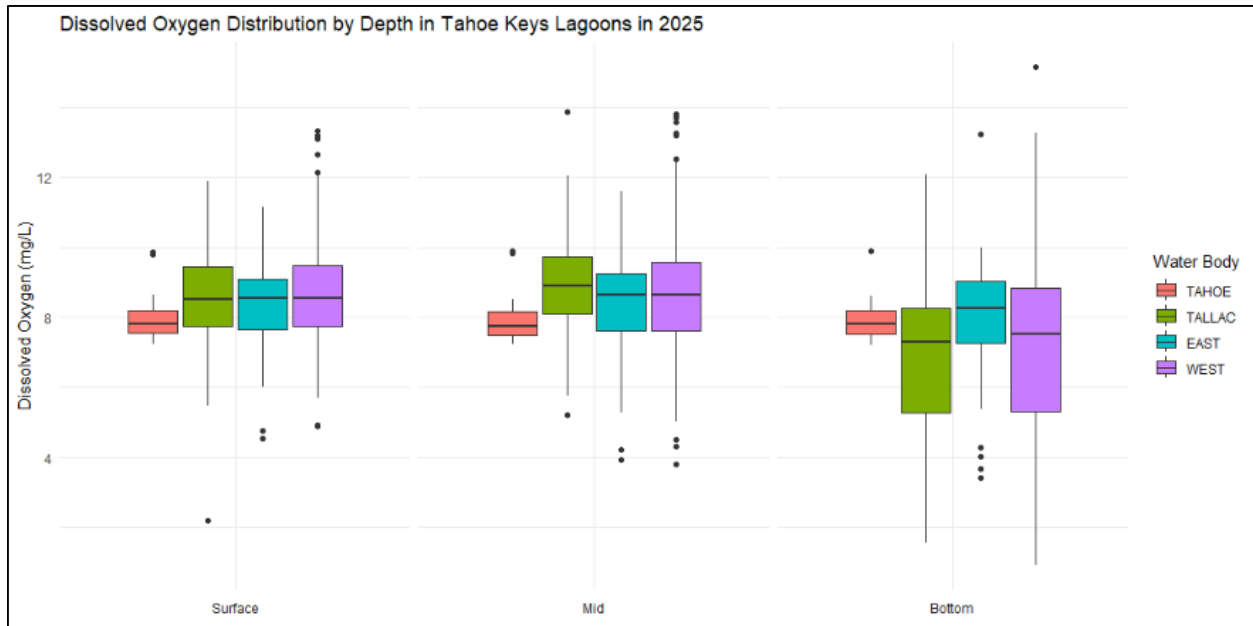


Figure 34. Distribution of dissolved oxygen (mg/L) collected at surface, mid, and bottom depths during the 2025 monitoring season summarized by water body (Lake Tahoe Shore Zone, Lake Tallac, East Lagoon, and West Lagoon) and sampling depth. Boxplots represent the median, interquartile range, and observed range of values.

3.4.1.6. Photosynthetically Active Radiation (PAR)

PAR measurements collected in 2025 demonstrate clear spatial and seasonal differences in light availability among monitored water bodies. Nearshore Lake Tahoe (Figure 35) consistently exhibited high surface PAR and gradual attenuation with the depth throughout the monitoring period, with substantial light penetration maintained at bottom depths. In contrast, the East Lagoon (Figure 36), West Lagoon (Figure 37) and Lake Tallac (Figure 38) showed rapid declines in PAR with depth, indicating shallow photic zones characteristic of lagoon systems with reduced flushing and elevated biological activity. Across lagoon sites, PAR was reduced by more than half within approximately 6.5-8ft, with near-zero values commonly observed below 10-13ft, particularly during mid to late summer. Seasonal patterns were evident across all water bodies. The highest surface PAR occurred in May - August, while light penetration to bottom depths was generally greatest earlier in the season before peak algal and macrophyte growth. It then declined during summer and fall with reduction of water clarity and shading from plant growth.

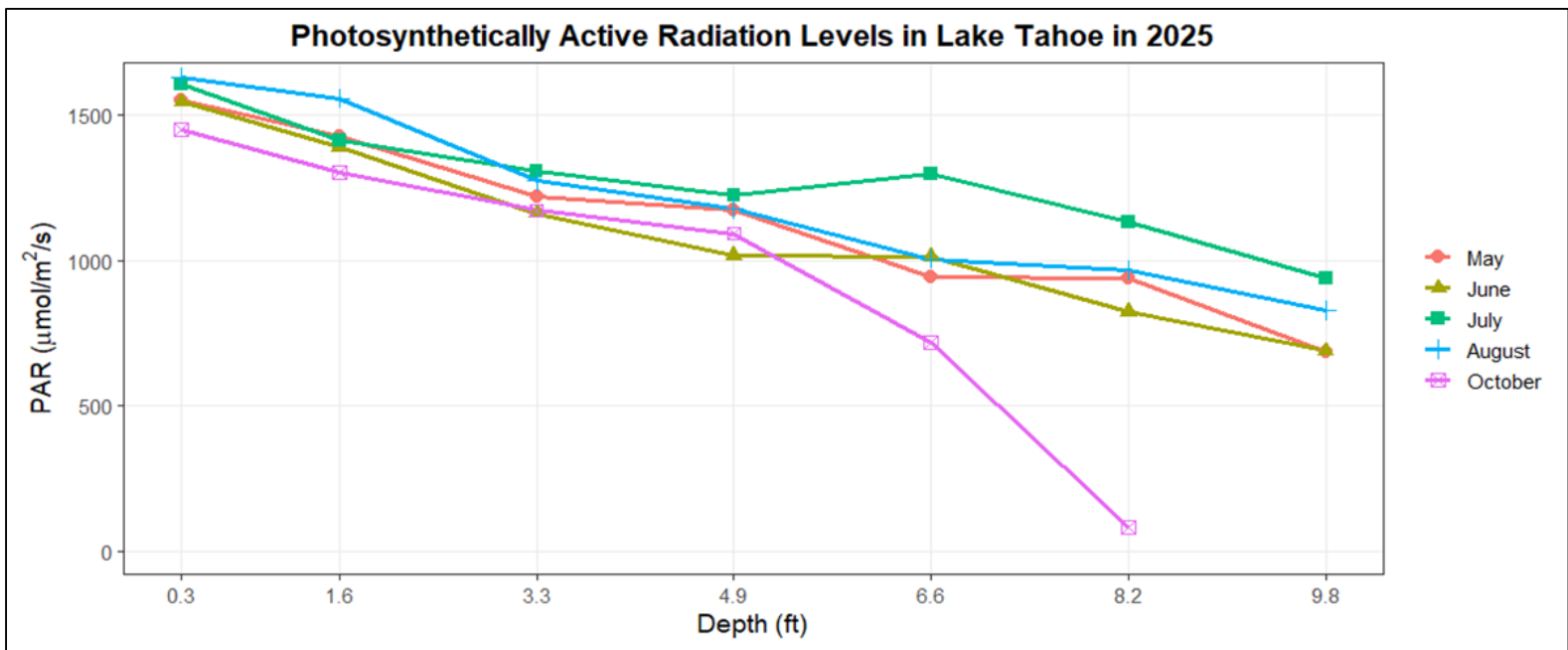


Figure 35. Photosynthetically active radiation ($\mu\text{mol}/\text{m}^2/\text{s}$) profiles measured in Lake Tahoe Shore Zone during the 2025 monitoring season, shown by depth for monthly sampling events (May-October).

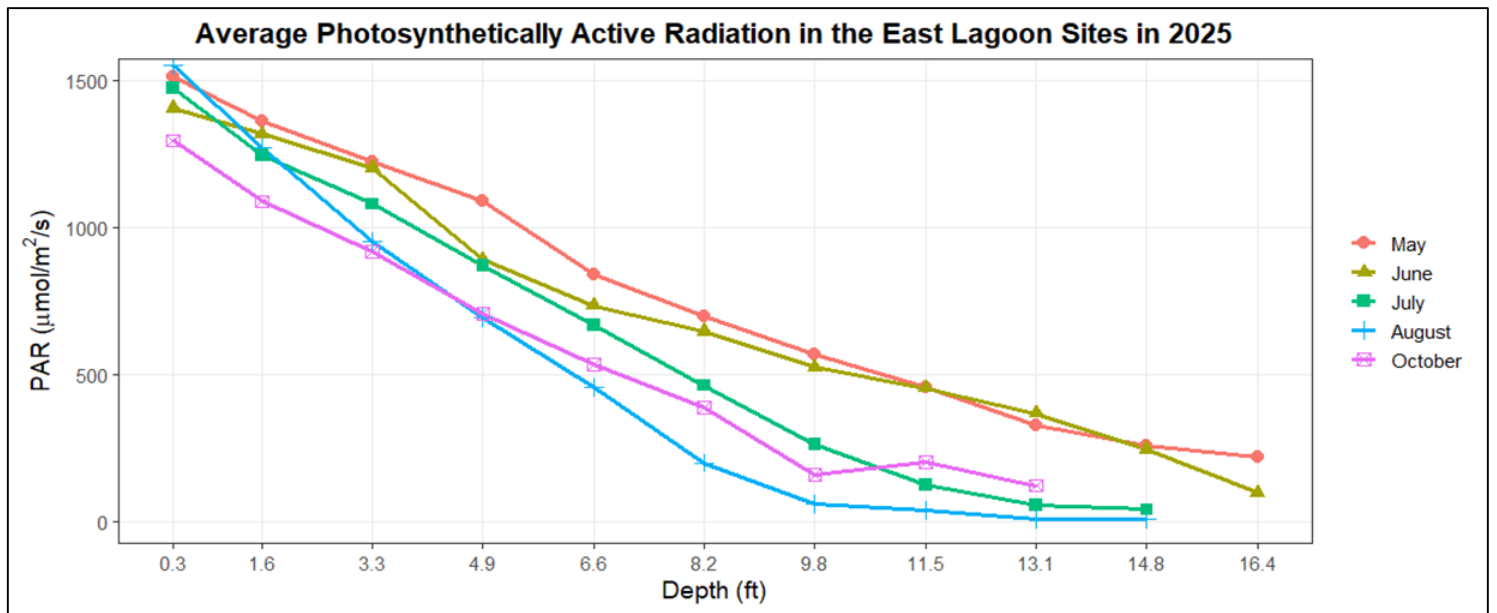


Figure 36. Photosynthetically active radiation ($\mu\text{mol}/\text{m}^2/\text{s}$) profiles measured in the East Lagoon during the 2025 monitoring season, shown by depth for monthly sampling events (May-October).

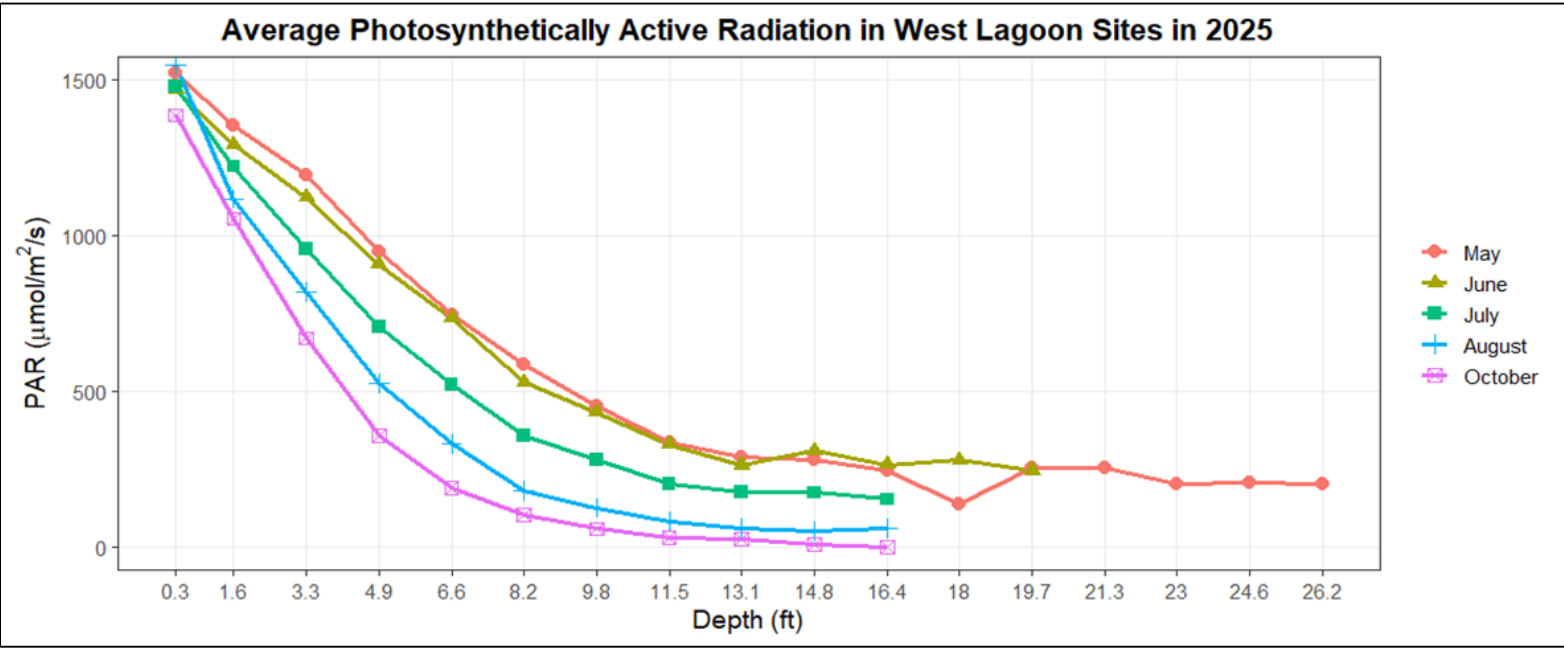


Figure 37. Photosynthetically active radiation ($\mu\text{mol}/\text{m}^2/\text{s}$) profiles measured in the West Lagoon during the 2025 monitoring season, shown by depth for monthly sampling events (May-October).

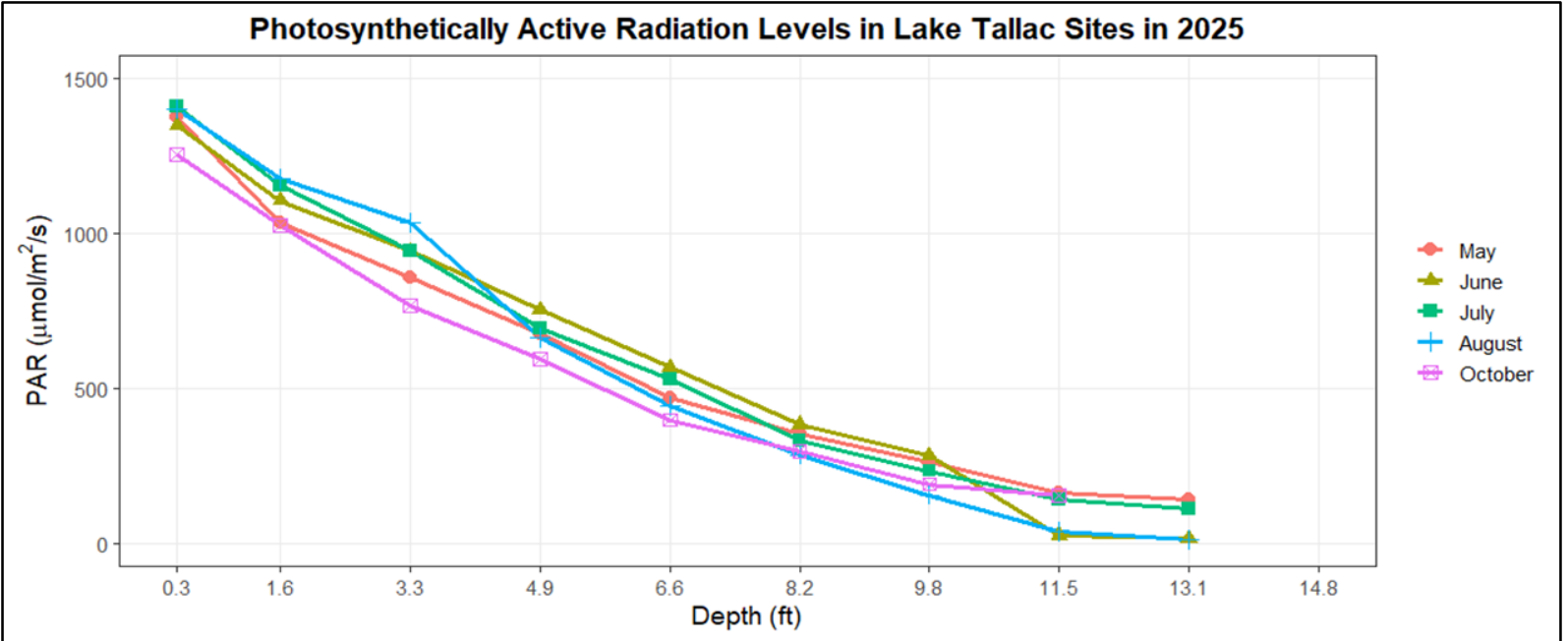


Figure 38. Photosynthetically active radiation ($\mu\text{mol}/\text{m}^2/\text{s}$) profiles measured in Lake Tallac during the 2025 monitoring season, shown by depth for monthly sampling events (May-October).

4.0 CONTROL METHOD PILOT STUDIES

4.1 PROCELLACOR

Curlyleaf pondweed (CLP) is one of the most rapidly spreading invasive aquatic species in Lake Tahoe and in the Tahoe Keys lagoons. The life-cycle of CLP provides the plant with late summer and fall conditions for dispersal of thousands of “turions” that are formed on growing plants during June and early July. When the mature plants begin in late summer, many of the newly formed turions, which have sunk to the bottom begin to sprout and form roots and new shoots and leaves. Each sprouted turion continues to grow until water temperature decreases below 10 -12 C, after which they remain “dormant” until water temperatures rise in early spring.

If the newly sprouted turions can be controlled (killed) in the fall, this will greatly reduce the “recruitment” of new plant in the spring. Combining fall management of turions with spring control methods will provide the most effective approach to reduce CLP impacts, and to reduce the likelihood of CLP movement to Lake Tahoe from the Keys lagoons.

CLP can be controlled by Endothall herbicide; however, this is primarily a “contact” herbicide so it may not affect the roots or turions except for the exposed leaves. The CLP turions may recover from the endothall treatment. The systemic herbicide ProcellaCOR, recently approved (registered) for use in California, may provide longer-term control since it can move to the roots and to the shoot-initiating areas in the turions.

However, the manufacturer does not list CLP as one of the aquatic plants that ProcellaCOR may control. Therefore, a mesocosm study was conducted to assess the efficacy of two rates of ProcellaCOR application (5 and 10 ppb) on newly sprouted Curlyleaf pondweed turions. The mesocosm study incorporated three replicates for each application rate and for the control.

Preliminary results from study are included in (Appendix D). Analysis of the data and applicable conclusions will be provided in a future report as part of the long-term IMRP process.

4.2 ORGANIC SEDIMENT REMOVAL (OSR)

The Tahoe Keys Waterways cover around 170 acres and were constructed in the late 1950s and early 1960s as part of development of the Tahoe Keys community. During construction, the lagoon bottoms were formed using hard-pack fill. After decades of biological production and deposition, a layer of decomposed aquatic plant material, referred to as the organic sediment layer, has accumulated above this hard substrate. Organic sediments can act as a reservoir to cycle nutrients back to the aquatic plant growth from which it originated. This cycling of nutrients can influence aquatic plant growth, including AIS, and potentially stimulate HAB formation.

The thickness of this organic sediment varies widely throughout the lagoons as well as between shoreline and mid-channel locations, complicating efforts to estimate total sediment volume. Using a standardized assumption of a 3-foot organic sediment depth across the 170-acre

lagoon system yields an estimation of 510 acre-feet or 822,800 cubic yards of organic sediment currently present within the waterways.

Removing the organic sediment layer has been identified by TKPOA as an option to significantly decrease the nutrient availability for AIS. Additional benefits include the reduction of the curlyleaf pondweed turion seed bank that may be present within the organic sediment layer and removal of established invasive and nuisance plants that may be rooted in the organic sediment layer.

A pilot project was designed to evaluate the feasibility of using suction dredging as the main method of removal. Suction dredging, however, produces large volumes of water that would be uneconomical to either transport away from the site or to treat to Basin Plan water quality objectives. Thus, the objective of the pilot study was to assess whether physical filtration of the slurry produced during suction dredging (i.e. organic sediment plus water) would result in water quality filtrate that would be acceptable to return to the Tahoe Keys Lagoons under a temporary exemption to certain water quality criteria.

Results and methodology are presented in the Draft Tahoe Keys Organic Sediment Removal Pilot Project 2025 report in Appendix E.

5.0 DISCONTINUED WEED CONTROL STRATEGIES AND PROJECTS

Since the 2014 issuance of the WDR, TKPOA has evaluated, and in many cases, tested, innovative methods of aquatic weed control. Table 2 below describes activities that have been tested and discontinued including the time of the activity's implementation, and the year of discontinuation. More details about each of these activities can be found in Appendix F.

In addition to the activities described in Table 2, there are a variety of additional aquatic weed control strategies that TKPOA has explored but not attempted due to determinations that the method was ineffective, technologically infeasible, economically infeasible, and/or not permissible by regulatory agencies or by federal or California state law. A detailed overview of all strategies TKPOA has considered (including biological control methods such as the introduction of milfoil weevils) can be found in Chapter 3.0 of the Amended Application for Exemption to the Basin Plan Prohibition on the Use of Pesticides for the Tahoe Keys West Lagoon Integrated CMT submitted to Lahontan by TKPOA in July 2017. Considerations for all mechanical methods can be found in Evaluation of Mechanical Control Methods for Aquatic Weeds in the Tahoe Keys Lagoons (TKPOA 2017c).

The circulation and treatment system continues to be non-operational. The history of the current system can be found in Appendix A. Evaluation of what kind of circulation will be needed for the lagoons to improve water quality, reduce harmful algal blooms, and restore more natural ecosystem functions in the lagoons are to be considered in the overall long-term plan.

Table 2. Discontinued weed control strategies and projects in the Tahoe Keys Lagoons

Activity	Duration of Implementation	Discontinued	Rationale for Discontinuation
Rototilling/ Rotovating	1988	1988	Questionable efficacy and potential to increase infestations of curlyleaf pondweed are the main reasons TKPOA has not pushed harder for rotovating. In addition, disruption of hydrosol by rototilling can lead to increases in turbidity above permitted threshold levels. In 2017, TKPOA proposed a test pilot for rotovating as a control method to Lahontan and TRPA, but the cost and extensive environmental review required, ultimately triggering CEQA/TRPA review, and potentially an EIR/EIS, were a deterrent to attempting a small-scale test. A synthesis of the discussion regarding rototilling and regulatory concerns is included in final notes from the June 14, 2017, regulatory meeting (available on request).
Dredging	2015	2016	The cost, regulatory challenges, and questionable efficiency of dredging as a longterm control method are the major deterrents for the use of dredging as an AIS control strategy. The West and East Channel are occasionally dredged to ensure navigation. The West Channel was most recently dredged in 2015. A detailed evaluation of dredging as an aquatic weed control method in the lagoons can be found in the CMT EIR/EIS.

Large Scale Bottom Barriers	2017	2017	Sediment buildup and regrowth of plants on top of the barriers (in the deposited sediment) has limited barrier effectiveness in most areas, though TKPOA has had success with installation of bottom barriers in Lake Tallac where there is minimal boat traffic. In Lake Tallac, there has typically been less sediment built-up on top of the barriers and plant growth was limited. TKPOA has observed that in areas with higher boat traffic, sediment builds up on top of the barriers more rapidly. TKPOA has generally concluded that using large-scale bottom barriers in densely infested areas with high boat traffic provides limited control of aquatic plants. In addition, large scale bottom barrier installation is expensive, approximately \$71,250 for the 0.75-acre test project conducted in 2017.
Yellow Pond Lily Weed Abatement	1 month	2020	Deemed ineffective due to the high re-growth rate of Yellow Pond Lilies.
Floating Treatment Wetlands (FTW)	2020	2022	Deemed ineffective due to results from 2020 and 2021 monitoring.
Seabins	2019	2022	Temporarily discontinued until completion of the CMT Project. Deemed unsuitable for the West Channel due to swamping by boats and waves.
Internal Bubble Curtains	2020	2022	Temporarily discontinued until after completion of the CMT Project.
Information on discontinued aquatic weed control methods is available from the 2016 Mechanical Control Evaluation (TKPOA 2017c), 2016 Mesocosm Study (TKPOA 2017d), and the 2017 Non-Chemical Control Methods Test (TKPOA 2018d).			

6.0 PROPOSED PROGRAM FOR AQUATIC WEED CONTROL IN 2026

The focus for 2026 will continue to ensure progress in aquatic weed management while forming large-scale application strategies. Insights gained from the data collected from the CMT will guide the development of long-term, large-scale approaches.

Operations in 2026 will include ongoing initiatives such as baseline water quality monitoring, algal bloom management, operations of at least one LFA system, continued use of UV-C treatments, selective DASH treatments, along with regular harvesting and skimming operations. Water quality staff will monitor the yellow pond lily infestation on the north side of the stormwater diversion structure and DASH will be deployed to remove any regrowth. Homeowners will continue to be encouraged to participate in the Bottom Barrier Program and progress will be tracked. Enhanced signage at the Boat Back-Up Station will be redeployed and permanent mountings will be presented for approval to the Board of Directors. Patrol boats will resume their post at the channel entrance to collect fragments from the bubble curtain and boat propellers along with encouraging boater compliance with the Boat Back-Up Station. Enhanced DASH and fragment work will be focused on the West Channel and the shoreline areas inside and outside of the channel. Outreach specifically aimed at sailboat owners will highlight their large keel as a fragment collection spot that needs removal before entering Lake Tahoe.

Through collaboration with TRPA and TRCD, the 15th Street lagoon AIS weeds will be heavily treated using DASH and bottom barriers to begin the eradication of the infestation and secure the 3-point barrier system to prevent spread into Pope Marsh.

Methods for tracking organic sediment thickness and composition will continue to be evaluated and tested to further understand the nutrient capacity and removal opportunities. While considering nutrient reduction options, HABs have been identified as a possible outfall from those activities. HABs identification, mitigation and prevention options will be sought after in conjunction with nutrient research.

7.0 LIST OF PREPARERS

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9.0 APPENDIX A – HISTORY OF CURRENT METHODS

History of Harvesting

Aquatic plant harvesters are large machines that use a series of metal teeth to cut and remove aquatic plants in the upper portion of the water column. The teeth of the harvesters reach approximately five feet below the surface of the water. Historically, cut weeds have been collected and transferred to holding platforms and then trailered to the Dover Corporation yard for decanting. In 2023, cut weeds were transported directly from collection points to the South Tahoe Material Recovery Facility where the harvested aquatic biomass was mixed with other green waste. After a few days/weeks, the mixed green waste was hauled out of the Tahoe Basin for disposal at a contracted composting facility in Nevada. Mechanical harvesting offers immediate improvement of access and navigability to waterways for boating and other recreation and reduces the annual nutrient loading in the lagoons during die-off of the aquatic plants. The large harvesters operated by TKPOA have been efficient in clearing thousands of pounds of plant material in a relatively short time.

Since the 1970's, harvesting has been the primary method to help maintain navigable waterways and other beneficial uses such as contact and non-contact water recreation¹. One of the primary objectives of the harvesting is to maintain a minimum of three feet of vessel hull clearance in the channels to minimize the potential for weeds to be transported from the lagoons into Lake Tahoe by watercraft.

In any given year, the schedule for harvesting is dictated to some degree by the timing of weed growth in relation to the boating season. The timing of weed growth is directly correlated with water temperature and light. Generally, once water reaches between 13°C – 15°C, the plants begin rapid growth (Smith et al. 1990, Anderson 2017). Therefore, in years following winters of drought, when the lake level is low and lagoon water temperature warms quickly in the spring, plant growth has occurred as early as mid- to late April, necessitating an earlier start to harvesting operations. In spring and early summer 2023, the lake level was high, and the lagoons warmed moderately slowly. TKPOA began harvesting in mid-June 2023, except for CMT project areas where minimal harvesting occurred. During the growing season, TKPOA continuously operates harvesters during working daylight hours (approximately 8am to 4:30pm daily). For many years, TKPOA's harvesting season extended through Labor Day. Beginning in 2019, TKPOA extended harvesting operations through October to remove as much plant material as possible from the lagoons before winter. This helps reduce nutrient recycling in the lagoons associated with plant decomposition.

To ensure that all the lagoons (West Lagoon, East Lagoon, and Lake Tallac) are harvested, TKPOA organizes its harvesting schedule by mapping the lagoons into sections and assigning designated times for harvesting activities. This allows each section of the Tahoe Keys Lagoons to be harvested every 21 days. TKPOA also employs skimmer boats in the West and East Lagoons to collect weed fragments generated by the harvesting process. Generally, skimmer boats follow the harvester to “clean” a lagoon area after harvesting. In 2023,

skimming activities were altered to follow the harvesters to “clean” each area after harvesting occurred, either the morning after, or later that same day. Harvesting and skimming schedules are created prior to the start of harvesting operations (updated monthly) and sent via email (E-Blast’) to homeowners so that homeowners are aware when harvesting will occur near their docks. The schedule and updates are also posted on the TKPOA website.

TKPOA currently operates four hydraulically controlled harvesters. Obstructions such as docks, pilings, and moored boats prevent the use of large mechanical harvesters in smaller areas. The plants in target areas must be harvested multiple times during the growing season to maintain navigable conditions. Weed fragments collected by skimmers and harvesters in 2023 were transferred to trailers, hauled to and then mixed with green waste at the South Tahoe MRF, and then transported to a composting site outside the Tahoe Basin. In addition to the harvesters, four dock boats were used to collect (skim) fragments in the Tahoe Keys. The TKPOA Omni Cat, barges, and fragment collection boats used in previous years were deemed unnecessary for fragment collection in 2023 as the use of dock boats kept the fragment control operations on track throughout the season.

TKPOA maintains a robust fragment collection program associated with its harvesting operations. This program focuses on skimming the lagoons for viable plant fragments after the harvesters pass through. For several years, TKPOA has employed multiple small skimming boats, and since 2018 has also operated the Omni Cat (noted above), a passive trash/debris skimmer vessel designed for relatively sheltered waters. The vessel, 23’ long and 8’3” wide, is manufactured with marine grade aluminum. In 2023, the decision was made to simplify the fragment collection program by using only dock boats for skimming. Due to the operational characteristics of the dock boats, the program has become more efficient. TKPOA has invested significantly in fragment control since harvesting began in the 1980s. In addition to investment in and deployment of skimmer boats and combined harvester/skimmer boats (like the Omni Cat, Tiger Cat and Aqua Harvester discussed above), TKPOA also collects fragments from the West Lagoon Boat Back-Up Station area and the West Channel bubble curtain area.

History of Boat Back-Up Station

The Boat Back-Up Station was deployed in 2016 (with funding support from The League to Save Lake Tahoe) just inside the West Channel of the West Lagoon as a method to reduce the transport of aquatic weed fragments from the lagoons into Lake Tahoe via watercraft. The Boat Back-Up Station is a designated area where a vessel headed toward Lake Tahoe from the lagoons is notified with signage to stop, reverse its propellers and back up approximately ten feet to dislodge any weed fragments attached to the boat’s propeller(s) or sailboat’s keel. TKPOA’s Boat Back-Up Station project includes an education and outreach component with a goal to educate homeowners and vacationers about AIS in the Tahoe Keys, including the potential impacts of transporting fragments out into Lake Tahoe.

History of West Channel Bubble Curtain

The West Channel bubble curtain produces a “V”-shaped barrier of bubbles in the water column. The “V” formation drives submerged plant fragments to the edges of the channel, where they can be collected and removed. The curtain of bubbles is created from perforated tubing running across the bottom of the channel that is connected to an air compressor. The air compressor constantly pushes air through the tubing, resulting in a sheet of bubbles that rise continuously to the surface. The intention of the bubble curtain is to contain stray plant fragments without impeding boating activity. A bubble curtain across the West Channel was first proposed by the TKPOA Stakeholder Committee as a potential technology to impede the spread of plant fragments from the Keys Lagoons into Lake Tahoe proper.

In 2018, with funding support from The League to Save Lake Tahoe, divers hired by TKPOA installed the West Channel bubble curtain. Since the program’s initiation, TKPOA has monitored and improved-upon bubble curtain operations.

In the spring of 2022, TKPOA installed a second bubble curtain in the West Channel, creating a double bubble curtain. The effectiveness of bubble curtains is dependent on the volume of air injected into the water column, the size of bubbles, and the number of diffuser lines. The installation of a second bubble curtain increases the bubbles present and provides additional protection, reducing the movement of fragments out to Lake Tahoe. Table 2 below identifies bubble curtain operational and functional challenges and solutions implemented to address these challenges.

The West Channel bubble curtains were operational in 2023. From June 21, 2023, to October 12, 2023, a total of 17.42 ft³ of fragments were collected from the West Channel bubble curtain area.

Table 2. Bubble Curtain – Challenges and Solutions

Challenge	Solution
Each of the four air compressors used to operate the bubble curtain in 2019 failed at least once during the 2019 season. Replacement was required multiple times. By the end of the season, TKPOA had replaced eight air compressors. As a result of the compressor failures, the bubble curtain operated only intermittently over the course of the 2019 season.	TKPOA concluded that investment in a significantly larger air compressor was required to maintain consistent operation of the bubble curtain. TKPOA purchased a 12.7 horsepower compressor with an output of 79 CFM in the early summer of 2020, built a new shed for the compressor, and installed the compressor in July of 2020. TKPOA has reported no compressor failure since installation of the new compressor.
During the 2019 season, TKPOA observed that the production of bubbles was impeded due to growth of aquatic weeds around the tubing.	TKPOA installed approximately 150 square feet of bottom barriers in the West Channel beneath the length of the bubble curtain tubing, and staff have observed a more consistent production of bubbles since. Bottom barriers may need to be removed and reinstalled on occasion to clear sediment and other debris that collects on the top of the barriers.

Fragments caught by the bubble curtain remained caught in the channel in front of the curtain and/or were pushed towards the edges of the channel by the bubbles. TKPOA identified the need for resources to remove collected fragments.	Beginning in 2018 and continuing through 2023, the TKPOA AIS Program instituted a new protocol to skim (with a skimmer boat) the south side of the bubble curtain (lagoon side) at least once each day during boating season to collect fragments. In addition, TKPOA installed a Seabin along the western bulkhead of the West Channel to attempt to continuously catch fragments pushed to the edge of the channel by the curtain. TKPOA Water Quality staff emptied the Seabin daily during boating season. However, wave action and changes in water level resulted in frequent dislodging of the Seabin. As such, TKPOA removed the Seabin from the West Channel in 2020.
Following monitoring in 2020 and 2021, TKPOA observed that fragments become trapped on the south side of the curtains, sink, and root at the base of the bubble curtain.	Three to four bottom barriers (10' x 20' or 10' x 25') will now be installed under each bubble curtain, in both the West and East Channels, to prevent rooting of fragments on the Channel floors.
The installation of the second line in 2022 for air bubbles (to create a double bubble curtain) exceeded the air volume capacity of the existing compressor, leading to insufficient airflow through the air lines.	TKPOA ordered a larger (variable frequency drive) compressor that had a delayed delivery due to supply chain issues. As of October 17, 2023, the West Channel has two fully operational compressors and a fully functional double bubble curtain. .
During the 2023 season there were electrical issues with the compressor for the East Channel bubble curtain, and it was not operational until November 16, 2023. There were significant delays in operating the compressor due to scheduling logistics with the power company and contractors, and shipping delays for various parts.	Due to incorrectly sized wiring and the electrical supply amperage being too low, the East Channel set-up has undergone a complete rewiring of the electrical system. A new pedestal and breaker box with appropriately sized breakers and wires were installed in 2023 with the appropriate amperage delivered from the supply line.

History of East Channel Bubble Curtain

In May 2022, TKPOA installed a second double bubble curtain in the East Channel. Funding for this East Channel bubble curtain unit came from The League to Save Lake Tahoe. Like that of the West Channel bubble curtain, monitoring was implemented for the new bubble curtain. The East Channel bubble curtain wasn't operational for most of the 2023 season due to electrical issues. These issues were resolved, and the bubble curtain was turned on November 16, 2023. Since the issues mentioned above persisted throughout the season, the total volume of fragments was not determined for the East Channel bubble curtain. In 2024, operation and responsibility of the East Channel bubble curtain was transferred to Suntex Marina.

History of Algal Bloom Monitoring and Management

Cyanobacteria, or blue-green algae, are naturally occurring photosynthetic prokaryotes that can be found in almost all bodies of water. These organisms are the dominant primary producers on Earth, contributing more than 25% of photosynthesis worldwide. Cyanobacteria are true bacteria, often unicellular. However, they can grow into large colonies that may be visible to the naked eye, often referred to as a harmful algal bloom (HAB) (UC Berkeley 2006,

Frontier 2015). Some cyanobacteria can produce secondary metabolites, such as cyanotoxins, which can be harmful to eukaryotes.

Exposure to cyanotoxins can cause allergic, respiratory, liver, kidney and nervous system reactions in mammals, and large blooms of cyanobacteria (not necessarily toxin-producing) can outcompete beneficial phytoplankton and cause a depletion of available oxygen in the water column (USGS 2012, Pearl and Otten 2013). Therefore, monitoring of cyanobacteria, especially for the presence of potentially toxic secondary metabolites, is important to protect both the health of the lagoon ecosystem as well as the health of residents and recreationists.

Cyanobacteria sampling in the Keys Lagoons was initiated in 2017, following the detection of a HAB in the West Lagoon in the late summer months. Since then, TKPOA has maintained a practice of visual observations for any algal blooms during regular maintenance activities (harvesting, skimming and other activities). In the event of an observed algal bloom, Water Quality staff collect surface water grab samples for lab analysis. Surface water grab samples are collected in a PETG plastic bottle and couriered on ice to Bend Genetics, LLC (an accredited lab in Rancho Cordova) for analysis within 24 hours. The May 2019 Standard Operating Procedures for Water Quality Sampling for the Tahoe Keys Lagoons (TKPOA 2019b) include protocols related to cyanobacteria sampling. In addition to sampling areas where a visual detection of a HAB is observed, Water Quality staff collect samples for lab analysis of cyanobacteria presence within the LFA study area just north of Venice Drive twice per month, regardless of any observed algal blooms.

History of Laminar Flow Aeration

In the Keys Lagoons, the accumulation of detritus at the bottom of the water column has been referred to as the ‘muck layer’ but is now referred to as the ‘organic sediment layer’. The organic sediment layer is a concern to TKPOA and Lake Tahoe Basin scientists as a source of nutrients that may help stimulate aquatic vegetation growth and improve conditions for HABs.

LFA was first recommended for testing as a macrophyte control method in Lake Tahoe by Stakeholder Committee members in 2017. LFA is a technology often used for improving water quality in water bodies where there is consistently low dissolved oxygen and a buildup of fine sediment (Restorative Lake Sciences, LLC 2012a, 2012b, 2016; Turcotte et al. 1991; University of Florida 2016). The technology uses microporous disks that are placed throughout the area to be treated. These disks are connected by self-sinking hoses connected to an air compressor. Air is pumped through the system creating an abundance of bubbles that create laminar flow and oxygenate the bottom of the water column where dissolved oxygen is typically the lowest. LFA has been used successfully with shallow, warmer waters with minimal circulation at low elevation; however, it has not been fully tested in conditions or an area such as Lake Tahoe, which has deeper, cold water at a much higher elevation (Restorative Lake Sciences, LLC 2012a, 2012b, 2016; Turcotte et al. 1991; University of Florida 2016).

Increasing the dissolved oxygen in the sediment layer promotes a reaction that converts (through oxygenation) ammonia into nitrite and then nitrate (EPA, 2021). The process is believed to be in part responsible for the reduction in organic matter seen in other LFA studies. Organic matter, a combination of animal and plant detritus, contains carbon and nitrogen as carbohydrates, lipids, amino acids, and proteins. The increase in dissolved oxygen and the disruption of organic matter aids in hydrolysis of carbohydrates and lipids, and proteolysis of proteins to amino acids, which can lead to nitrification and denitrification.

In late 2018 and into early 2019, TKPOA Water Quality staff consulted with Lahontan to develop an LFA test and to obtain the required permits. In 2019, 11 diffusers with an air compressor and necessary power source were installed within a finger of the West Lagoon immediately north of Venice Drive in mid-April of 2019. In September 2020, a second LFA site with eight diffusers was installed in the West Channel but was removed after one year. The LFA sites included in the CMT consist of the 2019 LFA installation (CMT Site 26) plus two new LFA installations in 2022, one in the West Lagoon (CMT Site 25) and one in the Lake Tallac Lagoon (CMT Site 27). Data and results on the monitoring of these CMT test sites in Year 2 and Year 3 are be presented in the CMT Project Annual Report that was submitted to Lahontan and TRPA in March 2025.

History of Ultraviolet Light (UV-C) Equipment Test

UV-C light is a new aquatic weed control method that has been experimentally tested at nearby Lakeside Marina and within the Keys Lagoons since 2020. The initial design of the UV-C treatment vessel is shown below in Figure 39. Recent research indicates the use of UV-C light (short-wave electromagnetic radiation light) can damage the cellular structure and DNA of both aquatic weeds and their fragments (TRCD 2019). Therefore, the possibility of UV-C light as a control method for aquatic weeds in the Tahoe Keys and the greater Lake Tahoe Basin is of great interest.



Figure 39. UV-C treatment vessel. Photo credit: John Paoluccio, Inventive Resources, Inc.

Preliminary experimental treatments of UV-C began within the Tahoe Keys Lagoons in 2020 at two locations, with data (including quadrat sampling and videos/pictures) collected by the University of Nevada, Reno (UNR).

UV-C treatments in 2022-2024 were part of the CMT. Data and results on the monitoring of these CMT test sites are presented in the CMT Final Report submitted to Lahontan and TRPA in 2025.

History of Hydroacoustic Scans

Hydroacoustic scanning of the Keys Lagoons has occurred regularly since 2015. Hydroacoustic scanning uses sonar technology to scan the bottom of a water body to determine and record the average surface water temperature, presence of plant matter, plant height, and biovolume. Biovolume is the volume of cells in a unit amount of water (normally quoted in cubic millimeters per liter). These data are then analyzed to determine the percent of the water column containing plant matter. By comparing the average percent of the water column containing plant matter to the total volume of the water body, the approximate amount of biomass (or biovolume) can be determined. Hydroacoustic data is also used to determine the average vessel hull clearance, which is the distance between the water surface and the top of the aquatic plant canopy.

History of Bottom Barriers

Bottom barriers, also known as benthic barriers, physically suppress aquatic plant growth and restrict sunlight. Depending on the barrier material, gas exchange may also be restricted. Barriers are typically large sheets of an impermeable or semi-permeable synthetic or natural material that is placed directly on the plants and anchored in place with weight. Barriers are installed by diver hand crews and can be placed under docks or piers that otherwise may be

difficult areas to treat with other methods. Synthetic barriers remain in place for at least 2-4 months and then are removed prior to winter.

In compliance with its WDR Order, TKPOA began a Bottom Barrier Program for homeowners within the Keys Lagoons in 2015. TKPOA's WDR permits the use of up to a total of five acres of bottom barriers within the lagoons in any season. In 2016, TKPOA proposed improvement measures to the program, including heavier weighting material for the barriers, use of professional divers for installation, and updating the TKPOA permit, Form 19. In addition, TKPOA received an increase in the number of bottom barriers from the Tahoe Resource Conservation District (TRCD). Additional background information on TKPOA's Homeowner Bottom Barrier Program can be found in the 2015-2022 Annual Reports submitted to Lahontan (TKPOA 2016a, TKPOA 2017a, TKPOA 2018a, TKPOA 2019a, TKPOA 2020a, TKPOA 2021a, TKPOA 2022a).

In 2022, TKPOA received Lahontan and TRPA approvals for the CMT Project, which include the testing of bottom barriers in Years 2 and 3 of the Project. The bottom barriers are one of the "Group B" control methods implemented in 2023. During Year 2 (2023) of the CMT, ten bottom barriers were installed in nine Year 1 CMT Group A Sites. Group A methods are large-scale treatments that were tested in 2022, whereas Group B methods are smaller site-specific, follow-up methods designed to treat regrowth of the invasive plants in the locations where Group A methods were successful in reducing biovolume of the target invasive plant species by at least 75%.

History of Circulation System

The existing TKPOA water circulation and treatment system is a substantial piping and pumping network that was originally intended to provide circulation, treatment, and mixing of the Keys Lagoons to improve water quality by decreasing turbidity, removing nutrients, preventing stagnation and increasing mixing. The system includes the following main components:

- Five vertical pumps incorporated with culvert piping across Alpine Drive, Emerald Drive, and Christie Drive.
- Two large volume circulation pump stations.
- Tahoe Keys water treatment plant (WTP) and pump station.
- Approximately 7,800 feet of large diameter (48" and 24") reinforced concrete pipe and welded steel circulation pipe along the perimeter of the Tahoe Keys with 18 distribution pipes (18" to 14" diameter) that circulate water into the various coves within the lagoons (R.O. Anderson 2016; Domenichelli & Associates, Inc. 2017).

The circulation and treatment system were shut down due to a cease-and-desist order from LRWQCB and has remained offline since the late 1990s. Restarting the system has been considered at various points and is part of the ongoing discussions around water quality. Testing and assessments need to be made regarding the system's design, current state and

function to determine the path forward whether reintroducing the system will achieve the water quality goals and standards set forth.

10.0 APPENDIX B – VESSEL HULL CLEARANCE BY ZONE DATA

Vessel Hull Clearance was calculated using data from hydroacoustic scanning described in section 3.2. The scans provide depth to top of plant canopy and depth to lagoon bottom values along the scan track. These numbers are averaged within each zone and plotted on graphs. With dense weed growth, depth to lagoon bottom values become inaccurate as the transducer has difficulty scanning all the way through the plant mass. The water column depth values on these graphs are therefore an estimation and water level should be checked against established staff gauges for accurate depth readings. Depth to top of plant canopy has not shown signs of inconsistency and can be considered true value.



Figure 40. Tahoe Keys Lagoons zone map, created in 2025.

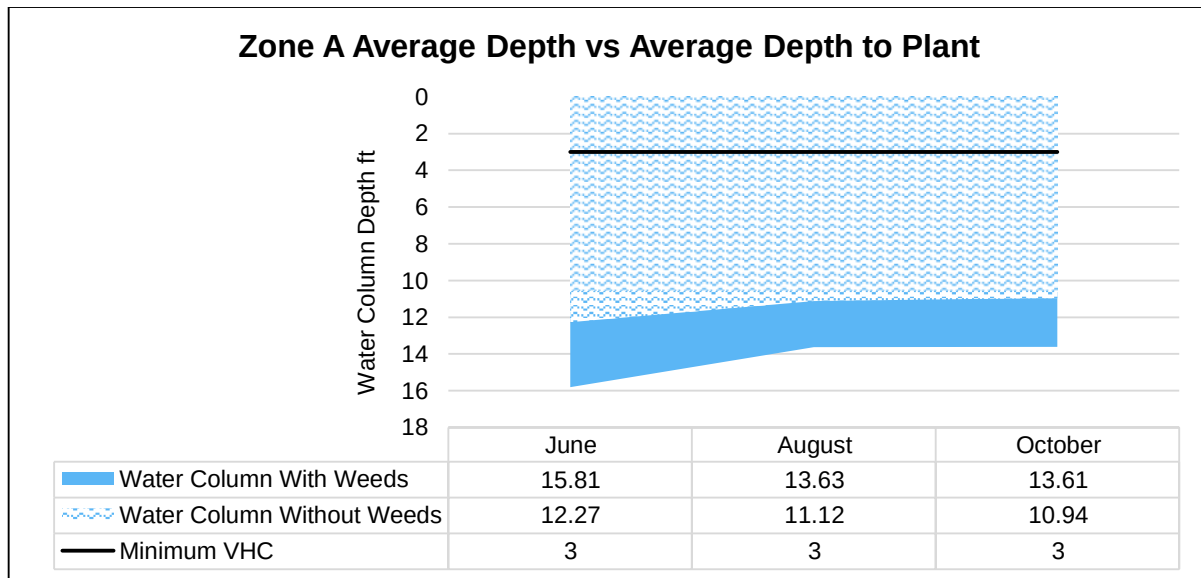


Figure 41. Zone A average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

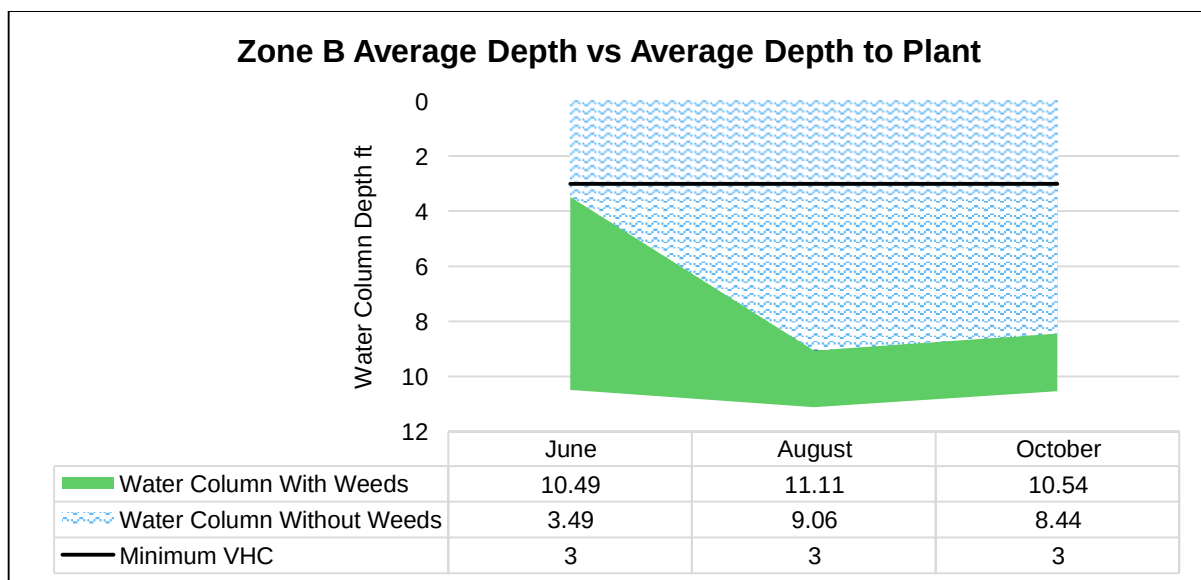


Figure 42. Zone B average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

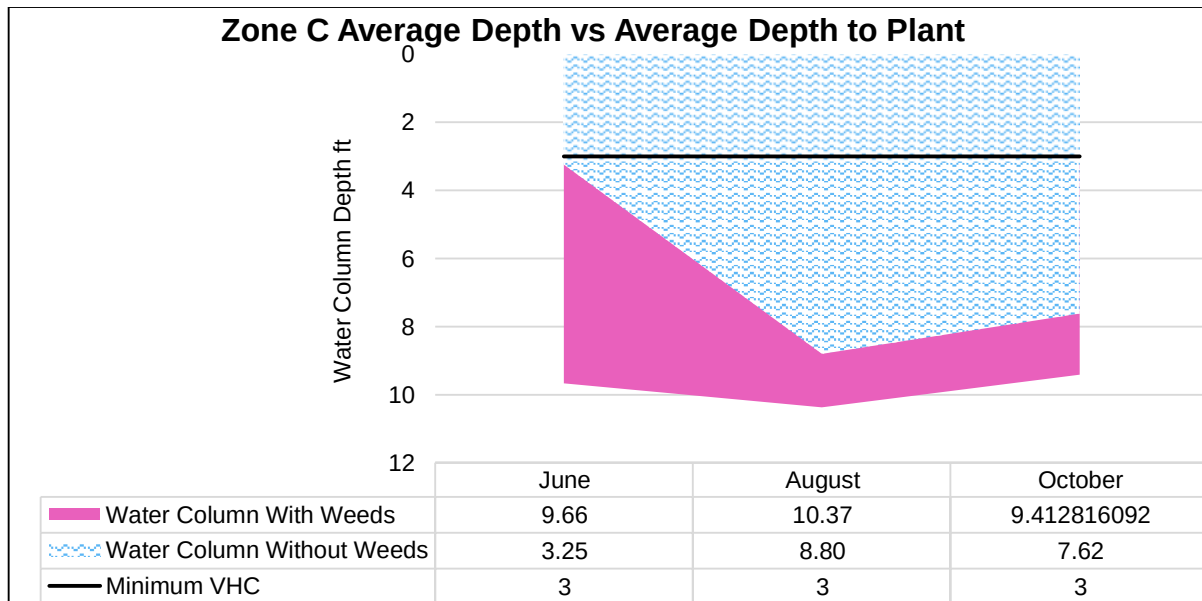


Figure 43. Zone C average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

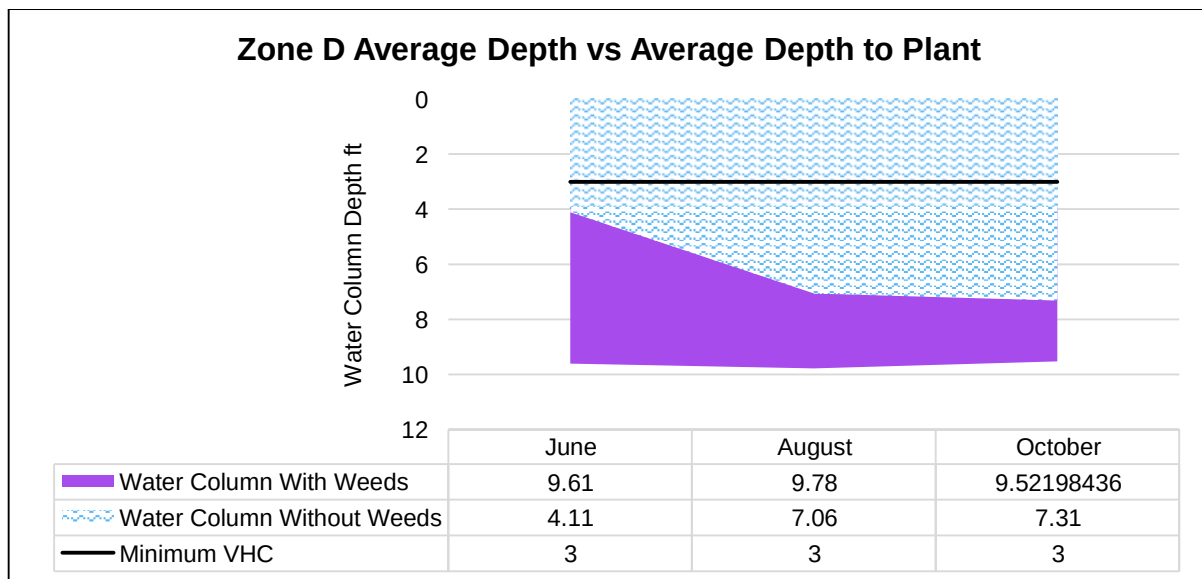


Figure 44. Zone D average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

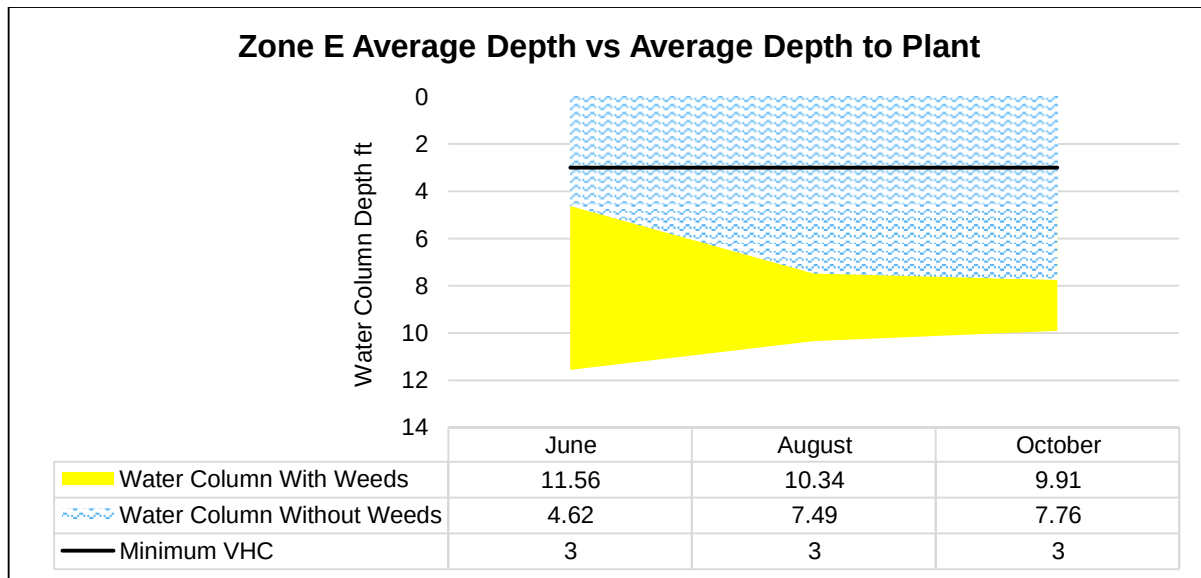


Figure 45. Zone E average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

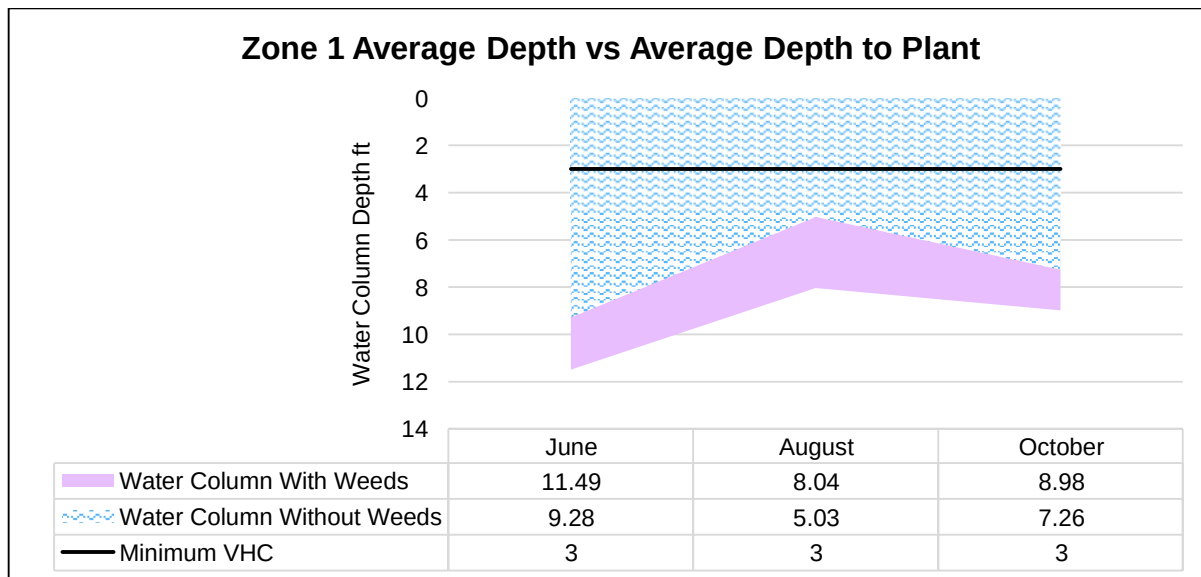


Figure 46. Zone 1 average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

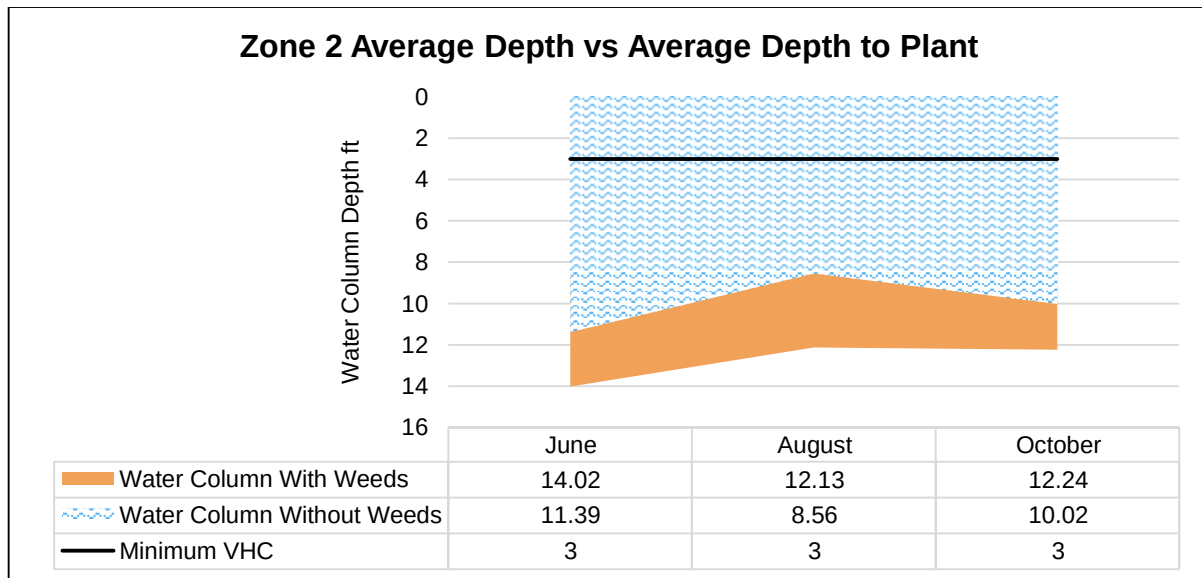


Figure 47. Zone 2 average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

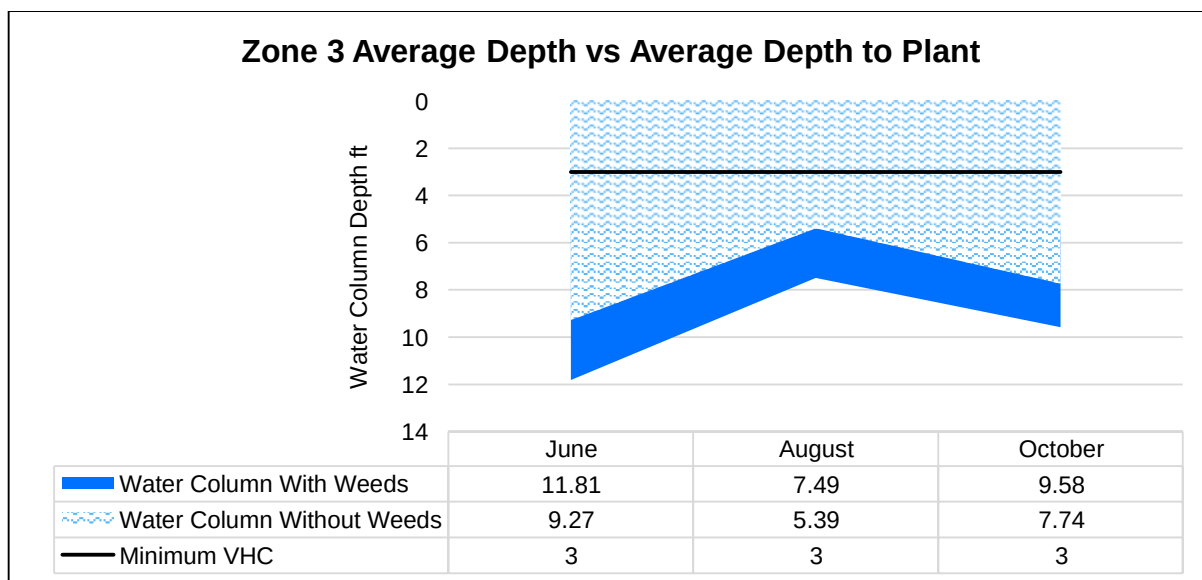


Figure 48. Zone 3 average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

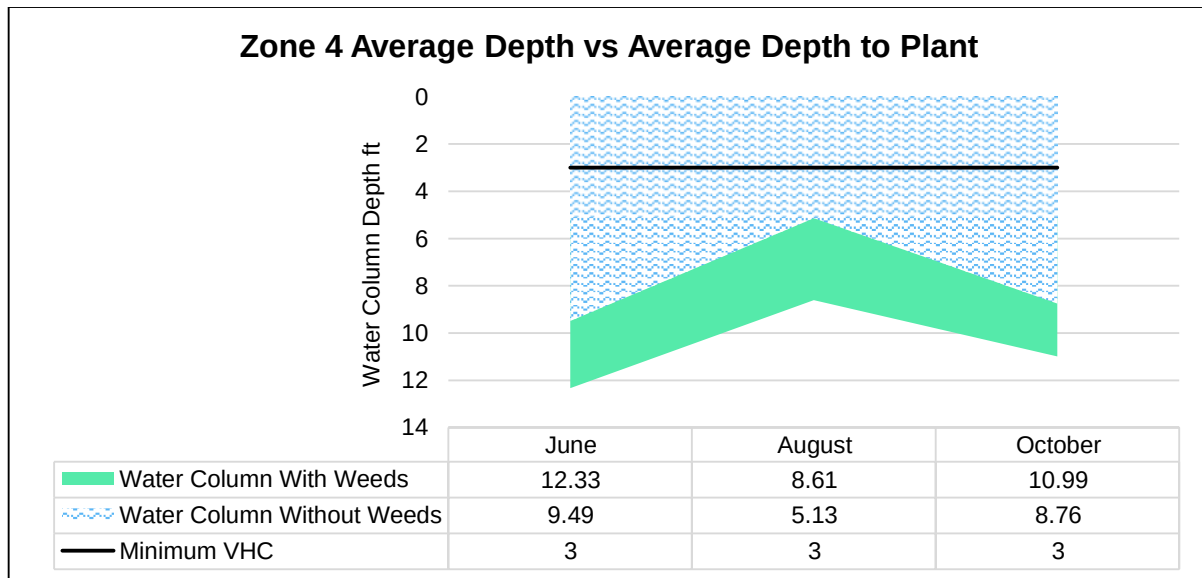


Figure 49. Zone 4 average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

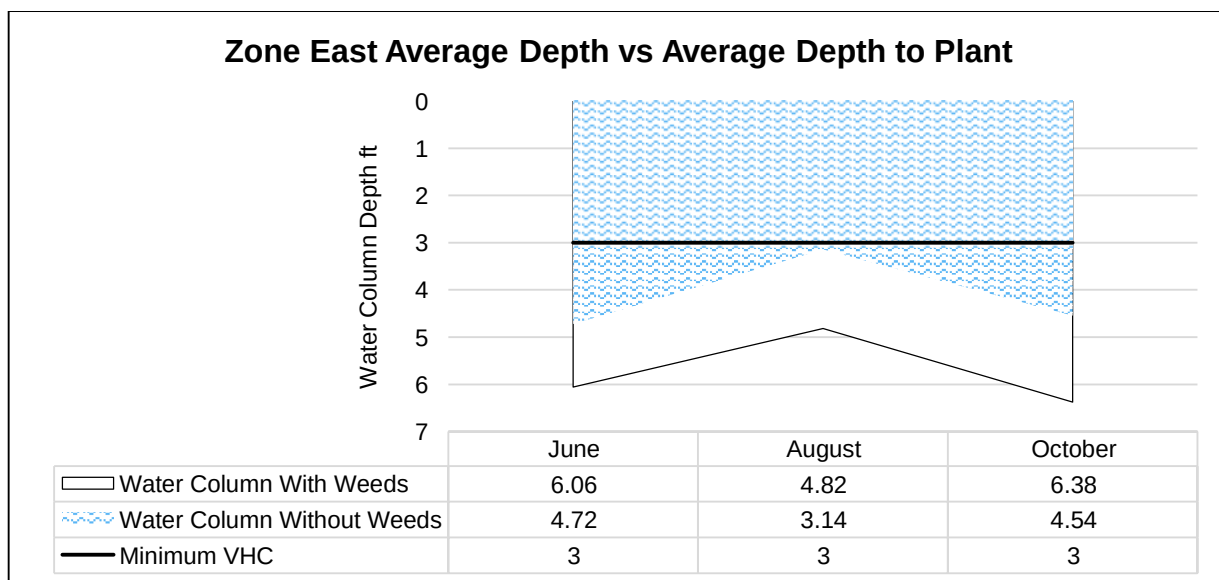


Figure 50. Zone East average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

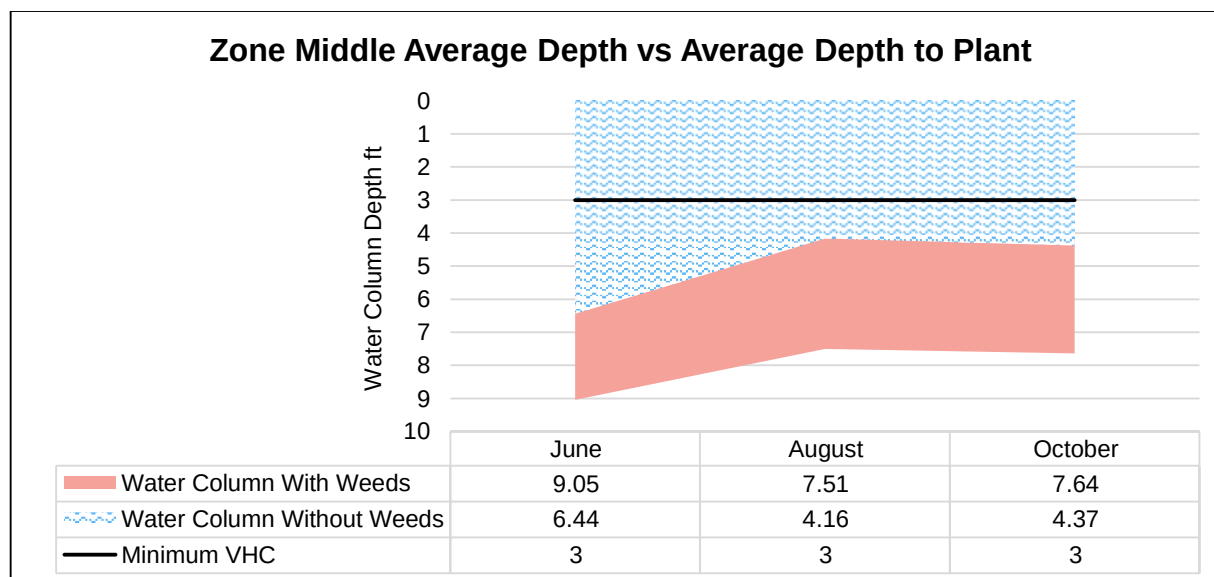


Figure 51. Zone Middle average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

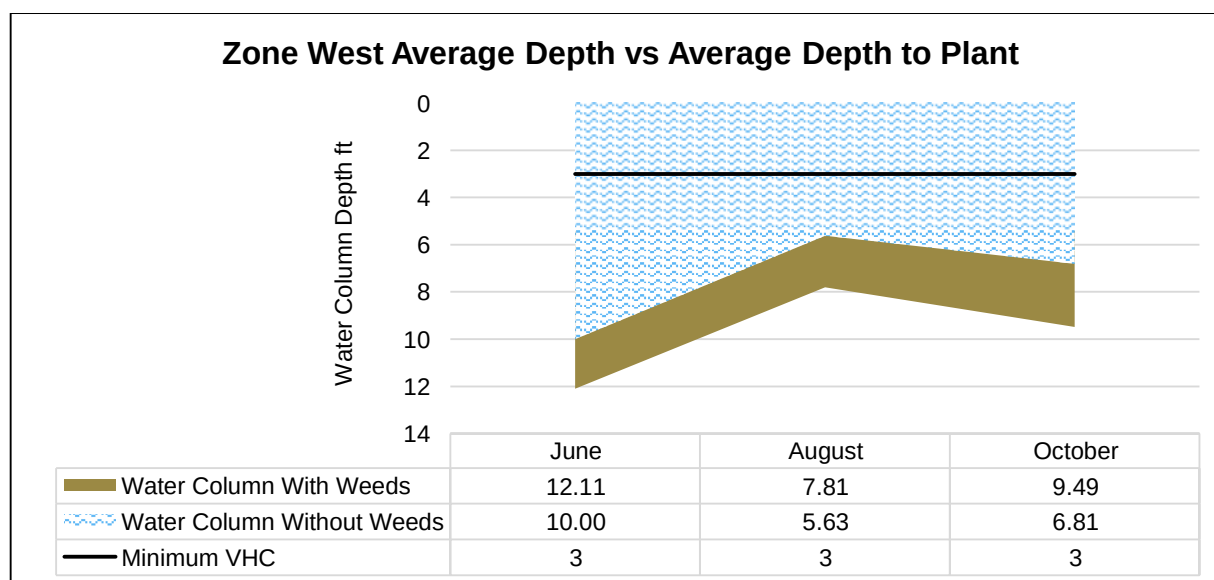


Figure 52. Zone West average water depth and depth to plant canopy measured from the water surface during June, August, and October 2025.

11.0 APPENDIX C – ULTRASONIC TECHNOLOGY

LG Sonic Ultrasonic Treatment Pilot Monitoring Results for the Tahoe Keys Lagoons

Prepared by the Tahoe Keys Property Owners Association

Introduction

Harmful Algal Blooms (HABs) have increased in size and occurrence worldwide due to warmer temperatures and increased nutrient inputs via direct and indirect sources (Paerl et al., 2018). HABs are caused by microscopic cyanobacteria that photosynthesize and multiply very quickly when water conditions are right. These conditions include warm stagnant waters, prolonged sunlight, and an influx of nutrients. During the process, different cyanobacteria species can emit toxins called anatoxin-a and microcystin which are harmful to animals and humans. Once these blooms die off, they sink to the bottom where bacteria decompose them depleting the waters of oxygen creating an unhealthy ecosystem (California Water Quality Monitoring Council). Since 2017, the Tahoe Keys Lagoons have had a steady increase in HABs, especially in the dead-end zones with limited circulation. HABs are now a common occurrence every summer season throughout the lagoons.

In 2023, the Tahoe Keys Property Owners Association (TKPOA) installed two LG Sonic Industrial Wet ultrasonic devices to test a new method of controlling HABs in dead-end waterways. These devices emit low-power ultrasonic waves in the top water layer, which interferes with the algae's ability to reach the surface to access sunlight and nutrients, preventing photosynthesis. This causes the algae to sink to the bottom where they decompose naturally without releasing harmful toxins. The ultrasonic waves have no negative effects on aquatic organisms, animals, or humans (Lg Sonic, 2023).

Site Selection

Site 22B and Site 20B were initially determined optimal test sites due to their dead-end locations as well as previous years' HABs occurrences. In 2025, Site LFAI also became an optimal site for testing ultrasonic technology. Site 20B had a power source close by from the TKPOA Pumphouse and homeowners gave permission to use their dock and electricity in Site 22B and LFAI. Site locations are shown in Figure 1.

Two ultrasonic units were first installed in June 2023 on a dock in Site 22B and nearshore in Site 20B. Both units were removed in October 2023. They were reinstalled in June 2024 in the same sites for consistency and again removed in October 2024. In 2025, one unit was placed in Site LFAI instead of Site 22B. The purpose of this switch was because TKPOA has historical HABs data in Site LFAI to better compare before and after use of ultrasonic technology. Another unit was continued in Site 20B.



Figure 53. LG Sonic Unit Locations

Installation

Each device contains (Figure 2):

- 1 control box with 12 different programs
- Transmitter cable
- Power cable
- Transmitter unit (up to 200m / 650ft treatment range per unit)
- Wiper unit
- Float
- Extension Flexi-arm

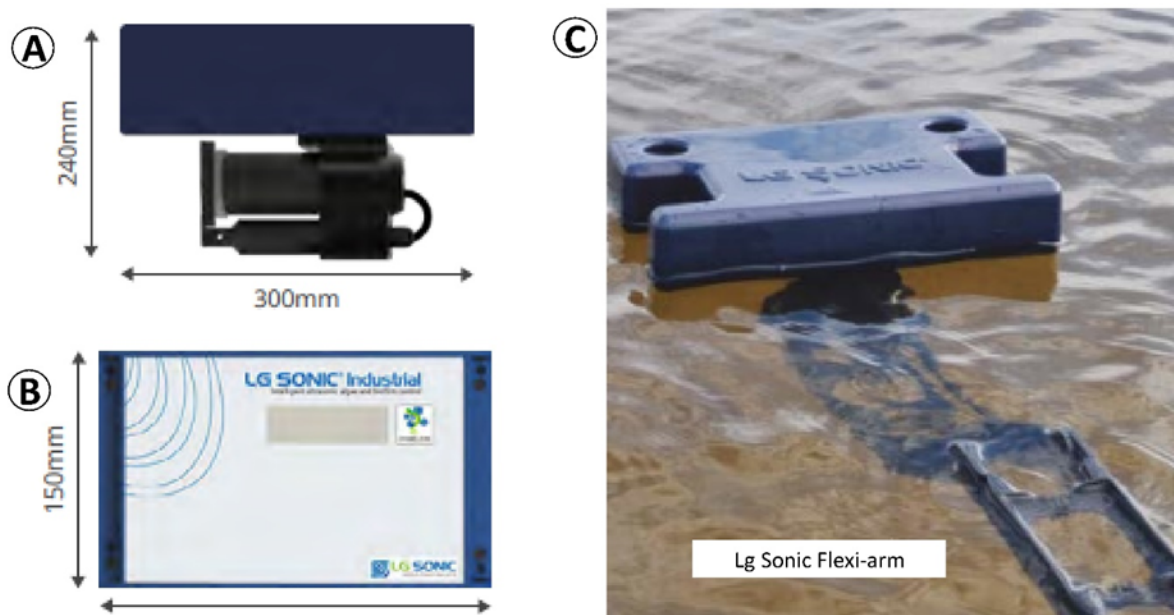


Figure 54. A) Transmitter unit attached to float. B) Control box. C) Flexi-arm attachment.

After consultation with the tech team at LG Sonic regarding the Tahoe Keys Lagoon characteristics, 'Program 9' was chosen for its specific wave form, frequency pause and amplitude that would work best within the waterways. This program was factory set before shipment and installation.

For Site 22B and LFAI, the transmitter unit and float were placed around 1ft away from the edge of the dock attached with a Flexi-arm so it could change with the water levels. The transmitter faced south towards the largest part of the 'problem area' with no obstruction. The transmitter cable was secured along the dock up to the control box that was housed inside a waterproof enclosure. The power cable was secured along the dock up to the house and plugged in in a waterproof area.

Site 20B made a secure attachment point on shore with a 6-foot stake and mounted the transmitter/ float using the Flexi-arm, ensuring sure it was fully submerged and facing a north-west direction. The transmitter cable was connected to the control box set on a concrete pad inside a waterproof box. The power cable fed into an underground pipe and connected to the power source inside the TKPOA pumphouse.

Maintenance

Before use, the units were calibrated using factory settings as instructed by the equipment manual. The device was visually monitored throughout the season and HAB sampling occurred for analysis.

Both transmitters have automatic wiper units so that muck and debris do not build up and block the ultrasonic waves. TKPOA technicians do routine checks of each system biweekly.

Data Collection

Available HABs monitoring data were used to evaluate potential effects of ultrasonic treatment. Monitoring at these sites was not specifically designed for ultrasonic evaluation but reflects locations where cyanotoxin data were available prior to and following installation of the LG Sonic units. Data from 2022 was omitted from this analysis due to the turbidity curtains put in place throughout the West Lagoon during Year 1 of the Control Methods Test (CMT). These turbidity curtains created stagnant waters, significantly elevating levels of both anatoxin-a and microcystin, which were not characteristic of typical lagoon waterways.

For a full description of HABs sampling standard operating procedures, refer to the Harmful Algal Blooms Existing Conditions Report (TKPOA, 2025).

Results

The main toxins detected in lab analysis were anatoxin-a and microcystin. Therefore, results will only focus on these two analytes. For a full description of cyanobacteria species commonly detected in the Tahoe Keys Lagoons and toxins they release, refer to the Harmful Algal Blooms Existing Conditions Report (TKPOA, 2025).

Site 20B

At Site 20B, prior to LG Sonic installation (2018-2022) a total of 23 samples were taken. Anatoxin-a concentrations ranged from non-detect to 0.56 µg/L and microcystin concentrations ranged from non-detect to 0.19 µg/L. Following LG Sonic installation (2023-2025), anatoxin-a concentrations ranged from non-detect to 2.77 µg/L and microcystin concentrations ranged from non-detect to 4.76 µg/L, with a total of 19 samples. Caution-level advisory for anatoxin-a occurred in 2018-2021, 2023, and 2025, while microcystin reached warning-level advisory levels in 2024.

Anatoxin-a Levels at Site 22B (LG Sonic vs. No LG Sonic)

Y-axis: Anatoxin-a (µg/L)

X-axis: Year (2023, 2024, 2025)

Legend: LG Sonic Installed? (No: Red circle, Yes: Teal triangle)

Date (Approx.)	LG Sonic Installed?	Anatoxin-a (µg/L)
2023-07-01	Yes	0.0
2023-07-15	Yes	0.8
2023-08-01	Yes	0.0
2023-08-15	Yes	0.0
2023-09-01	Yes	0.0
2023-09-15	Yes	0.0
2024-06-01	Yes	0.0
2024-06-15	Yes	1.6
2024-07-01	Yes	1.5
2024-07-15	Yes	0.0
2024-08-01	Yes	0.2
2024-08-15	Yes	0.0
2024-09-01	Yes	0.0
2025-01-01	No	0.3

Microcystin Levels at Site 22B (LG Sonic vs. No LG Sonic)

Y-axis: Microcystin (µg/L)

X-axis: Year (2023, 2024, 2025)

Legend: LG Sonic Installed? (No: Red circle, Yes: Teal triangle)

Date (Approx.)	LG Sonic Installed?	Microcystin (µg/L)
2023-07-01	Yes	0.0
2023-07-15	Yes	0.2
2023-08-01	Yes	0.5
2023-08-15	Yes	0.8
2023-09-01	Yes	0.0
2024-06-01	Yes	0.0
2024-06-15	Yes	0.2
2024-07-01	Yes	12.0
2024-07-15	Yes	6.0
2024-08-01	Yes	0.0
2024-08-15	Yes	0.5
2024-09-01	Yes	0.0
2025-01-01	No	0.5

Site LFAI

Tahoe Keys Property Owners Association
Integrated Management Plan for Aquatic Weeds for the Tahoe Keys Lagoons (2025 Update)

a warning-level anatoxin-a concentration observed in 2019. Microcystin reached a caution-level advisory threshold in 2021.

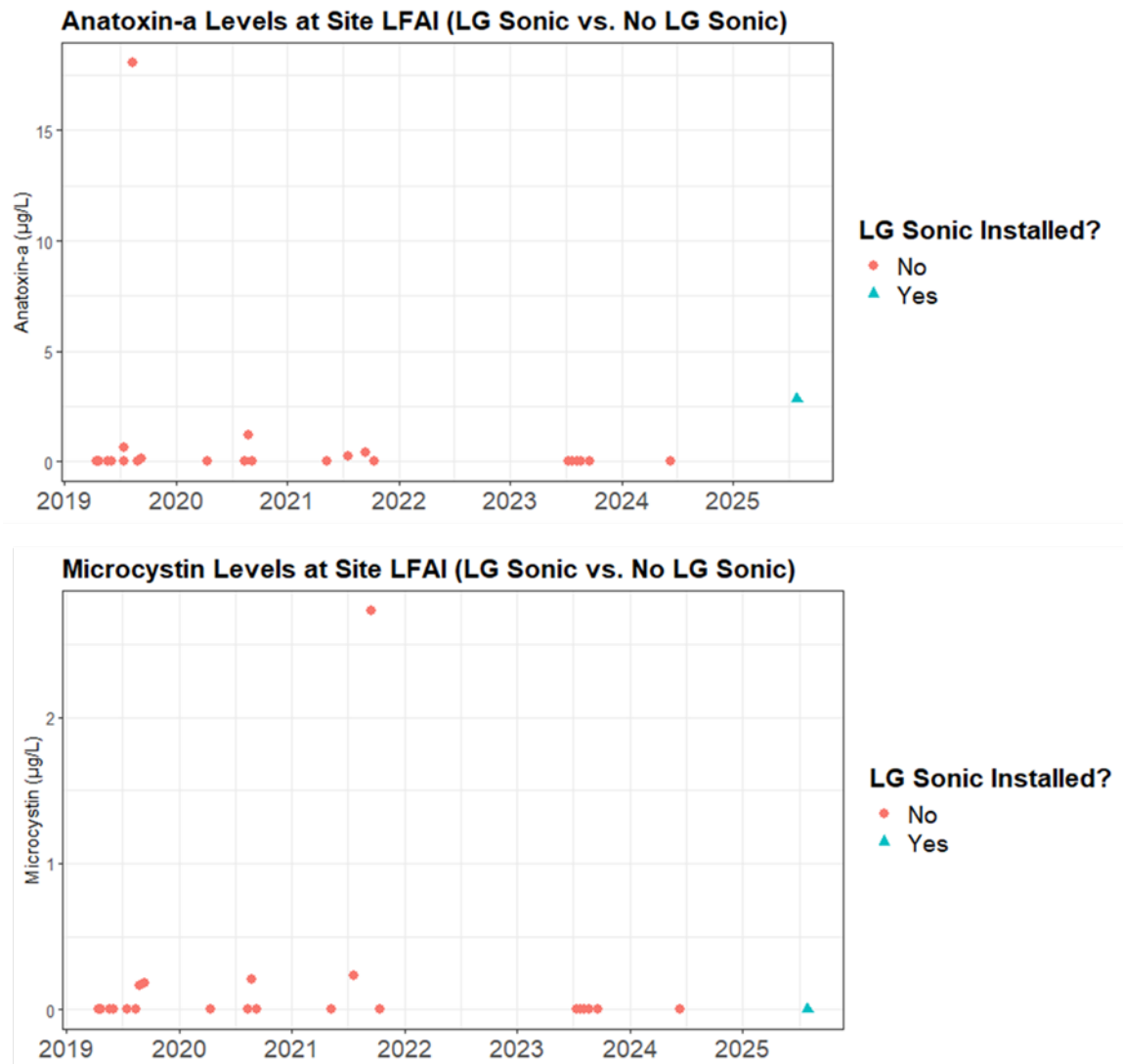


Figure 57. Cyanotoxin levels for Site LFAI before and after LG Sonic installation

Discussion

Cyanotoxin concentrations across Sites 20B, 22B, and LFAI did not show a consistent or sustained reduction following installation of LG Sonic ultrasonic units. While many post-installation samples remained low or non-detect, elevated anatoxin-a and microcystin concentrations continued to occur during individual sampling events, indicating that ultrasonic treatment alone did not consistently suppress HAB-related toxins under the conditions evaluated.

Interpretation of 2025 data is particularly limited. At Site 20B, dense accumulations of aquatic vegetation and debris frequently obstructed the ultrasonic emissions, even when cleared regularly by the skimming crew. At Site LFAI, the unit had trouble remaining in a fixed position due to storm events, boat traffic, and seasonal water-level fluctuations. These operational challenges likely affected device performance. In addition, sampling frequency in 2025 was limited to one or two samples per site due to budget constraints, further reducing the ability to assess treatment effects.

Evaluation of ultrasonic technology in a field setting is also complicated by variable environmental conditions that influence HAB development independently of ultrasonic operation, including water temperature, nutrient availability, daylight, wind-driven mixing, and seasonal vegetation growth. These factors vary spatially and temporally within the lagoons and make it difficult to isolate treatment effects from natural environmental variability.

TKPOA will continue to operate ultrasonic units in future years to expand the dataset and will work with LG Sonic to explore different program settings. There are 12 program settings on each unit, each having specific wave form, frequency pause and amplitude based on water characteristics and types of cyanobacteria. Locations of each unit will be modified within these sites to better secure the units and keep their signal clear of aquatic vegetation and debris.

References

California Water Quality Monitoring Council (CWQMC) n.d. California Harmful Algal Blooms (HABs) Portal. My Water Quality: California Harmful Algal Blooms.

<https://mywaterquality.ca.gov/habs>

LG Sonic 2023. How ultrasonic algae control works.

<https://www.lgsonic.com/ultrasonic-algae-control/>

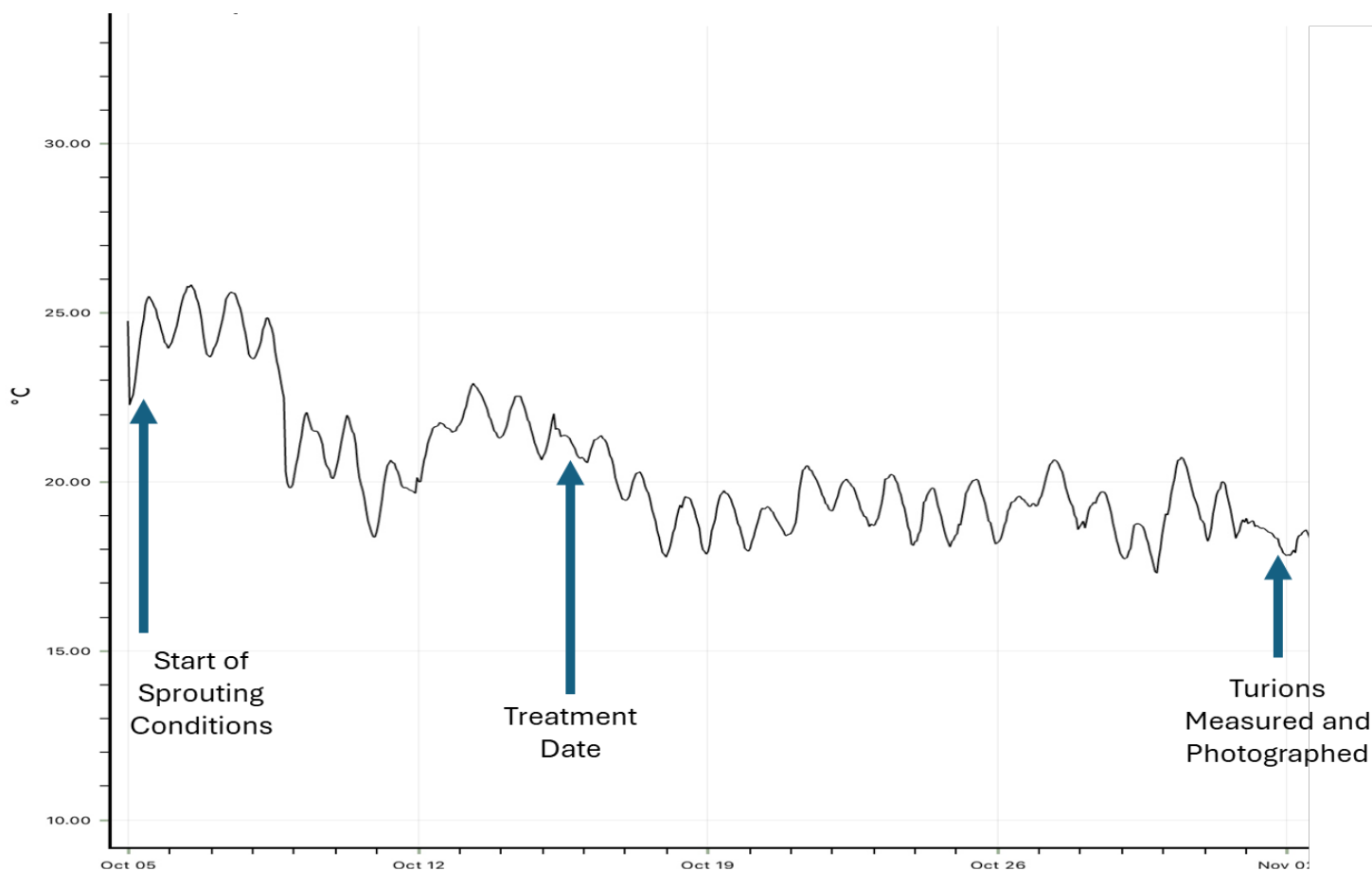
Paerl, Hans W., Timothy G. Otten, and Raphael M. Kudela 2018. Mitigating the expansion of harmful algal blooms across the freshwater-to-marine continuum. *Environmental Science & Technology*, 52(10), pp. 5519–5529.

Tahoe Keys Property Owners Association (TKPOA) 2025. Tahoe Keys Lagoons Water Quality Improvements Project, Harmful Algal Blooms Existing Conditions Report.

12.0 APPENDIX D – PROCELLACOR

The purpose of the Mesocosm study was to determine efficacy of two rates of ProcellaCOR (5 and 10 ppb) on newly sprouted Curlyleaf pondweed turions using replicated treatments. The EPA and California Department of Pesticide Regulation (CDPR) regulate ProcellaCOR to 25ppb per treatment with a max of 50ppb per year. Typical dosage for Eurasian Watermilfoil is 5 – 7ppb. There is currently no typical dosage for Curlyleaf Pondweed.

- Curlyleaf pondweed turions were collected from CMT Control Sites (September 2024)
- Sprouted for 10-12 days (October 5-15 (Figure 1))
- Three separate mesocosms were used: Controls (no ProcellaCOR); 5 ppb ProcellaCOR; 10 ppb ProcellaCOR
- Three replicate treatments occurred for each of the three separate mesocosms
- Temperature recorded hourly
- Plant lengths were measured, number of leaves formed were counted, and plants were photographed for each mesocosm and replicate



¹¹Figure 58. Temperature in 1 Liter Turion Sprouting Containers: Sprouted Oct. 5, 2024; Treated with ProcellaCOR October 15, 2024

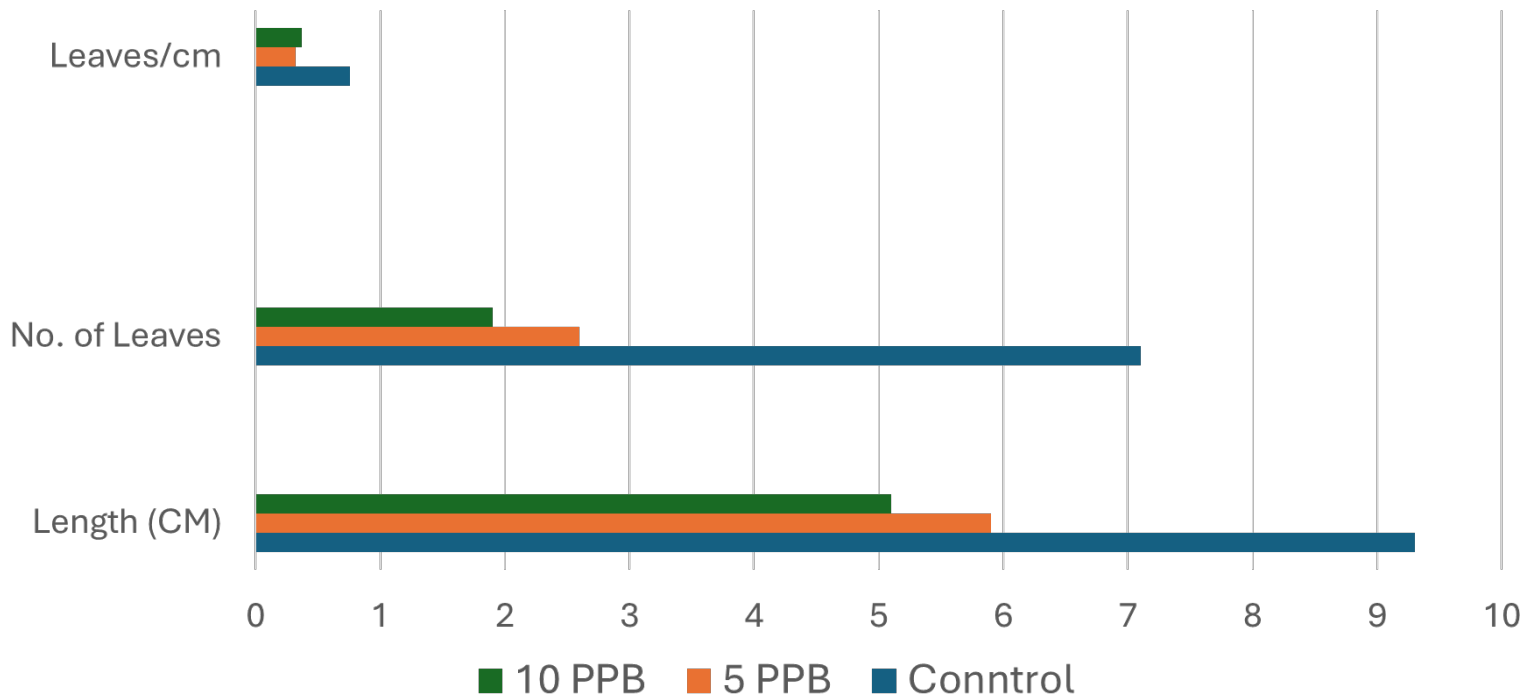


Figure 59. Sprouted CLP Turions: 15 DAT ProcellaCOR (Control, 5 PPB and 10 PPB) (Mean, 3 replicates)



Figure 60. Plant Length measurement method



Figure 61. 15 DAT 10ppb



Figure 62. 15 DAT 5ppb



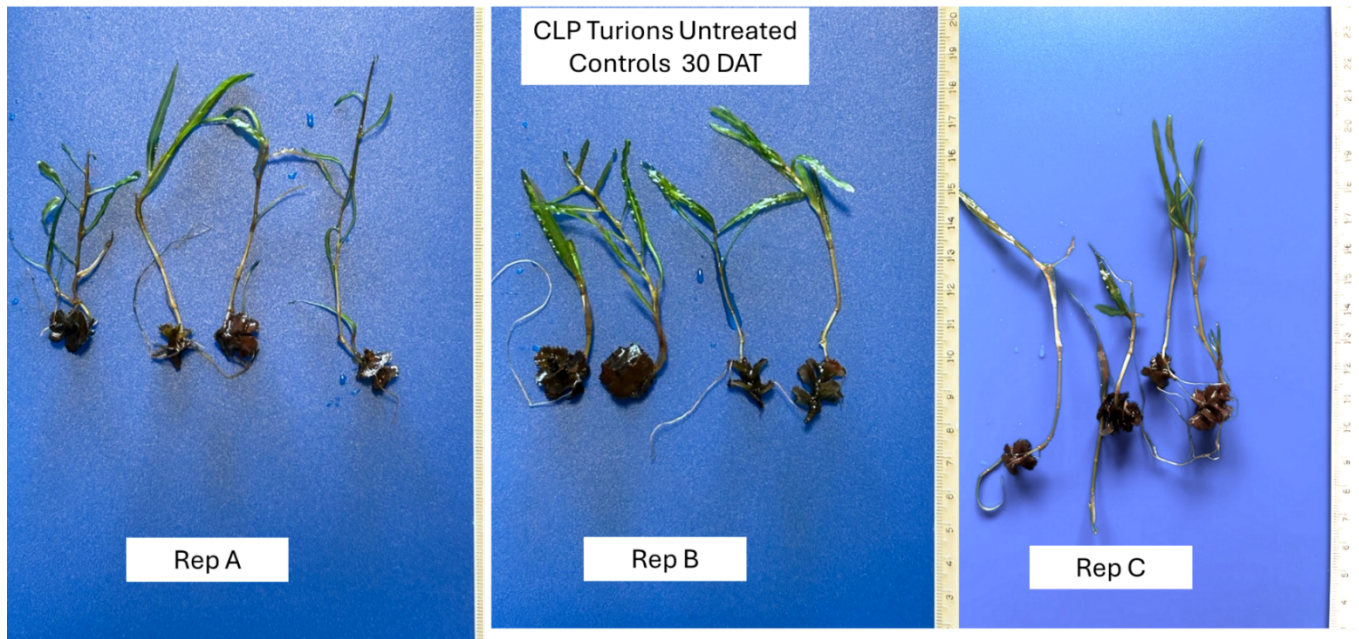


Figure 63. CLP Turions Untreated; Controls 30 DAT

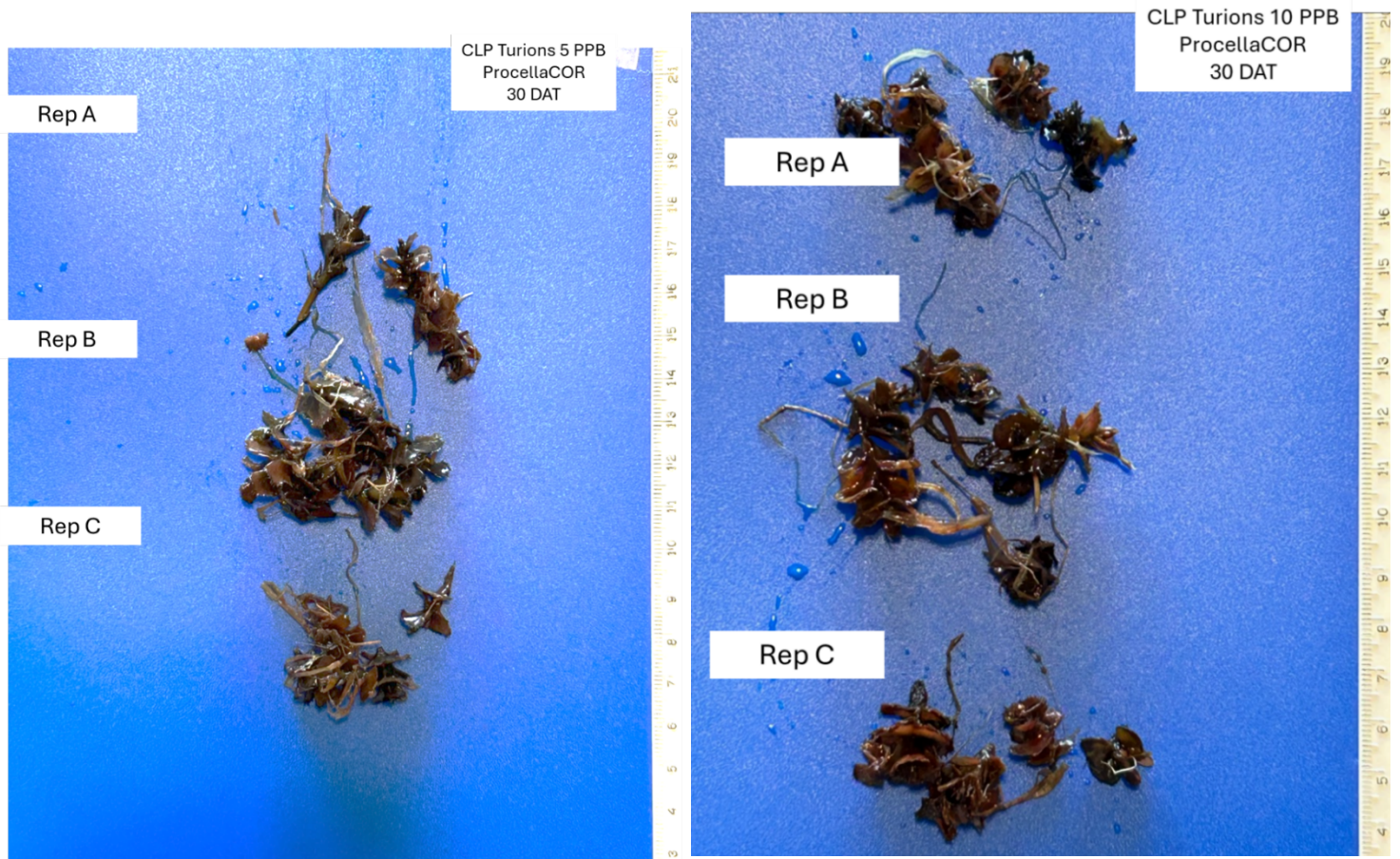


Figure 64. CLP Turions 5 PPB; ProcellaCOR 30 DAT

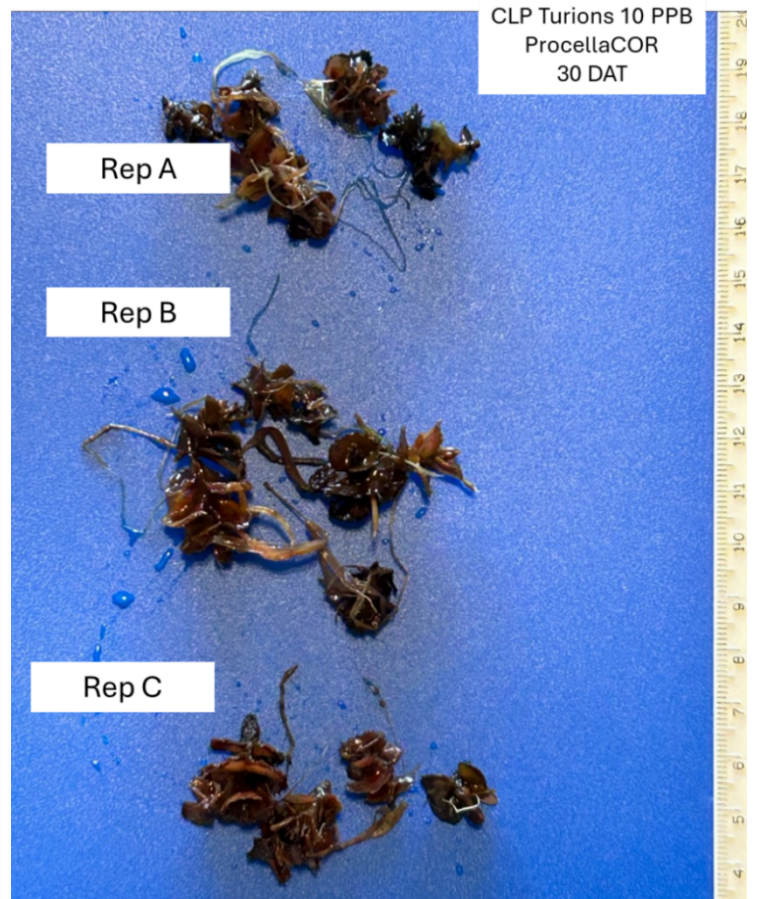


Figure 65. CLP Turions 10 PPB; ProcellaCOR 30 DAT

Tahoe Keys Organic Sediment Removal Pilot Project 2025

Prepared by
Tahoe Keys Property Owners Association



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Introduction

The Tahoe Keys Waterways cover around 170 acres and were constructed in the late 1950s and early 1960s as part of development of the Tahoe Keys community. During construction, the lagoon bottoms were formed using hard-pack fill. After decades of biological production and deposition, a layer of decomposed aquatic plant material, referred to as the organic sediment layer, has accumulated above this hard substrate. Organic sediments can act as a reservoir to cycle nutrients back to the aquatic plant growth from which it originated. This cycling of nutrients can influence aquatic plant growth, including AIS, and potentially stimulate HAB formation.

The thickness of this organic sediment varies widely throughout the lagoons as well as between shoreline and midchannel locations, complicating efforts to estimate total sediment volume. Using a standardized assumption of a 3-foot organic sediment depth across the 170-acre lagoon system yields an estimation of 510 acre-feet or 822,800 cubic yards of organic sediment currently present within the waterways.

Removing the organic sediment layer has been identified by TKPOA as an option to significantly decrease the nutrient availability for AIS. Additional benefits include the reduction of the curlyleaf pondweed turion seed bank that may be present within the organic sediment layer and removal of established invasive and nuisance plants that may be rooted in the organic sediment layer.

A pilot project was designed to evaluate the feasibility of using suction dredging as the main method of removal. Suction dredging, however, produces large volumes of water that would be uneconomical to either transport away from the site or to treat to Basin Plan water quality objectives. Thus, the objective of the pilot study was to assess whether physical filtration of the slurry produced during suction dredging (i.e. organic sediment plus water) would result in water quality filtrate that would be acceptable to return to the Tahoe Keys lagoons under a temporary exemption to certain water quality criteria.

Methodology

Overview

There are two main products identified with the suction dredging method:

1. Organic sediment material
2. Large volumes of water removed from the lagoons during the suction process.

The organic sediment material can be bagged, dried and disposed of through local resources similarly to how TKPOA disposes of the weed fragments from harvesting. However, the volume of water is too large to make storage and trucking a viable option. Therefore, the objective of this pilot study was to evaluate filtration methods capable of removing sufficient suspended solids and organic material from the produced water to allow the water to be returned to the same lagoon area from which it originated.

Study Location and Sediment Removal

Due to its general isolation and distance from the West Channel, the southwest corner of the West Lagoon, adjacent to the intersection of Venice Drive and Alpine Drive, was identified as an appropriate location to obtain organic sediment for this pilot study (Figure 1). This location also has safe and easy shoreline access and is TKPOA common property, avoiding the need for private-owner approval for access. Certified divers from Hiuga Diving Company, which is licensed by the California Contractors State License Board (CSLB License No. 1011839) measured organic sediment depth and identified a square area approximately 20ft from shore in all directions with 30-36 inches of accumulated organic sediment, as illustrated on Figure 1. This area was chosen as the suction site to allow the divers to keep the suction intake more than 2 feet above the lagoon bottom and prevent the removal or disruption of the hard mineral substrate that defines the lagoon bottom.



Figure 1. Sediment depths at dredging site of OSR Pilot Project

Five intermediate bulk container (IBC) totes (totaling about 1,375 gallons) of mixed organic sediment and water were then suctioned from the target area in the lagoon and transported to the TKPOA Texas Avenue yard for filtration testing.

Filtration Types Evaluated

The following filtration materials were evaluated individually and in series to determine the proper combination needed for optimum organic sediment retention and cleanest effluent water:

- 1/8-inch hole netting (coarse pre-filter)
- 80 US Sieve dewatering sediment bag

- 270 US Sieve dewatering sediment bag
- 500 US Sieve cartridge filters

The 1/8-inch hole netting is equivalent to the bags used to collect AIS plant fragments obtained during diver-assisted suction harvesting (DASH). The US Sieve sizes were chosen based on readily available standard filtration options before custom options are explored. Scenarios using the netting and dewatering bags were gravity fed. The cartridge filters required a pump to pressurize the system for filtering. Samples of the organic sediment collected as well as the effluent water were analyzed both in house and sent to a certified laboratory to determine concentration in standard water quality parameters, nutrient levels, and solids concentration. All sediment and effluent water were contained, collected and disposed of without any discharge to land or surface water. **No water or sediment was returned to the lagoons during this pilot study.**

Filtration Scenarios

Five filtration scenarios were designed to evaluate organic sediment retention and effluent quality:

Scenario 1 (S1): Standalone Dewatering bags

Sediment-water mixtures were gravity fed through dewatering bags as the sole filtration method. Both 80 US Sieve and 270 US Sieve bags were tested, including variation with and without applied weighting, as well as overnight settling and decanting.

Scenario 2 (S2): Netting Followed by Dewatering Bag

A two-stage gravity-fed filtration approach was tested, using 1/8-inch hole coarse netting as a pre-filter followed by a 270 US Sieve dewatering bag to capture finer material.

Scenario 3 (S3): Dewatering Bags in Series

Effluent from the 80 US Sieve dewatering bag was gravity fed through a 270 US Sieve dewatering bag.

Scenario 4 (S4): Netting Followed by Multiple Dewatering Bags (Planned, Not Executed)

This scenario, outlined in the SOP (see Appendix X), proposed gravity-fed filtration through 1/8-inch coarse netting followed by 80 US Sieve and 270 US Sieve dewatering bags in series. Based on results from Scenario 3 showing minimal sediment capture, Scenario 4 was deemed unnecessary and was not conducted.

Scenario 5 (S5): Cartridge Filtration

Effluent from both the 80 US Sieve and 270 US Sieve dewatering bags were pumped through three 500 US Sieve cartridge filters in series.

Results

Four filtration scenarios (S1, S2, S3, S5) were executed during the pilot study, with multiple sub-samples collected within scenarios.

Scenario 1 (S1): Standalone Dewatering Bags

S1.80

Two hundred seventy-five gallons of sediment-water mixture from the IBC totes were gravity fed through the 80 US Sieve dewatering bag. Weights were placed on top of the bag to press out the water. Fifty gallons remained in the dewatering bag and 200 gallons of filtrate were collected. Organic sediment captured in the dewatering bag had a thick clay-like consistency with no turions observed (Figure 2).



Figure 2. Sediment captured in S1.80

S1.80.v2

A repeat of S1.80 was conducted without applying weights to the dewatering bag.

S1.270

Two hundred seventy-five gallons of sediment-water mixture from the IBC totes were gravity-fed through the 270 US Sieve dewatering bag. Initially, 80 gallons of filtrate were collected. Organic sediment captured in the dewatering bag had a thick clay-like consistency with no turions observed (Figure 3).



Figure 3. Sediment captured in S1.270

S1.270.decant

The 80 gallons of filtrate was kept undisturbed overnight and a sample of just the top 1/4 of the water column was collected to determine if any natural settling occurred.

S1.270.overnight

The dewatering bag was left undisturbed overnight and an additional 120 gallons of filtrate were collected and sampled independently from the original 80.

S1.500

Unfiltered sediment-water mixture from the totes was pumped through three 500 US Sieve filter cartridges. The cartridges clogged immediately and no effluent or sediment was collected.

Scenario 2 (S2): Netting Followed by Dewatering Bag

S2.270.net

Two hundred seventy-five gallons of sediment-water mixture from the IBC totes were gravity fed through the 1/8-inch hole netting. Organic sediment captured in the netting contained plant fibers, rocks and approximately ten turions (Figure 4).



Figure 4. Sediment captured in S2.270.net

S2.270

The filtrate from the 1/8-inch hole netting was gravity fed through the 270 US Sieve dewatering bag. Organic sediment captured in the dewatering bag had a fine clay texture with no turions observed (Figure 5).



Figure 5. Sediment captured in S2.270

Scenario 3 (S3): Dewatering Bags in Series

S3

The filtrate from S1.80 was gravity-fed through a 270 US Sieve dewatering bag. There was only a very fine-grained material collected but the amount was not sufficient for a sample to be collected.

Scenario 5 (S5): Cartridge Filtration

S5.80.500

The filtrate from S1.80.v2 was pumped through three 500 US Sieve filter cartridges. There were no solids collected as the material was completely retained within the cartridges (Figure 6).



Figure 6. Sediment captured in the three 500 US Sieve filter cartridges

S5.270.500

The filtrate from S1.270 was pumped through three 500 US Sieve filter cartridges. There were no solids collected as the material was completely retained within the cartridges (Figure 7).



Figure 7. Sediment captured in the three 500 US Sieve filter cartridges

The two tables below show the field and laboratory analytical results for both the filtrate water and the captured organic sediment solids. The average water and sediment concentrations for the West Lagoon are also provided in the respective tables as a point of comparison. West lagoon averages are based on samples taken from April through October.

Table 3. Water quality comparisons of OSR filtrate water samples vs West Lagoon water sample averages

EFFLUENT WATER	West Lagoon Avg.	S1.80	S1.80.v2	S1.270	S1.270.decant	S1.270.overnight	S2.270.net	S2.270	S3	S5.80.500	S5.270.500
Temperature (*C)	19	9	10	12	9	8	10	11	13	6	5
pH (su)	8.5	7.0	7.3	7.2	7.8	7.6	7.3	7.3	7.2	6.7	6.6
Turbidity (NTU)	3	699	140	98	97	189	412	352	568	68	80
Dissolved Oxygen (mg/L)	8.13	2.80	4.55	6.69	7.77	5.48	2.25	4.10	5.26	7.75	5.95
Electrical Conductivity (us/cm)	152	168	158	187	193	176	192	178	170	158	180
Ammonia (mg/L)	0.02	0.90	0.27	1.10	1.10	1.10	1.30	1.10	0.78	0.16	0.81
Nitrate (mg/L)	0.23	0.03	ND	0.03	0.05	0.03	0.04	0.09	0.15	ND	0.05
Total Phosphorus (mg/L)	0.01	0.28	0.11	0.11	0.14	0.08	ND	0.10	0.14	0.08	0.07
TKN (mg/L)	0.3	7.7	2.9	3.1	2.7	4.0	6.1	6.2	5.8	2.0	2.6
Orthophosphate (mg/L)	N/A	0.08	ND	ND	ND	0.02	ND	0.03	0.07	ND	0.03
Nitrite (mg/L)	N/A	0.05	0.04	ND	0.04	0.07	0.02	0.10	0.07	ND	ND
Total Dissolved Solids (mg/L)	N/A	190	110	140	140	150	180	160	120	110	120
Total Suspended Solids (mg/L)	N/A	1700	240	130	120	230	1000	640	1600	190	78

Table 5. Organic sediment solid comparisons of OSR sediment samples vs West Lagoon sediment sample averages

ORGANIC SEDIMENT SOLIDS	West Lagoon Avg.	S1.80	S1.80.v2	S1.270	S2.270.net	S2.270
Phosphorus (mg/kg)	175	130	ND	140	130	ND
Ammonia (mg/kg)	71	70	94	87	100	91
Nitrate (mg/kg)	ND	ND	ND	ND	ND	ND
TKN (mg/kg)	749	24	26	28	30	24

Discussion

Figure 8 presents a comparison of the turbidity levels from each of the filtrate samples with the West Lagoon average. The turbidity in each of the filtrate samples was appreciably greater than the average for the lagoon water. The lowest turbidity achieved was 68 NTU when the sediment was filtered in series using the 80 US Sieve bag and then through the three stage 500 US Sieve filter cartridges. The 270 into 500 US Sieve was slightly higher, at 80 NTU. Without the second stage filtering from the finer filter cartridges, achieving a turbidity under 100 NTU does not appear to be achievable.

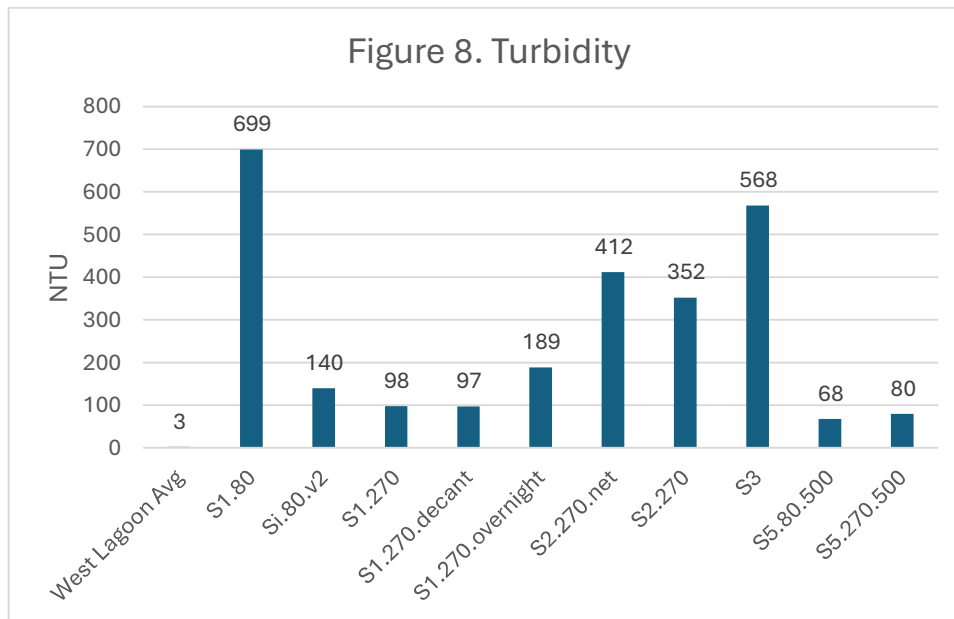


Figure 8. Turbidity

Figures 9 through 11 provide a comparison of the average nutrient concentrations ammonia, total Kjeldahl nitrogen (TKN), and total phosphorus, respectively, in the West Lagoon water column with those in each of the filtrate samples. TKN is a measurement of ammonia plus organic nitrogen and in the context of the Tahoe Keys lagoons is generally associated with reducing conditions (i.e., low dissolved oxygen). Oxidized forms of nitrogen, such as nitrate and nitrite, are generally not present at significant levels in water samples from the Tahoe Keys lagoons due to the highly reducing conditions associated with the organic sediment. Ammonia concentrations in the filtrate samples range from approximately 10 to over 50 times greater than the average lagoon water concentration. TKN and total phosphorus concentrations in the filtrate samples range from approximately 10 to 20 times the average lagoon water concentration.

Total dissolved solids (TDS) and electrical conductivity (EC) levels are relatively consistent across all the filtration scenarios, which is expected because the physical filtration is not likely to have had a significant effect on dissolved parameters.

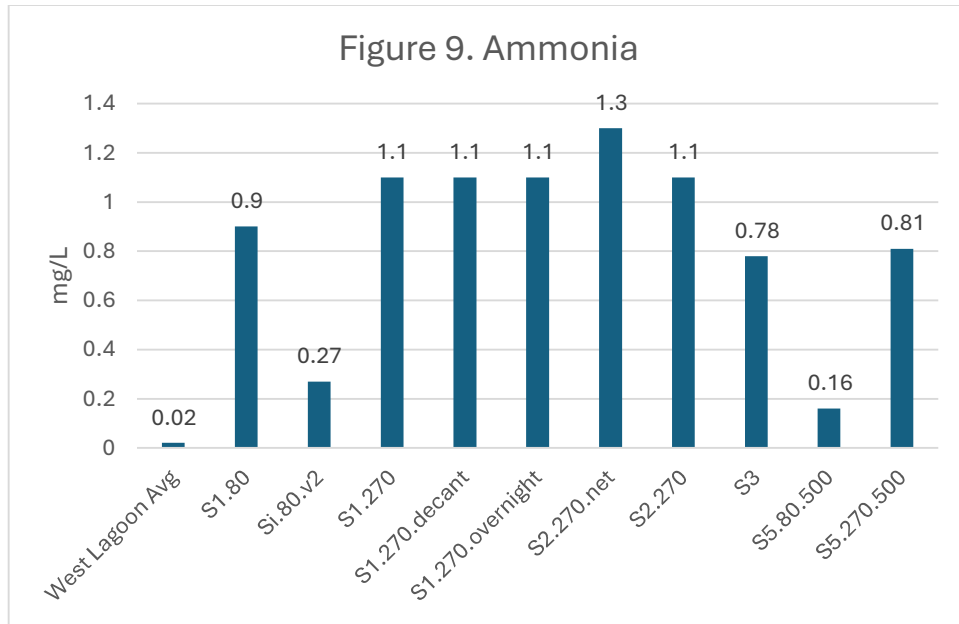


Figure 9. Ammonia

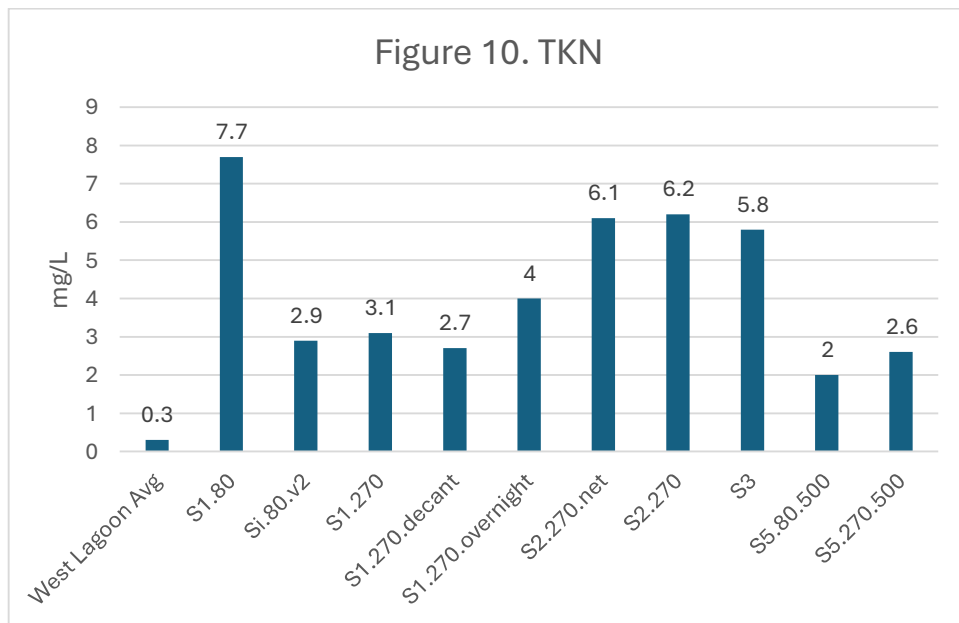


Figure 10. TKN

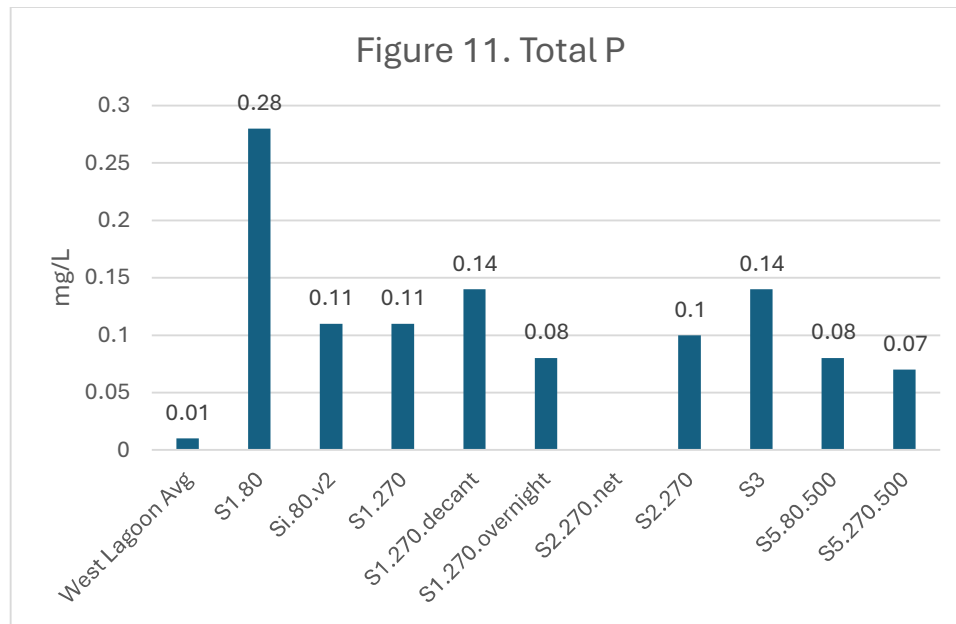


Figure 11. TKN

When comparing the averages for the West Lagoon water to the filtrate water samples, we were unable to reach comparable levels when it comes to the standard field water quality parameters (Turbidity, pH, DO, EC).

Conclusions

As stated in Section 1, the objective of the pilot study was to assess whether physical filtration of the organic sediment and water produced during suction dredging would result in water quality that would be acceptable to return to the Tahoe Keys lagoons. Certain filtration combinations may be sufficient to reduce turbidity and total suspended solids levels to allow return of the filtrate to the Tahoe Keys lagoons, as long as any impact in the lagoons would be temporary and short term, and as long as there would be no effect on water clarity near the channels leading to Lake Tahoe. However, all filtrate samples show significant increases in nutrient levels, with the concentrations being of concern for stimulating further AIS growth and/or the formation of harmful algal blooms (HABs).

Based on the nutrient results from this pilot study, the filtration methods tested are not appropriate for treatment of organic sediment and water produced by suction dredging, if the intent is to return the filtrate water back to the lagoons. For suction dredging to be feasible, other methods of filtering the organic sediment and nutrients would need to be identified.

Alternatively, nutrient sequestration in situ could be evaluated with a pilot study using lanthanum modified clay. The use of lanthanum modified clay was evaluated in the environmental review of the Control Methods Test and was allowed under the permits that were issued. However, it was never deployed during the Control Methods Test, so a field pilot test may be warranted at this time.

List of Preparers

The following individuals prepared the text presented in this report.

Name	Title	Role
Kristine Lebo	Waterways Manager/ AIS Program Coordinator	Primary Author and Editor
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Appendix - OSR Pilot SOP

Supplies

Sediment bag sizes

- 1/8in hole netting
- 6x6 at 80 us sieve
- 6x6 at 270 us sieve
- 3 filter cartridges 500 us sieve

IBC Totes

25yd intermodal roll off box

4in trash pump

3 cartridge filter housing

Sample jars

Process Steps

1. Sediment collection: Remove sediment from lagoon at Alpine and Venice corner between 20 – 80ft offshore (*See Figure 1*). Use 4in hose to pump sediment into IBC totes on shore. Check turbidity before and after pumping.
2. Sediment filtration: Pump sediment from IBC tote into sediment bag that is secure inside roll off box. Allow water to drain out of bag into roll-off box. Test water quality.
3. Sediment disposal: Pump water back into IBC totes to use for irrigation of common areas. Remove sediment bag. Test sediment. Dispose of sediment bag at refuse center.

Sediment Filtration Testing Scenarios

Scenario 1 “Stand alone”: Pump sediment directly into 80us sieve or 270us sieve or 500us sieve

Scenario 2 “Coarse filter”: Pump sediment through 1/8in pore mesh then into 80us sieve or 270us sieve

Scenario 3 “In series”: Pump sediment in series into 80us sieve first then take the outfall water and pump into 270us sieve.

Scenario 4 “Course series”: Pump sediment into 1/8in mesh then into 80us sieve then into 270us sieve.

Scenario 5 “Fine filters series”: Pump sediment in series into 80us sieve or 270us sieve first then take the outfall water and pump into 500us sieve.

Water Quality Testing

In House: Turbidity, Conductivity, pH, Temp, DO, Nitrate, Ammonia, Total Phosphorus, TKN

Lab Analysis: TSS, Nitrate, Ammonia, Total Phosphorus, TKN, TOC, Ortho P

Total samples estimated at: 6

Sediment Testing

In House: Turion Count

Lab Analysis: % Organic Matter, Nitrate, Ammonia, Total Phosphorus, TKN

Total Samples estimated at: 5



Figure 66. OSR Pilot Project 2025 Sediment Depth

14.0 APPENDIX F – DESCRIPTION OF DISCONTINUED METHODS

Seabins

A Seabin is a surface-skimming (pool skimmer-type) technology from Australia that actively collects debris floating on the water's surface. When a pump within the bin is switched on it creates a vortex that pulls debris into a collection net while allowing water to flow through the bin. When full, the collection net is removed from the unit and emptied.

In 2019, TKPOA deployed a single Seabin in the West Channel along the western bulkhead (shown in Figure 67) and again in 2020 using a floating dock to anchor the Seabin. The addition of the floating dock was an effort to combat wave and wind disturbance that frequently swamped (caused the Seabin to sink to the bottom of the channel) or dislodged the Seabin from its platform anchor in 2019. However, despite the new floating dock, the Seabin was plagued with operational challenges caused by the frequent wind and wave disturbance and required significant maintenance (up to four times weekly). TKPOA Water Quality staff ultimately removed the Seabin in September of 2020 with a recommendation of utilization in areas with less wind and wave disturbance, or to invest in a wave attenuator to protect the Seabin to improve its effectiveness.

The Seabin project in the Tahoe Keys was placed on hold during the 2021 and 2022 seasons and was discontinued in 2023 due to the conditions of the West Channel being inadequate for the Seabin to properly function.



Figure 67. Seabin attached to the West Channel bulkhead.

Dock Bubblers

In 2020, TKPOA began researching the potential use of dock bubblers to manage algae within the Keys Lagoons. This concept was first proposed to TKPOA's WQC in 2018-2019 by TKPOA residents. The 2020 TKPOA Water Quality Special Assessment ballot initiative included funding for the purchase of five dock bubblers (e.g., Figure 68) for installation in the West Lagoon. Installation of dock bubblers in Spring 2021 was postponed due to a combination of low water and limited staffing.

In 2022, TKPOA temporarily installed a type of dock bubbler on homeowners' docks in CMT combination UV-C/herbicide treatment sites to assist with mixing and dissipation of herbicides. No data was collected, and the bubblers were removed in late 2022. Deployment of dock bubblers is planned in future years in areas that may be prone to algal blooms. Dock bubblers were not employed starting in 2023 but may be used in the future.



Figure 68. Example of a dock bubbler

Rotovating

Rototilling underwater or rotovating describes underwater tillage of aquatic plants. Like tilling on land, rototilling tills the hydrosol to remove plants, particularly roots and rhizomes. This requires specialized machinery that can access aquatic weeds either from shore, or more typically, from a barge. The depth that the unit tills depend on the size of the tines used and typically rotovators till eight to 10 inches into the sediment or hydrosol. Rotovators (Figure 69) are not usually fitted to collect fragments of plants or rhizomes created by tilling.



Figure 69. Rotovator

Floating Treatment Wetlands

Floating Treatment Wetlands (FTW) are artificial structures created with the goal of improving water quality. Woven from dense, recycled-plastic fibers, the islands provide a space for plants to quickly flourish and create biofilm. As plants establish themselves across the FTWs, the root structure mass increases and grows to deeper depths of the water column. Biofilm, also known as beneficial microbes, increases as plant structure increases. This biofilm rids the water of excessive nutrients, creating a cleaner and healthier body of water. In 2020, the AIS Program at TKPOA installed 15 Floating Treatment Wetlands in two locations within Lake Tallac (Figure 70) to improve water quality conditions. This project acted as a pilot study to determine the effectiveness of FTW and if they are viable in the West Lagoon.

The project objectives were as follows

- Reduce nutrients and suspended solids within the water column.
- Protect and enhance habitat for native “non-nuisance” species in the Keys Lagoons.
- Protect recreation in the Tahoe Keys Lagoons which are available for public access and use.
- Help prevent public health issues through reducing an environment for harmful and dangerous algae blooms as well as mosquito infestations.
- Improve the City of South Lake Tahoe’s storm water management.

It was determined that FTW’s were ineffective in achieving all the above. More details on the monitoring SOP and results can be found in the 2020 Lake Tallac Control Projects Report (TKPOA 2020b).

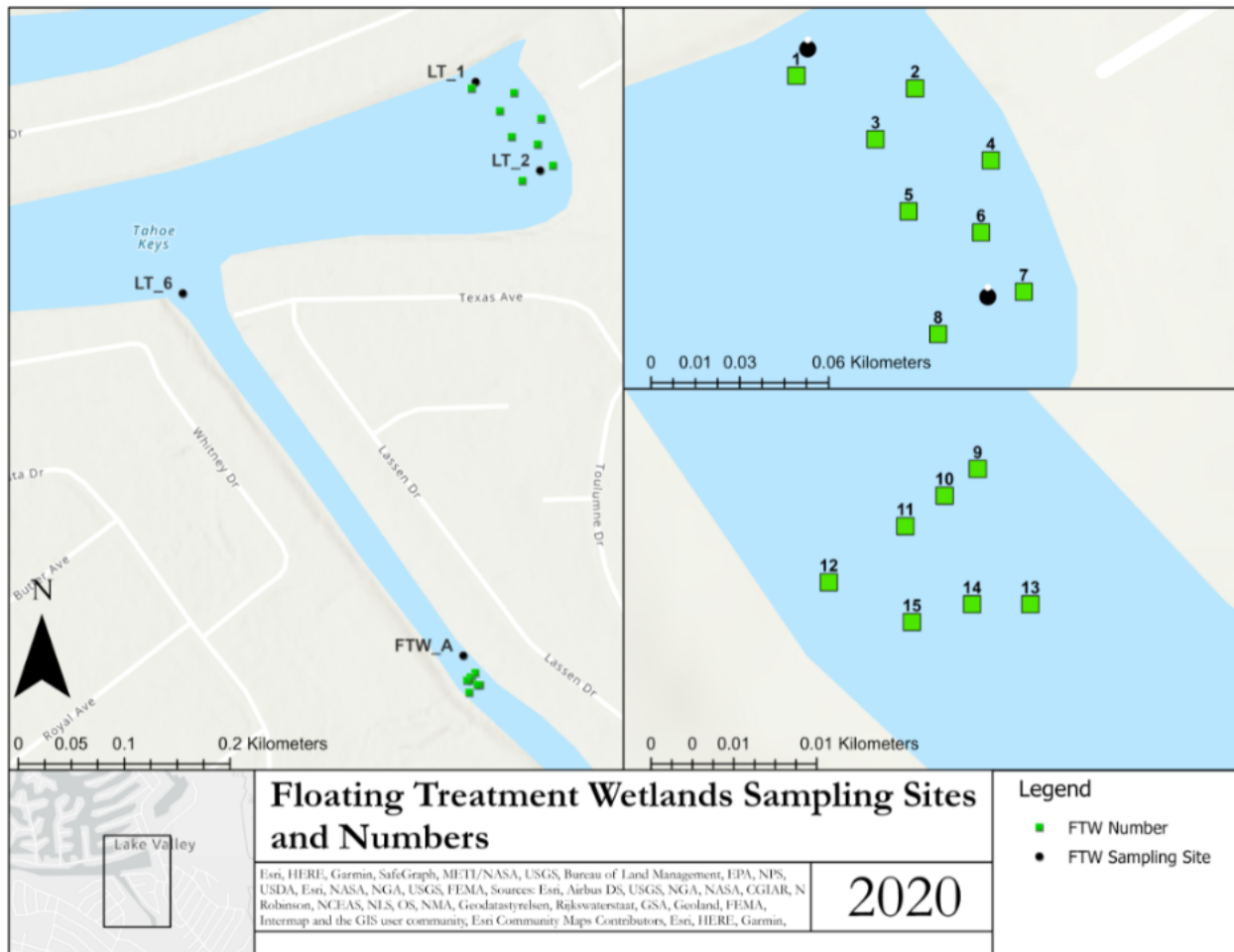


Figure 70. Map of floating treatment wetlands sites

15.0 APPENDIX G – ACRONYMS AND ABBREVIATIONS

°C	Celsius
µS/cm	microsiemens per centimeter
µg/L	micrograms per liter
AIS	Aquatic Invasive Species
BMPs	Best Management Practices
CDPR	California Department of Pesticide Regulation
CEQA	California Environmental Quality Act
CLP	Curlyleaf pondweed
CMT	Control Methods Test
DO	Dissolved oxygen
EC	Electrical conductivity
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Environmental Science Associates
FTW	Floating Treatment Wetlands
IQR	Interquartile Range
HAB	Harmful Algal Bloom
IMP	Integrated Management Plan
Keys Lagoons	Tahoe Keys Lagoons
LFA	Laminar Flow Aeration
Lahontan	Lahontan Regional Water Quality Control Board
LRWQCB	Lahontan Regional Water Quality Control Board
LTSLT	League to Save Lake Tahoe
m	meters
mg/L	milligrams per liter
mV	millivolts
NPS	Nonpoint Source Pollution
NTU	Nephelometric Turbidity Unit
ORP	Oxidation reduction potential
PAR	Photosynthetically Active Radiation
SEA	Sierra Ecosystem Associates
SOP	Standard Operating Procedure
STR	South Tahoe Refuse
TKN	Total Kjeldahl nitrogen
TKPOA	Tahoe Keys Property Owners Association
TN	Total nitrogen
TRPA	Tahoe Regional Planning Agency
TRCD	Tahoe Resource Conservation District

UNR	University of Nevada, Reno
USFS	United States Forest Service
UV-C	Ultraviolet Light Treatment
WDR	Waste Discharge Requirements
WC	Waterways Committee (previously Water Quality Committee)
WTP	Water Treatment Plant
YPL	Yellow Pond Lily