# TAHOE KEYS PROPERTY OWNERS ASSOCIATION

## TAHOE KEYS LAGOONS AQUATIC WEED CONTROL METHODS TEST

## BIOLOGICAL RESTORATION REPORT AND CERTIFICATION

**FEBRUARY 28, 2025**

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Prepared for
Tahoe Keys Property Owners Association

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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AIP | Aquatic Invasive Plants |
| APAP | Aquatic Pesticide Application Plan |
| APAP Amendment 1 | Aquatic Pesticide Application Plan Amendment 1 |
| BB | Bottom Barriers |
| BMI | Benthic Macroinvertebrates |
| CalEPA | California Environmental Protection Agency |
| CeDe | coontail |
| CMT | Control Methods Test |
| COLD | Cold Freshwater Habitat |
| DASH | Diver Assisted Suction Harvesting |
| DEIR/EIS | Draft Environmental Impact Report/Environmental Impact Statement |
| DO | Dissolved Oxygen |
| ElCa | Elodea |
| ESA | Environmental Science Associates |
| EPT | Ephemeroptera, Plecoptera, Tricoptera |
| IBI | index of biological integrity |
| Lahontan | Lahontan Regional Water Quality Control Board |
| League | League to Save Lake Tahoe |
| LFA | Laminar Flow Aeration |
| MMRP | Mitigation Monitoring and Reporting Program |
| MRP | Monitoring Reporting Program |
| NPDES | National Pollutant Discharge Elimination System Permit |
| Project | Tahoe Keys Lagoons Aquatic Weed Control Methods Test Project |
| QA/QC | Quality Assurance/Quality Control |
| QAPP | Quality Assurance Project Plan |
| SEA | Sierra Ecosystem Associates |
| SWAMP | Surface Water Ambient Monitoring Program |
| TKPOA | Tahoe Keys Property Owners Association |
| TRCD | Tahoe Resource Conservation District |
| TRPA | Tahoe Regional Planning Agency |
| UV-C | Ultraviolet light |
| UV-C Combo | UV-C Combination (treatments of both herbicide and UV-C) |
| WDR | Waste Discharge Requirements |

# 1.0 INTRODUCTION

The Tahoe Keys Property Owners Association (TKPOA) implemented a three-year test in two of the three Tahoe Keys lagoons from 2022 through 2024 with the goal of achieving and maintaining a 75% reduction in Aquatic Invasive Plants (AIP) through use of various treatments/applications in test sites (see Appendix Y of the Year 3 Annual Report). This report evaluates data collected during the Tahoe Keys Lagoons Aquatic Weed Control Methods Test (CMT) Project to determine if the sites that received herbicide applications and Ultraviolet light (UV-C) treatments have recovered or returned to 'typical' conditions. Restoration (recovery) indicates that the conditions in the lagoons reflect pre-project conditions or better (TKPOA 2022a).

According to Section 8.9 of the CMT Project Aquatic Pesticide Application Plan (APAP) Amendment 1, a qualified biologist must evaluate data including water quality, macrophytes, and BMI during the last year of the CMT Project (Year 3). Using this evaluation, a biologist must prepare a restoration report to certify that restoration has been achieved within two years post-herbicide application (TKPOA 2022a). To evaluate restoration in the treatment sites, pre-CMT data and 2024 CMT Project Control (untreated) site data are compared to data collected in 2024 at UV-C and herbicide application sites. Note that herbicide applications only occurred once in 2022, whereas UV-C treatments were repeated throughout the CMT Project. Restoration in the lagoon treatment areas is based on key ecosystem indicators as identified in APAP Amendment 1 (TKPOA 2022a).

## 1.1 Overview and Summary Results

The biological assessments described later in this report detail data collected for specific aquatic parameters in the Tahoe Keys West and Lake Tallac lagoons. These parameters were selected based on the crucial function they serve in the health of the lagoons' aquatic ecosystems and based on discussions with Lahontan staff. The following metrics were evaluated in the lagoons:

- Macrophytes (native aquatic plants)
- Water Quality (multiple parameters)
- Benthic Macroinvertebrates (BMI)

Additionally, results from sediment sampling for residual herbicides are included in this report to address restoration of lagoon sediments to pre-herbicide application conditions. Only the selected indicators for restoration (listed above and in Section 8.9 of APAP Amendment 1) are evaluated in the following sections. For detailed assessments regarding all data collected during the CMT Project, see the CMT Annual Reports.

In summary, Section 2.0 (Results) below and later sections demonstrate that restoration has been achieved in both the West and Tallac lagoons for all metrics evaluated. In addition, laboratory analyses results were non-detect for Endothall and Triclopyr and their degradants for lagoon sediments sampled in 2022 and 2024, respectively.

The data analyses presented in Section 2.0 are organized to first describe the data results, collection protocol, and evaluation methods, then to evaluate the pre- and post-project data for both the West and Lake Tallac lagoons for each data category. This report represents post-treatment data within two years of herbicide applications as defined in the Lahontan National Pollutant Discharge Elimination System (NPDES) Permit for the CMT Project (Lahontan 2022).

## 1.2 Scope of the CMT Project

Year 1 of the CMT Project tested stand alone, one-time applications of herbicides, UV-C, and Laminar Flow Aeration (LFA). Combination treatments using herbicide and UV-C ("UV-C Combo") were also planned for Year 1; however herbicides were only applied to the shoreline areas in the Combo Sites because the UV-treatment boats were unable to access these sites. The UV-C treatments in the Combo Sites began in Year 2 and continued in Year 3. Herbicides were not applied in Years 2 and 3 of the Project.

As described in the Year 1 CMT Annual Report, the CMT applied two California Environmental Protection Agency- (CalEPA) approved aquatic herbicides. Endothall (Aquathol K potassium salt) was applied to achieve a concentration of 2 ppm in small areas of both the West and Lake Tallac lagoons, while Triclopyr Renovate 3 (liquid) and Renovate "OTF" (granular) were applied to achieve a concentration of 1 ppm in small areas of the West Lagoon only (TKPOA 2023a). A total of approximately 15.5 acres of surface area in the West Lagoon received two types of herbicide applications distributed across 12 separate sites, whereas only one 2-acre site in the Lake Tallac Lagoon received one type of herbicide (Endothall). UV-C treatments at the UV-C Only sites were applied and replicated in subsequent years of the CMT Project using vessels containing LED UV-C light arrays (IRI 2023).

Non-herbicide treatments were used in Years 2 (2023) and 3 (2024) of the CMT Project to determine if the initial reduction or "knock-back" in AIP species achieved in Year 1 could be sustained. Replicated spot treatments consisting of Bottom Barriers (BB), Diver Assisted Suction Harvesting (DASH), and UV-C were used in Years 2 and 3. The locations of the spot treatments were based on the target plants present, size of infestation, and location of infestation (TKPOA 2023a). The same treatments implemented in Year 2 were implemented in Year 3 with some expansions to bottom barrier and UV-C test areas.

For more information on CMT treatments throughout the years, please see the CMT Annual Reports. While the CMT Project tested multiple treatments, only herbicide and UV-C test areas are evaluated for recovery in this report as required by the Lahontan NPDES Permit (2022) and Draft Environmental Impact Report (DEIR)/Environmental Impact Statement (EIS) (Lahontan and TRPA 2020).

## 1.3 NPDES Requirements for Assessing Biological Restoration

Per the NPDES Permit, the Discharger (i.e., TKPOA) must characterize impacts of the chemical discharges on aquatic life in application sites The aquatic communities and conditions of physical aquatic habitat must be documented post-Project through biological monitoring techniques (Lahontan 2022). The NPDES states that a qualified biologist must provide a certification assessing restoration of non-target aquatic life and benthic communities within treatment areas two years post-treatment (post-herbicide application). The certification must be accompanied by a report detailing the pre-project and post-project monitoring (Lahontan 2022). Requirements from the NPDES for the "biological assessment" report include:

- certification that all affected non-target biological communities have been restored,
- a detailed description of pre-project and post-project monitoring,
- an explanation of assessment methods used, and
- rationale for certification.

## 1.4 APAP Amendment 1 Requirements for Assessing Biological Restoration

APAP Amendment 1 describes the ecosystem recovery indicators as native fish, BMI and native plant species (excluding coontail, a target species for this project). Since warm water, non-native fish primarily occupy the lagoons, native fish have been removed as an indicator of recovery as stated in Section 8.9 of APAP Amendment 1. And although native plant species and BMI are the identified indicators for achieving restoration in the lagoons, Section 8.9 of APAP Amendment 1 also lists water quality as a category for evaluating recovery.

The above-mentioned documents that describe the indicators for restoration also present general criteria for achieving recovery. For the macrophyte data, APAP Amendment 1 states that "fully restored means plant composition will be similar to or show increases in native species presence and/or diversity compared to pre-test conditions." Additionally, aquatic plant restoration has been achieved if the structure and function of native macrophytes is similar to pre-project conditions (TKPOA 2022a). A detailed evaluation of the effects of the CMT treatments on target plant species is presented in the CMT Year 3 Annual Report.

APAP Amendment 1 also provides details for BMI recovery where a reduction in tolerant BMI species would indicate that the lagoons have become less degraded and "able to support more diverse species." As described in APAP Amendment 1, the metrics for the BMI recovery evaluation are:

- "Function will be judged by the metrics and indices related to trophic levels (e.g., functional feeding groups) and productivity (e.g., abundance biomass).
- Structure will be judged on metrics and indices related to richness and diversity (e.g., taxa richness, multivariate observed/expected) model predictions, multivariate ordination and presence of sensitive and rare taxa."

APAP Amendment 1 further states that the lagoons restoration status evaluation will be based on comparisons with both pre-CMT and post-CMT conditions in untreated Control sites due to the variable water levels present year-to-year. Since the NPDES Permit and APAP Amendment 1 do not specifically describe criteria for water quality restoration, general statements from Section 8.9 of APAP Amendment 1 (comparisons of pre-CMT and post-CMT conditions) were used to develop the criteria for water quality restoration.

## 1.5 Other CMT Documents Reviewed for Assessing Biological Restoration

The evaluation criteria used in this report are based on guidelines and details provided by the NPDES Permit and APAP Amendment 1 as described above. The Permit and APAP Amendment describe herbicide test sites as areas of focus for the restoration report; however, the DEIR/EIS (Lahontan and TRPA 2020) identify UV-C treatment sites as areas that also require assessment post-project. As a result, this report includes an evaluation of data collected at CMT sites where UV-C treatments occurred in addition to areas that received herbicide applications in 2022. Other CMT documents reviewed for addressing post-Project biological restoration were:

- Final EIR/EIS,
- Mitigation Monitoring and Reporting Program (MMRP),
- Lahontan Findings of Fact Resolution No. R6T-2022-0002 Attachment A, and
- TRPA CMT Environmental Improvement Program Permit.

The above documents do not discuss the selected indicators relative to post-Project restoration, rather, they detail mitigation measures and Best Management Practices (BMP) for the CMT Project. For more information regarding the implementation of these measures, see the CMT Annual Reports.

Related to biological restoration of the lagoons, biological surveys and reporting were completed pre- and post-CMT treatment (spring/fall 2022-2024) on an annual basis per the NPDES and APAP Amendment 1 requirements. As part of the surveys, surface aquatic and riparian habitat conditions in treatment sites were evaluated (“ecotonal surveys”) to determine if the areas would be/were impacted by CMT treatments. The ecotonal surveys resulted in no observations of adverse impacts associated with project activities. For more information regarding the findings of the biological surveys, see the CMT Ecotonal Reports (TKPOA 2022b, 2022c, 2023b, 2023c, 2024a, 2024b).

## 1.6 Evaluation Criteria

While the evaluations in Section 2.0 are structured to fit the characteristics of each data type, the general criterion for achieving restoration remains basically the same. If one or both datasets that received no treatments from 2022 through 2024 (i.e., pre-CMT and 2024 CMT Control Site datasets) are similar to the 2024 treatment site datasets, then restoration has been achieved. Impacts as a result of herbicide applications or UV-C treatments will be considered significant if the 2024 treatment site data is substantially different from the pre-CMT data and 2024 Control site data. All major differences across the datasets for each data type will be noted.

## 2.0 RESULTS

This report evaluates native plant species (excluding coontail), water quality, and BMI as indicators for post-CMT Project restoration in the Tahoe Keys lagoons. Fish, as mentioned previously, were eliminated as an indicator due to the abundance of invasive, warm water fish in the lagoons. Fully restored for each of the indicators means that the conditions in the lagoons reflect pre-project conditions or better (Lahontan 2022). Summary conclusions for each of the indicators analyzed in this report are detailed below.

### 2.1 Plants (Native)

Macrophytes are one of the selected indicators of habitat restoration and/or improvement following implementation of the CMT, specifically, the recovery of native plants (excluding coontail). The metrics used to evaluate the macrophyte data are frequency of occurrence and biovolume percent. The 2024 post-treatment data for the aquatic plants in Section 3.1.3 of this report shows that native plant species have increased, and AIP species have decreased in both occurrence and biovolume for the West and Lake Tallac lagoons when compared to 2020 and CMT 2024 Control site conditions. This indicates that restoration has been achieved for both the West and Lake Tallac lagoons.

### 2.2 Water Quality

The parameters that were selected for evaluating water quality in the lagoons are temperature, pH, turbidity, and DO. These parameters were required to be monitored during the CMT Project as they impact other aquatic life through complex interrelationships. While the temperature in 2019 varied from 2024 temperatures, both contained similar ranges, and the 2024 Control site data remained consistent with the application/treatment sites data both in the West and Lake Tallac lagoons (Figures 8 and 9). A similar pattern occurred for all the water quality parameters when comparing the 2019 and 2024 datasets (Figures 10 through 15). In every case, the 2024 application/treatment site datasets were similar to the 2024 Control site datasets, indicating restoration for water quality in the West and Lake Tallac lagoons.

### 2.3 Benthic Macroinvertebrates (BMI)

The metrics used to analyze BMI in the lagoons are overall richness, EPT richness, diversity, tolerance, and function. These metrics, used in combination with the IBI, resulted in a detailed evaluation of BMI data, which can be reviewed in the BMI Summary Report (Attachment B). As described in Section 3.3.3 of this report, data collected from the 2024 sampling event showed all the metrics as either being statistically equivalent to the pre-treatment values (2022) or showing improvement from pre-treatment values in both the West and Lake Tallac lagoons. Overall richness has increased in some cases, and tolerance has decreased, suggesting that water quality may have improved in treatment sites post-treatment. As a result, restoration for BMI in the West and Lake Tallac lagoons has been achieved.

# 3.0 DATA COLLECTION METHODS AND ANALYSES

The data collected from biological monitoring pre- and post-CMT Project herbicide applications and UV-C treatments are presented and evaluated below with respect to whether the Tahoe Keys lagoons have been restored to pre-project conditions or better. While considerable additional monitoring data was collected for the CMT Project, it is not evaluated in this report. The following sections address data collection and assessment for macrophytes, then water quality, and lastly, BMI. All the data analyzed below were collected in accordance with the National Lakes Assessment Field Operations Manual (EPA 2017).

## 3.1 Macrophytes (Including Target and Non-Target Species)

SEA, under contract by TKPOA, has conducted annual aquatic macrophyte surveys since 2015 to measure aquatic plant composition, frequency of occurrence, and species abundance in the Tahoe Keys lagoons. To assess restoration in the lagoons, an evaluation of frequency of occurrence and biovolume percent data in the West and Lake Tallac lagoons is presented in Section 3.1.3. The evaluation criteria are based on the following datasets:

- 2020 Pre-treatment data,
- 2024 CMT Control site data, and
- 2024 CMT Herbicide Application/UV-C Treatment site data

The treatment sites that are evaluated include Herbicide Only sites, UV-C Combo sites (i.e., both herbicide and UV-C treatments), and UV-C Only sites. The data collection methods, data evaluation method, and the macrophyte restoration evaluation are provided below.

### 3.1.1 Data Collection Methods

Macrophyte surveys and reporting are conducted on an annual basis as required by the Waste Discharge Requirements (WDR) permit issued by the Lahontan Regional Water Quality Control Board (Lahontan), Order No. R6T-2014-0059 on July 18, 2014. The macrophyte survey reports summarize the results of annual aquatic macrophyte surveys completed in the Tahoe Keys lagoons (TKPOA 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022d, 2023d, 2024c, 2025). Data from these surveys in addition to data collected from hydroacoustic scanning were used to generate aquatic plant species metrics within the application and treatment sites. This report evaluates macrophyte data from 2020 (pre-CMT) and 2024 (CMT Year 3). The timing of the annual macrophyte surveys, data sampling method, percent composition metric, and hydroacoustic scan data are described in the following sections.

#### 3.1.1.1 Data Collection Timing

The annual aquatic macrophyte surveys have occurred from late June to mid-July since 2015. This survey focuses on submersed and floating-leaf aquatic plants in the littoral

zones of the surveyed areas in the three Keys lagoons. This timing was selected to be an identifiable point in the growing season and to capture germinating, sprouting, flowering, and fruiting stages, and typically high abundance of the various species. Note that the data used in the analyses below represent a 'snapshot' of the aquatic plants in late June/early July only and do not capture plant changes throughout the season. Results of the 2022 through 2024 CMT Project will be fully addressed in the CMT Draft Final Report that is scheduled for submittal to Lahontan April 30, 2025.

#### 3.1.1.2 Data Sampling Method

The point-intercept rake sampling method is used to determine percent species composition. Point-intercept sampling involves vertically inserting a double-tined, telescoping pole-mounted "thatch" rake into the water until reaching the bottom, twisting the attached vertical pole when retrieving the rake, identifying the plant species present, and recording percent composition of the plant species in the retrieved rake sample.

Hydroacoustic scanning is used to determine percent biovolume of aquatic plants in the lagoons. Hydroacoustic scanning uses sonar technology to determine and record a water body's depth, presence of plant matter, plant height, and biovolume percent. Scans are made using a Lowrance HDS Live 7 unit attached to a boat. The system is fine-grained, collecting data at a frequency of 10 times per second. The digitized data is uploaded to and interpreted by BioBase, a third-party data processing subscription service company.

#### 3.1.1.3 Frequency of Occurrence

After being visually assessed, the percentage of species composition of each rake sample is recorded and photographed. The composition of each species is represented as a percentage of the rake sample. Georeferenced sample locations are accessed by boat, typically along regularly spaced and somewhat linear transects according to conditions of the area. Percent composition data from the 2020 and 2024 annual macrophyte surveys are used to calculate frequency of occurrence. Frequency of occurrence is the rate at which a plant species appears within a given sample. This metric does not measure abundance but measures the presence/absence of a species. Thus, a high percentage frequency indicates the species is very common and a low percent frequency means that a species is rare, or uncommonly encountered.

#### 3.1.1.4 Biovolume

Biovolume represents the percentage of the water column occupied by plant matter at each sonar ping (acoustic signal) collected during hydroacoustic scanning (see Appendix I of the Year 3 Annual Report). The calculation for percent plant biovolume is plant height divided by water depth multiplied by 100 for each location along a traveled path. Biovolume values range from 0% (bare bottom with no plants in water column) to 100% (vegetation growth sonar signal 'returns' from the bottom to the surface). Hydroacoustic scans are conducted on a regular basis by TKPOA Water Quality staff to track the growth of aquatic macrophytes throughout the season. The scans used for analysis in this report

are those that closely coincided with the timing of the annual macrophyte surveys (late June to early July). To calculate species biovolume, the following data are used:

- Spatial data (polygons) of areas to be analyzed,
- Macrophyte rake sample data, and
- Hydroacoustic scan (total plant biovolume) data from BioBase.

Species composition (%) data from rake sampling and hydroacoustic scan data are used to calculate percent biovolume by species. Percent biovolume by species is analyzed by extracting hydroacoustic scan biovolume percent data at all macrophyte sampling locations within the areas of analysis using ArcGIS Spatial Analyst. This gives species composition at positions where TKPOA hydroacoustic scan biovolume data were taken. The two datasets are then multiplied to form a biovolume percentage for each data point and species.

### 3.1.2 Data Evaluation Method

The 2020 (pre-treatment) and 2024 (post-treatment) data collection years were selected to evaluate macrophyte restoration in the West and Lake Tallac lagoon herbicide application and UV-C treatment sites. Note that herbicide was only applied in 2022, while UV-C treatments were in progress throughout the 2022-2024 data collection seasons. Spatial data obtained from macrophyte rake sampling and hydroacoustic scan transect sampling for species occurrence were analyzed using the percent composition data obtained from the annual macrophyte rake point-intercept surveys for both the 2020 and 2024 datasets.

The two primary vegetation metrics that assess biological restoration, as defined in this section, are plant species frequency of occurrence and percent biovolume. For the frequency of occurrence metric, restoration for macrophytes has occurred if:

- the AIP species have decreased or are similar in occurrence and
- native species occurrence rates are similar to or show increases in presence and/or diversity compared to pre-treatment (2020) conditions.

For the biovolume percent metric, restoration for macrophytes has occurred if

- the 2024 plant composition in UV-C treatment and 2022 herbicide application sites is similar to, or shows increases in native species presence and/or diversity compared to the pre-treatment conditions (2020) or
- the 2024 plant compositions in CMT application/treatment sites are similar to or show increases in native species presence and/or diversity compared to the untreated Control sites (2024).

The 2020 data collection year was selected for comparison to the 2024 datasets because it is the baseline year for tracking the AIP relative to the TRPA Threshold Standard. The 2020 water year also represents recent and ‘typical’ conditions for the lagoons (see Figure 16), meaning the lake level conditions and lagoon water volumes are consistent with average water years. For the macrophyte analyses and graphs presented later in this report, comparisons were limited to data collected from late June to early July.

### 3.1.3 Macrophyte Restoration Evaluation

The aquatic plant species that are used to assess restoration in the lagoons are AIP target species and native desirable species. The scientific and common names for the species present in each category are presented below.

AIP (Target) Species

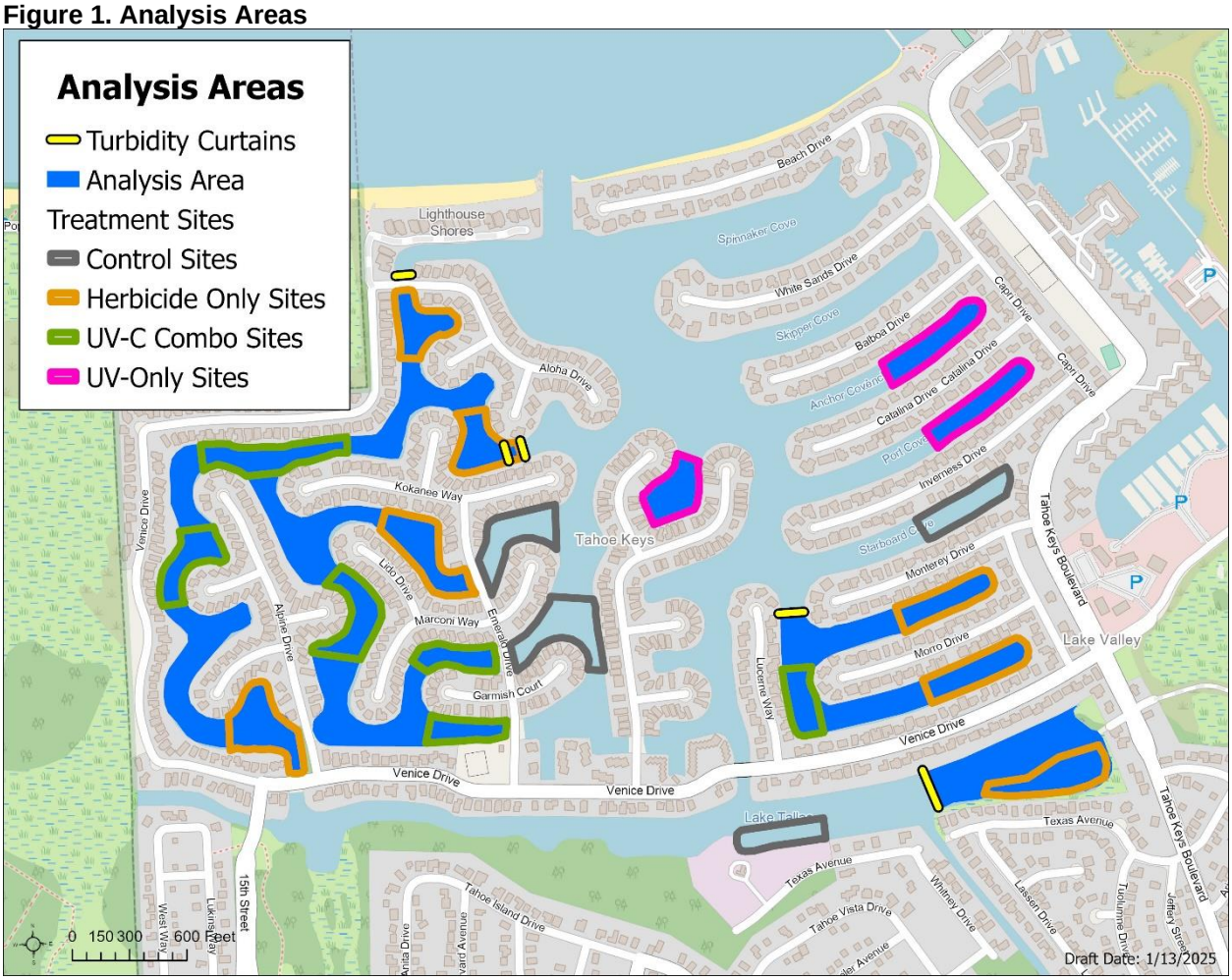
- *Myriophyllum spicatum* (Eurasian watermilfoil)
- *Potamogeton crispus* (curlyleaf pondweed)
- *Ceratophyllum demersum* (coontail)

Desirable (Non-target) Native Species

- *Potamogeton richardsonii* (Richardson's pondweed)
- *Potamogeton foliosus* (leafy pondweed)
- *Elodea canadensis* (elodea)
- *Brasenia schreberi* (watershield)
- *Myriophyllum quitense* (Andean watermilfoil)
- various species of macro-algae and filamentous algae including Nitella, Chara, Spirogyra.

Figure 1 depicts the regions of the lagoons that were analyzed for macrophyte restoration in this report. All areas behind the turbidity curtain barriers in the West and Lake Tallac lagoons were analyzed due to the potential effects of the CMT herbicide applications and UV-C treatments. The data was obtained from rake samples collected in the blue areas shown in Figure 1 on an annual basis (2020 and 2024) as part of the annual macrophyte survey. Attachment A contains the raw macrophyte data and data tables used to create the following graphs.

**Figure 1. Analysis Areas**




*The polygons represent CMT herbicide application and UV-C treatment sites.

#### 3.1.3.1 Frequency of Occurrence

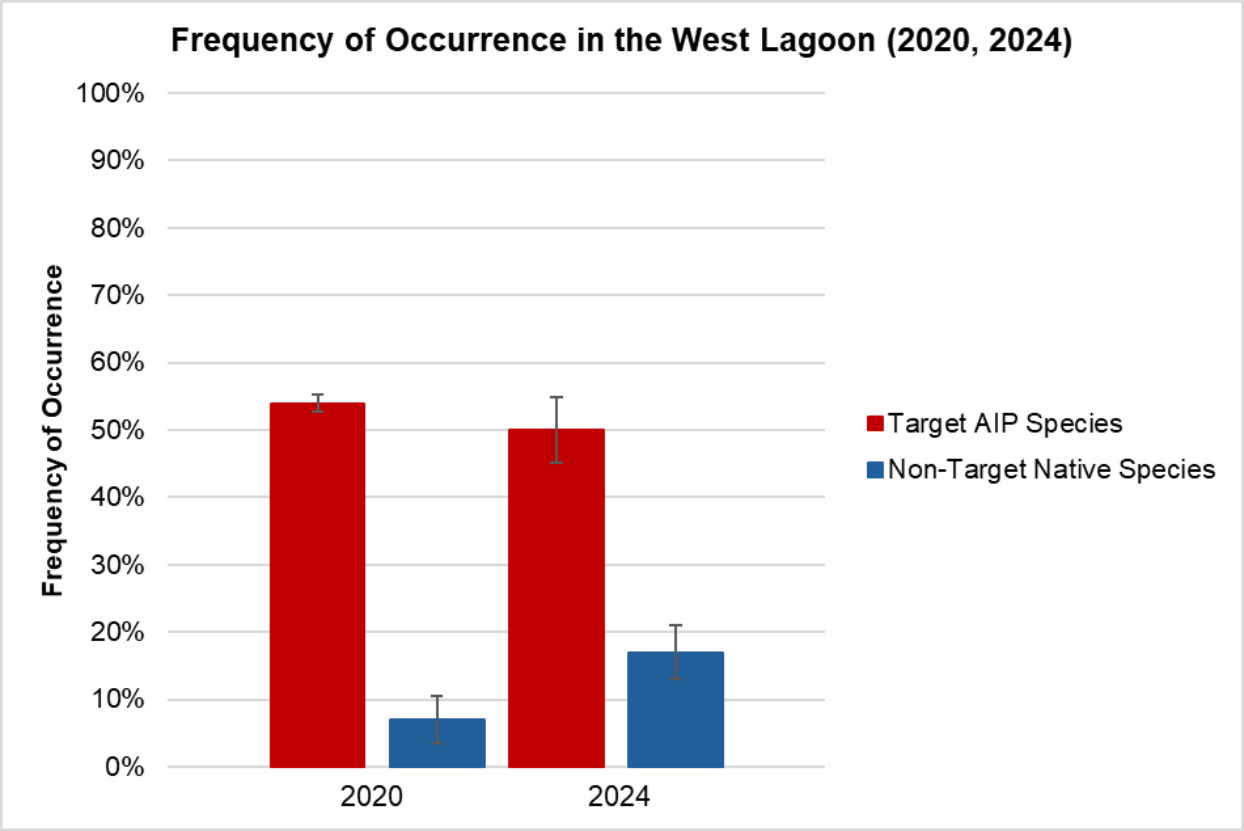
This analysis focuses on average percent frequency of occurrence for target AIP species and desirable (non-target) native species in the areas shown in Figure 1. The West and Lake Tallac lagoons contain different ecosystem characteristics, such as connection or isolation from Lake Tahoe. As a result, the graphs below present data from each lagoon separately.

*West Lagoon*

The West Lagoon occurrence rates for 2020 and 2024 are displayed in Figure 2 below. Standard error bars are included in the figure to show the accuracy and variability of the data. All the West Lagoon occurrence rate data have a standard error of 5% or less. The target AIP species occurrence rate decreased from 54% in 2020 to 50% in 2024. In 2020, the frequency of occurrence for “non-target” native species was 7%. In 2024, the native species occurrence rate increased to 17%. The 2024 AIP species occurrence rates in the West Lagoon are lower than pre-treatment (2020) conditions while the native species occurrence rates increased. Considering this data, the frequency of occurrence metric for

macrophyte species shows restoration and improvement in the West Lagoon herbicide application and UV treatment areas.

**Figure 2. Frequency of Occurrence in the West Lagoon (2020, 2024)**

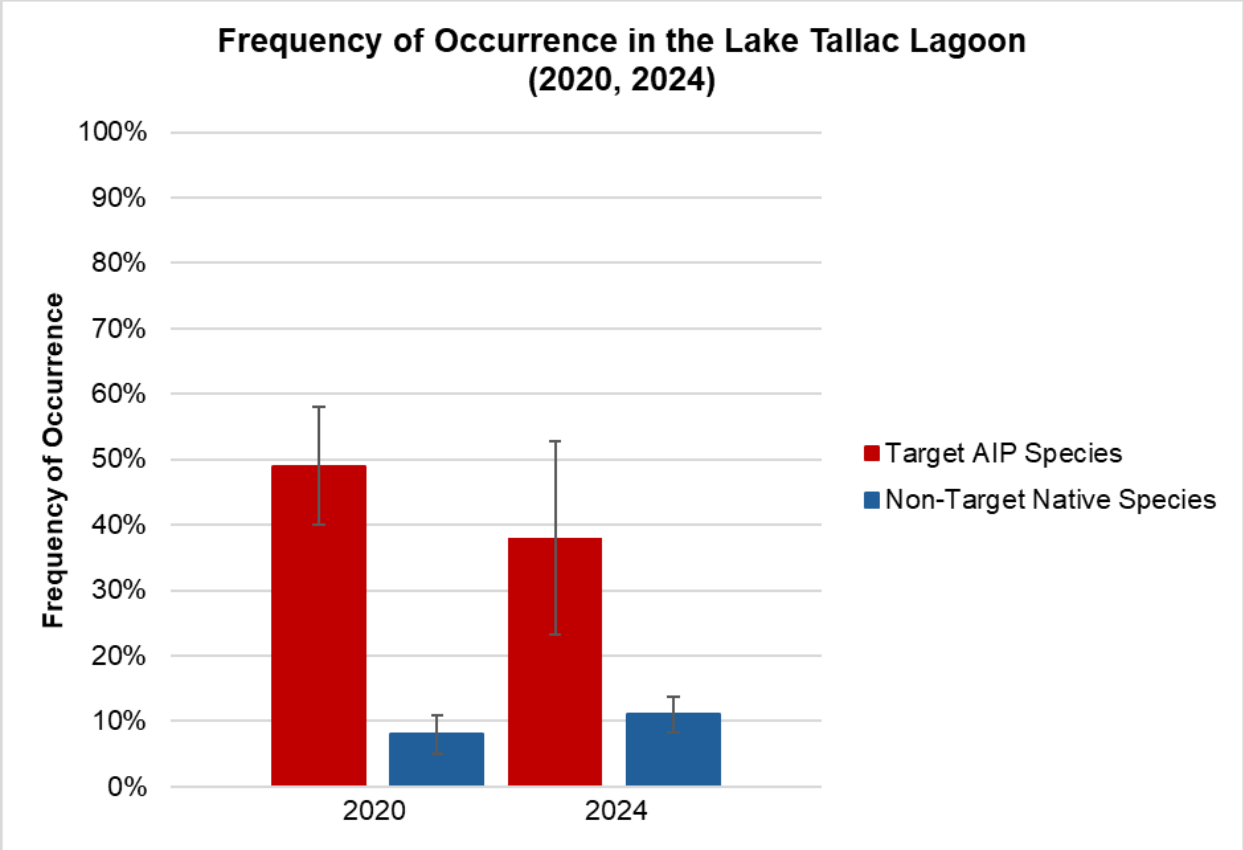



*The 2024 data does not reflect the CMT results as it only includes data from late June to early July for the analysis areas in Figure 1.

*Lake Tallac Lagoon*

The Lake Tallac Lagoon occurrence rates are depicted in Figure 3 below. Standard error bars are included in the figure to show the accuracy and variability of the data. All the Lake Tallac Lagoon occurrence rate data have a standard error of 15% or less. The target AIP species occurrence rates decreased from 49% in 2020 to 38% in 2024. The non-target native species increased in frequency of occurrence from 2020 to 2024 with occurrence rates of 8% and 11%, respectively. The 2024 AIP species occurrence rates in the Lake Tallac Lagoon are lower than pre-treatment conditions while the native species occurrence rates increased. Considering this data, the frequency of occurrence metric for macrophyte species shows restoration and improvement in the Lake Tallac Lagoon herbicide area.

**Figure 3. Frequency of Occurrence in the Lake Tallac Lagoon (2020, 2024)**




*The 2024 data does not reflect the CMT results as it only includes data from late June to early July for the analysis areas in Figure 1.

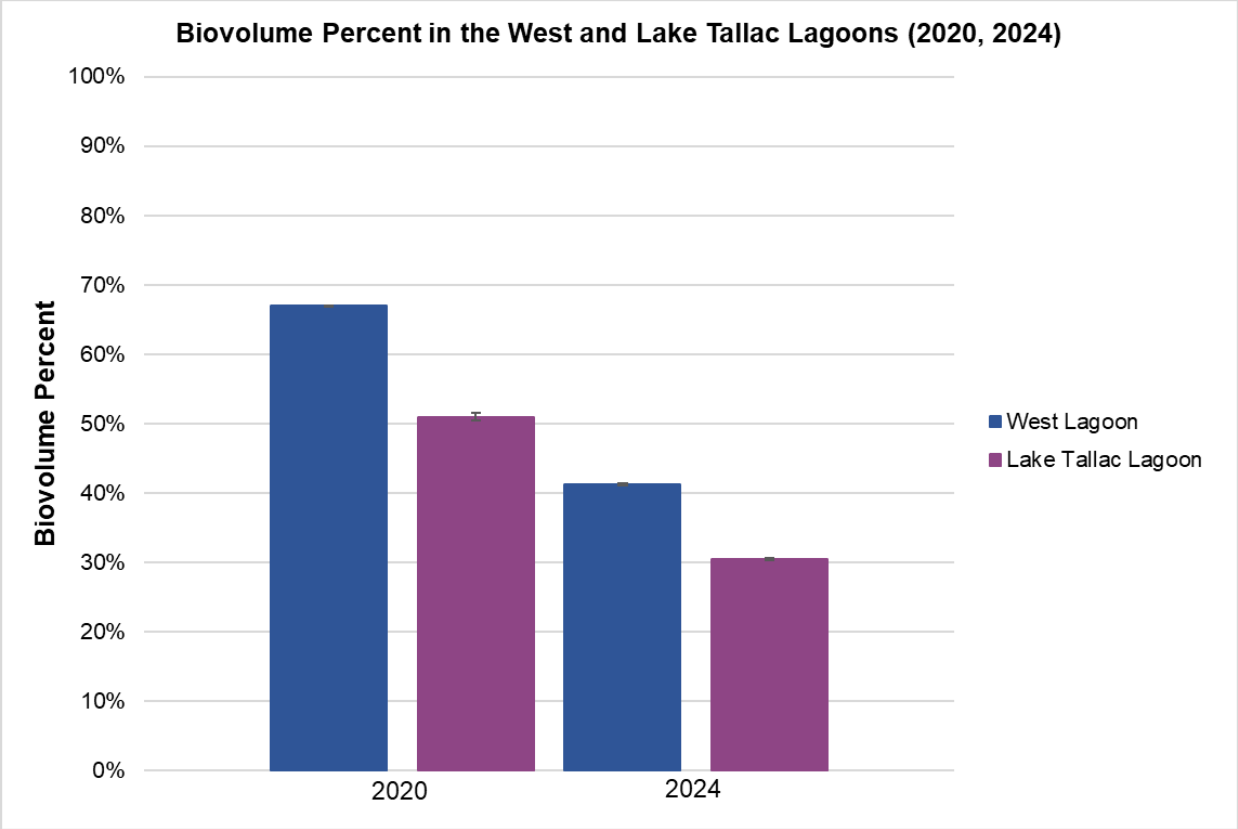
#### 3.1.3.2 Biovolume

As mentioned previously, biovolume represents the percentage of the water column occupied by submersed plant matter at each sonar ping collected during hydroacoustic scanning. The following sections first describe the overall biovolume percentage for all species in the areas in each lagoon shown in Figure 1 and then analyze target AIP and non-target native species by treatment type.

*Biovolume Percent in the West and Lake Tallac Lagoons*

Figure 4 depicts average biovolume percentages for the West and Lake Tallac lagoons treatment areas in Figure 1. The figure shows overall biovolume percentage for all species (AIP/Target and Native/Non-target). Standard error bars are included in the figure to show the accuracy and variability of the data. The West and Lake Tallac lagoons biovolume percent data have a standard error of below 1%, which indicates high accuracy given the large amount of raster cell samples extracted from Biobase. Both lagoons show a decrease in biovolume percent in 2024 compared to 2020. In the West Lagoon, average biovolume decreased from 67% in 2020 to 41% in 2024. In the Lake Tallac Lagoon, average biovolume decreased from 51% in 2020 to 30% in 2024.

**Figure 4. Biovolume Percent in the West and Lake Tallac Lagoons (2020, 2024)**




*The 2024 data does not reflect the CMT results as it only includes data from late June to early July for the analysis areas in Figure 1.

*Biovolume Percent by Species and Treatment Type*

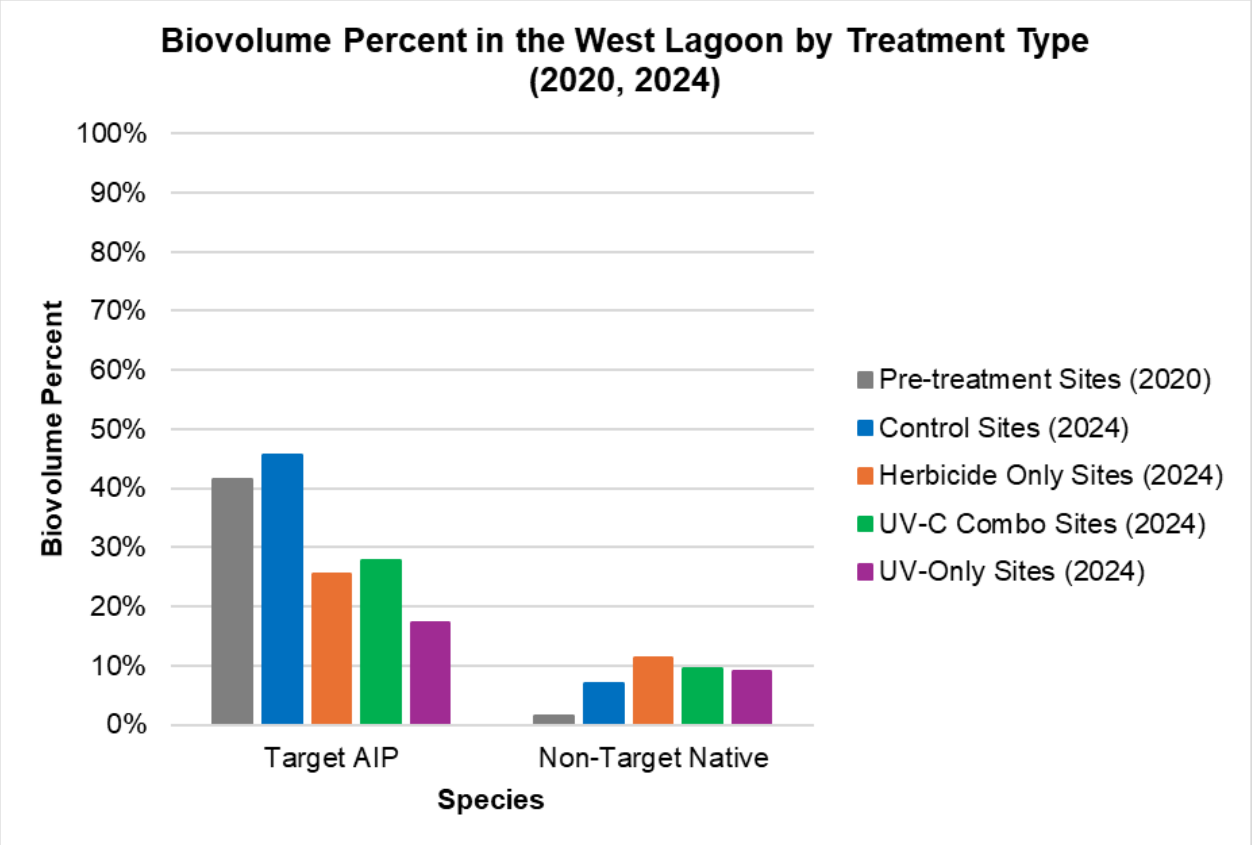
Evaluations using data collected within each herbicide application and UV-C treatment area are presented below for macrophyte restoration. The 2024 data was collected within the individual treatment sites by Sierra Ecosystem Associates (SEA) on behalf of TKPOA and Environmental Science Associates (ESA) on behalf of TRPA. The 2020 data was collected by SEA prior to CMT implementation.

The biovolume values in Figure 5 (West Lagoon) and Figure 6 (Lake Tallac Lagoon) display biovolume percentages for AIP target species and non-target native species in 2020 and 2024. Biovolume percentages for these species comprise data collected exclusively within the CMT application and treatment polygons shown in Figure 1, which include: Control, UV- Only, Herbicide Only, and UV-C Combo sites. As described previously, data for biovolume percent in the application and treatment polygons is based on the hydroacoustic scans performed by TKPOA staff at approximately the same time that the SEA and ESA rake samples were taken. Since various data sets from multiple sources and different times were combined to calculate the final values shown on Figures 5 and 6, standard error bars are not displayed, however they would likely be small similar to Figure 4 due to the large raster sample sizes extracted from Biobase.

West Lagoon

Control and treatment site biovolume data is presented in Figure 5 below. In 2020, before CMT treatments began, the biovolume percentage for AIP species was 42% while the 2024 biovolume percent in the Control sites is 46%. These values should be relatively similar since no treatment occurred in 2020 or within the Control sites from 2022 through 2024. AIP species biovolume in the three application/treatment site types is much lower than either the 2024 Control or the 2020 pre-treatment values. The 2024 average biovolume for AIP species is 25% in Herbicide Only sites, 28% in UV-C Combo sites, and 17% in UV-C Only sites. Non-target native species biovolume percentages in treatment sites are higher than the 2024 Control (7%) and 2020 pre-treatment (2%) values with Herbicide Only sites at 11% and UV-C Combo and UV-C Only sites at approximately 9%. Within the application/treatment sites, the increase in native species biovolume and decrease in AIP biovolume since CMT treatments began indicates that macrophyte restoration has been achieved for the West Lagoon.

**Figure 5. Biovolume Percent in the West Lagoon by Treatment Type (2020, 2024)**



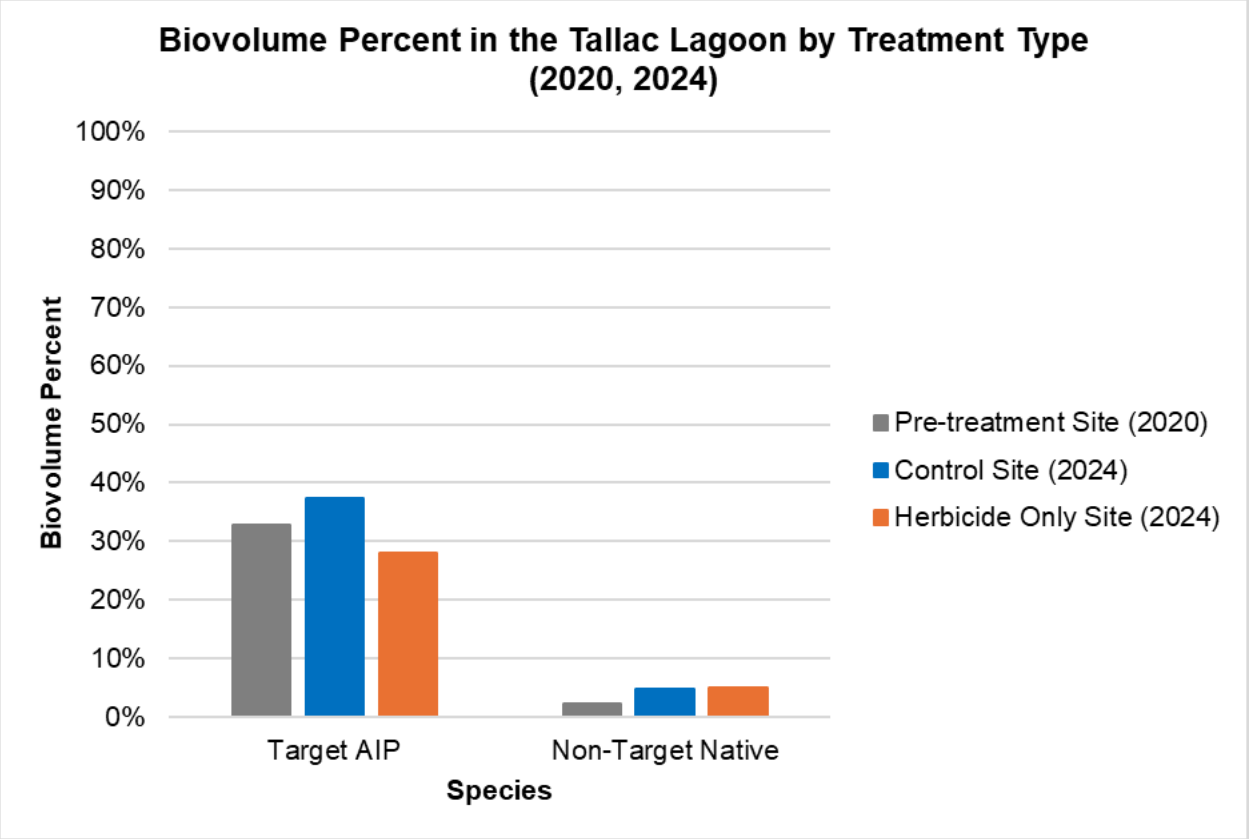

*Herbicide application only occurred in 2022. UV-C treatments occurred from 2022 through 2024.
**The 2024 data does not reflect the CMT results as it only includes data from late June to early July.

Lake Tallac Lagoon

The Lake Tallac Lagoon Control and application/treatment site biovolume data is presented in Figure 6 below. In 2020, the biovolume percentage for AIP species was 33%, while the Control site in 2024 is 37%. These values should be relatively similar since no treatments occurred in 2020 or within the Control site from 2020 through 2024. The

2024 AIP species biovolume in the Lake Tallac Herbicide Only site (28%) is lower than both the 2024 Control and 2020 pre-treatment values. The 2024 non-target native species biovolume percentage in the Herbicide Only site (5%) is higher than the 2020 pre-treatment value (2%) and the same as the 2024 Control site. Within the application/treatment site, the increase in native biovolume and decrease in AIP biovolume since CMT treatments began indicates that macrophyte restoration has been achieved for the Lake Tallac Lagoon.

**Figure 6. Biovolume Percent in the Lake Tallac Lagoon by Treatment Type (2020, 2024)**




*Herbicide application only occurred in 2022
**The 2024 data does not reflect the CMT results as it only includes data from late June to early July.

## 3.2 Water Quality

TKPOA and others have collected water quality data in the Tahoe Keys lagoons for several years. To assess restoration in the Tahoe Keys lagoons post-CMT treatments, temperature, pH, turbidity, and Dissolved Oxygen (DO) in the West and Lake Tallac lagoons are evaluated in Section 3.2.3. The evaluation criteria are based on the following datasets:

- 2019 Pre-treatment data,
- 2024 CMT Control site data, and
- 2024 CMT Herbicide Application/UV-C Treatment site data

The treatment areas that are evaluated include Herbicide Only sites, UV-C Combo sites, and UV-C Only sites. The data collection methods, data evaluation method, and the water quality restoration evaluation are provided below.

### 3.2.1 Data Collection Methods

TKPOA with support from the Tahoe Regional Planning Agency (TRPA), Tahoe Resource Conservation District (TRCD), and the League to Save Lake Tahoe (League) have worked together since 2011 to identify and address the AIP and related water quality issues in the Tahoe Keys lagoons. Since 2016, water quality has been measured and recorded by different entities at varying frequencies. This report evaluates data from 2019 (pre-CMT) and 2024 (CMT Year 3) that was collected by TKPOA. The 2019 pre-CMT and 2024 CMT data collection protocols and TKPOA's Quality Assurance/Quality Control (QA/QC) process are described in the following sections.

#### 3.2.1.1 Pre-CMT Data Collection

In 2019, TKPOA used YSI ProDSS sonde equipment to measure temperature, pH, DO, and turbidity at 5 depths in the water column. A depth finder instrument was used to locate and record depths throughout the water column before water quality monitoring was performed. Measurements were collected in 2019 from 8:00 AM to 2:00 PM 1 to 2 times a month from May through October at 14 sampling locations in the West and Lake Tallac lagoons. To aid stabilization of the equipment sensors, TKPOA positioned the probe for about two minutes in the water column before recording the measurements onto a field datasheet.

#### 3.2.1.2 CMT Data Collection

During the CMT Project from 2022 through 2024, TKPOA used Hydrolab sonde equipment to measure temperature, pH, DO, and turbidity at incremental depths in the water column. A depth finder instrument was used to locate and record the middle depth at each location prior to water quality monitoring. Measurements were collected from 11:00 AM to 2:00 PM once per week at 75 sampling locations in the West, East, and Lake Tallac lagoons. Three locations were monitored in each CMT site to characterize the water quality conditions. To aid stabilization of the equipment sensors, TKPOA positioned the probe for about two minutes in the water column before recording the measurements onto a field datasheet. Table 1 below summarizes the data collected.

**Table 1. Dataset Summary Table**

| | **Pre-treatment (2019)** | **CMT Year 3 (2024)** |
|---|---|---|
| **Parameters/ (Depth)** | pH, Temp, DO, Turbidity, SPC, Ammonium, Chlorophyll, ORP (5 depths) | pH, Temp, DO, Turbidity, SPC, ORP (middle) |
| **Equipment Type** | YSI ProDSS Sonde | Sonde Hydrolab |
| **Frequency** | 1-2x/month | 1x/week |
| **Number of WQ Stations** | 14 | 75 |

#### 3.2.1.3 Quality Assurance/Quality Control Process

TKPOA has followed a QA/QC process for all the data collected at the Tahoe Keys lagoons since 2016. This includes transferring data from field notes to a computer spreadsheet and noting any values that are inconsistent with historical or field observations. In 2018, TKPOA established more stringent water quality sampling protocols based on Lahontan's Surface Water Ambient Monitoring Program (SWAMP). These protocols directed TKPOA staff to increase the sampling density and locations from previous protocols. TKPOA also calibrated all water quality sampling equipment within 24 hours prior to the monitoring event in accordance with the manufacturer's instructions. Prior to boarding the vessels, TKPOA confirmed that all equipment needed for the day was on board and ready for data collection. Monitoring that occurred in 2024 also followed the CMT Quality Assurance Project Plan (QAPP) protocols.

### 3.2.2 Data Evaluation Method

The 2019 (pre-treatment) and 2024 (post-treatment) data collection years were selected to evaluate water quality restoration in the West and Lake Tallac lagoons herbicide application and UV-C treatment sites. Due to the submittal timing of this report, the 2024 datasets represent post-treatment data as it was collected during the latest season. Note that some of the data collected in the 2024 season occurred while UV-C treatments were in progress, however the Control site data depicts 'untreated' lagoon conditions for that year. Herbicides were only applied in Year 1 of the CMT Project (2022). An explanation of the datasets used for evaluating restoration, the data analysis and averaging methods, and the water quality monitoring stations are described below.

#### 3.2.2.1 2019 and 2024 Datasets

The 2019 data collection year was selected for comparison to the 2024 datasets due to the comparable monitoring frequencies. The 2020 and 2021 datasets do not contain comparable monitoring frequencies relative to 2024 because water quality measurements were missed throughout the season due to the COVID pandemic and Caldor Fire. The data collected in 2019 and 2024 also reflects conditions during high-water years, meaning the lake level conditions and lagoon water volumes are similar across the datasets. For the water quality analyses and graphs presented later in this report, comparisons were limited to data collected at approximately the same depth (mid-depth). The water quality evaluations are from the data collection period of May through October.

#### 3.2.2.2 Data Analysis

A series of graphs are presented in Section 3.2.3 comparing pre-treatment data (2019) to data collected during Year 3 of the CMT Project (2024). Since the West and Lake Tallac lagoons have different aquatic conditions, the graphs displaying each water quality parameter evaluation are presented for each lagoon.

The evaluation of ‘restoration’ status is based on comparisons of pre-CMT (2019) conditions in the untreated Control sites to conditions at herbicide application and UV-C treatment sites during Year 3 (2024) of the CMT. Significant differences between the 2019 pre-treatment and 2024 Control site data are identified along with comparisons to the Lahontan Water Board Basin Plan Water Quality Objectives (WQO), where applicable. If the 2024 CMT application/treatment site data is substantially degraded compared to the 2019 and 2024 Control site data, then restoration is considered to not have been achieved. However, if the 2024 CMT treatment data is similar to either or both the 2019 dataset and 2024 Control site dataset, then restoration of water quality in the lagoons has been achieved.

#### 3.2.2.3 Averaging Method

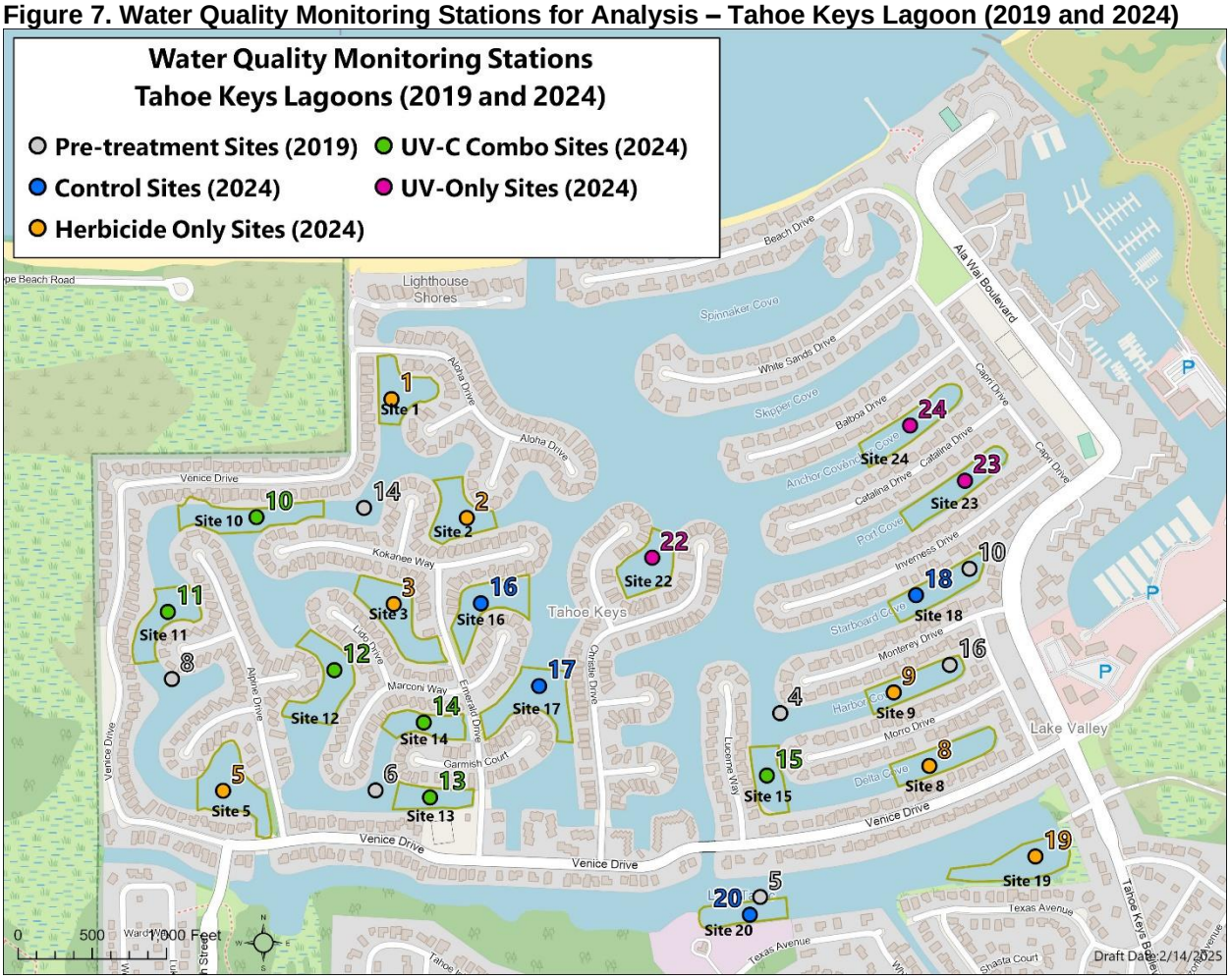
The 2024 dataset contains an extensive number of data points collected in both the West and Lake Tallac lagoons. Monitoring was performed at different locations in 2019 and 2024. As a result, averaging the data collected from certain sites in each lagoon was necessary to assess overall restoration of the lagoons. Additionally, different monitoring frequencies occurred between the data collection years (see Table 1).

To represent the West Lagoon water quality conditions in 2019, data from 6 sites near the herbicide application and UV-C treatment locations were averaged and compared to the average of the 2024 data collected in the West Lagoon Control sites, 2022 Herbicide Only application sites, 2022 UV-C Combo sites, and 2022 through 2024 UV-C Only sites. The 2024 data collected from the three monitoring stations in each CMT site were averaged, and all the sites with the same treatment type were then averaged by week for each CMT herbicide application/UV-C treatment type. Due to the limited water quality monitoring stations in the Lake Tallac Lagoon (one in 2019 and two in 2024), averaging was not necessary to show pre- and post-treatment conditions.

#### 3.2.2.4 Water Quality Monitoring Locations

Figure 7 depicts the water quality monitoring stations in the Tahoe Keys lagoons from which water quality data is analyzed for the 2019 and 2024 data collection years. The gray dots, or TKPOA water quality sites, are locations that were measured in 2019. The 2024 datasets are represented as follows: the blue dots are Control sites, the orange dots are Herbicide Only sites, the green dots are UV-C Combo sites, and the purple dots are UV- Only sites. Since somewhat different locations were used to measure water quality between the 2019 and 2024 datasets, this map is intended to display why certain site datasets were selected for comparison to others. Table 2 further outlines the sites across the two datasets that are compared to each other.

**Figure 7. Water Quality Monitoring Stations for Analysis – Tahoe Keys Lagoon (2019 and 2024)**




*Herbicide applications only occurred in 2022.

**Table 2. Water Quality Monitoring Station Guide**

| Pre-treatment (2019 Data) | CMT Control Sites (2024 Data) | Herbicide Only (2024 Data for 2022 Application Sites) | UV-C Combo (2024 Data for 2022 Application and 2022-2024 UV-C Treatments) | UV-C Only (2024 Data for 2022-2024 UV-C Treatments) |
|---|---|---|---|---|
| West Lagoon | | | | |
| 4, 6, 8, 10, 14, 16 Avg. | 16, 17, 18 Avg. | 1, 2, 3, 5, 8, 9 Avg. | 10, 11, 13, 14, 15 Avg. | 22, 23, 24, Avg. |
| Lake Tallac Lagoon | | | | |
| 5 | 20 | 19 | No Herbicide, No UV | No Herbicide, No UV |

### 3.2.3 Water Quality Restoration Evaluation

To meet restoration analysis requirements stated in the CMT NPDES permit and APAP Amendment 1, 2022 Herbicide application and 2022-2024 UV-C treatment sites were

evaluated to assess restoration of water quality in the lagoons. The following sections analyze differences in temperature, DO, pH and turbidity in the West and Lake Tallac lagoons between 2019 and 2024. Attachment A contains the mid-depth sonde water quality data used to create the graphs presented and analyzed below with highlighted cells to signal where values surpassed the WQO.

#### 3.2.3.1 Temperature

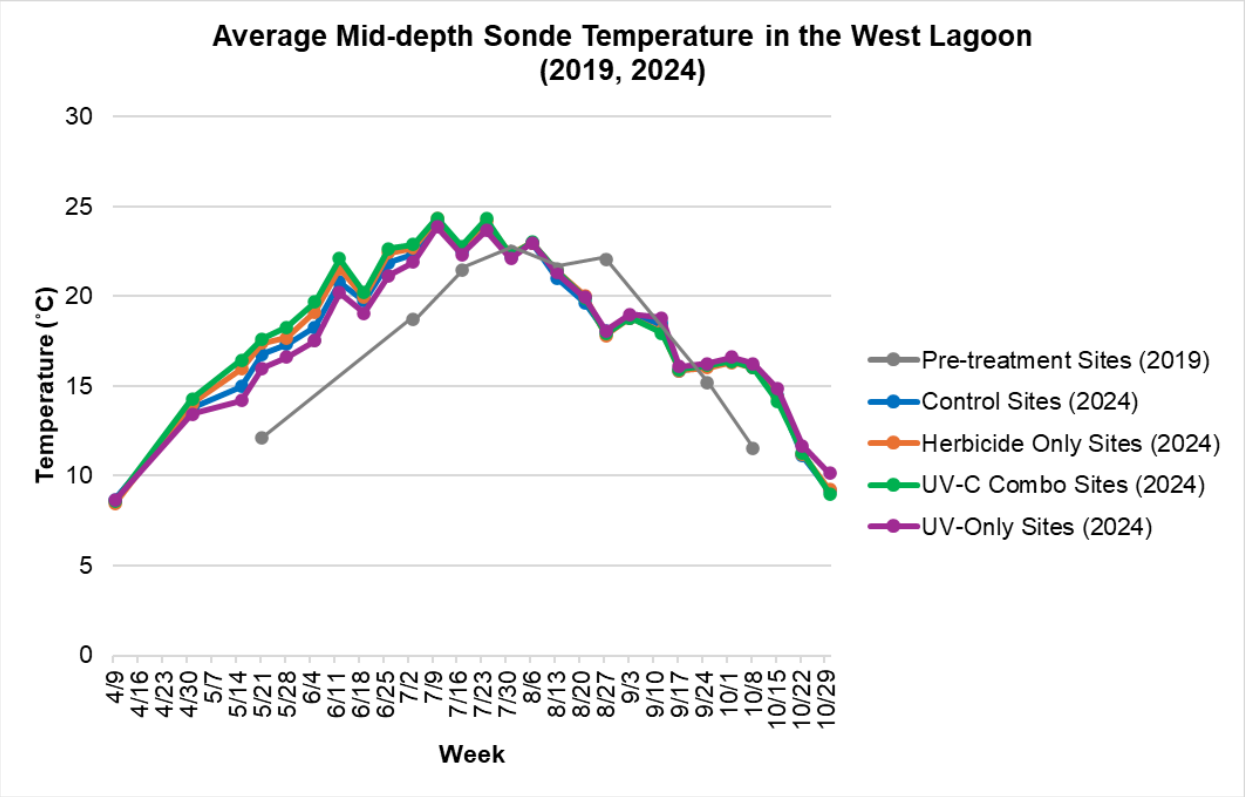
Water temperature is a measurement of thermal energy that largely governs habitat conditions for different types of aquatic life. The WQO for temperature in waters with the Cold Freshwater Habitat (COLD) classification of beneficial use states that “temperature shall not be altered” (Lahontan 2021). There is no clarification on what ‘altered’ indicates in the Basin Plan. The temperature data analyzed in this report are presented in degrees Celsius. A description of temperatures pre- (2019) and post- (2024) treatment are described below for the West and Lake Tallac lagoons.

*West Lagoon*

Figure 8 displays mid-depth sonde temperature in the West Lagoon for the 2019 pre-treatment dataset, 2024 Control site dataset, 2024 data in 2022 herbicide application areas, and 2024 data in 2022 through 2024 UV-C treatment locations. In the West Lagoon, the 2019 pre-treatment values display a similar pattern to those in the 2024 Control, herbicide application, and UV-C treatment locations, but are generally lower than values in 2024.

According to the Temperature Existing Conditions Report (TKPOA 2024d), air and water temperature are positively correlated. A drop in air temperature to 4.44 degrees Celsius occurred in mid-May 2019, causing a delay in the warming of the lagoons for that year. Ranges are similar for both the 2019 and 2024 data, with all values falling between approximately 8 and 25 degrees. Peak temperatures reached approximately 23 degrees Celsius in 2019 and 25 degrees Celsius in 2024. In both years, peak temperatures occurred in July. The 2019 pre-treatment data, 2024 data for the 2022 herbicide application and 2022 through 2024 UV-C treatments, and 2024 Control site data display similar patterns throughout the season, other than the delay in lagoon warming that occurred in 2019. Further, the 2024 temperature data for all the application/treatment sites are nearly the same as the 2024 Control sites, indicating that the 2024 West Lagoon treatment site temperatures represent similar and therefore ‘restored’ conditions.

**Figure 8. Average Mid-Depth Sonde Temperature in the West Lagoon (2019, 2024)**



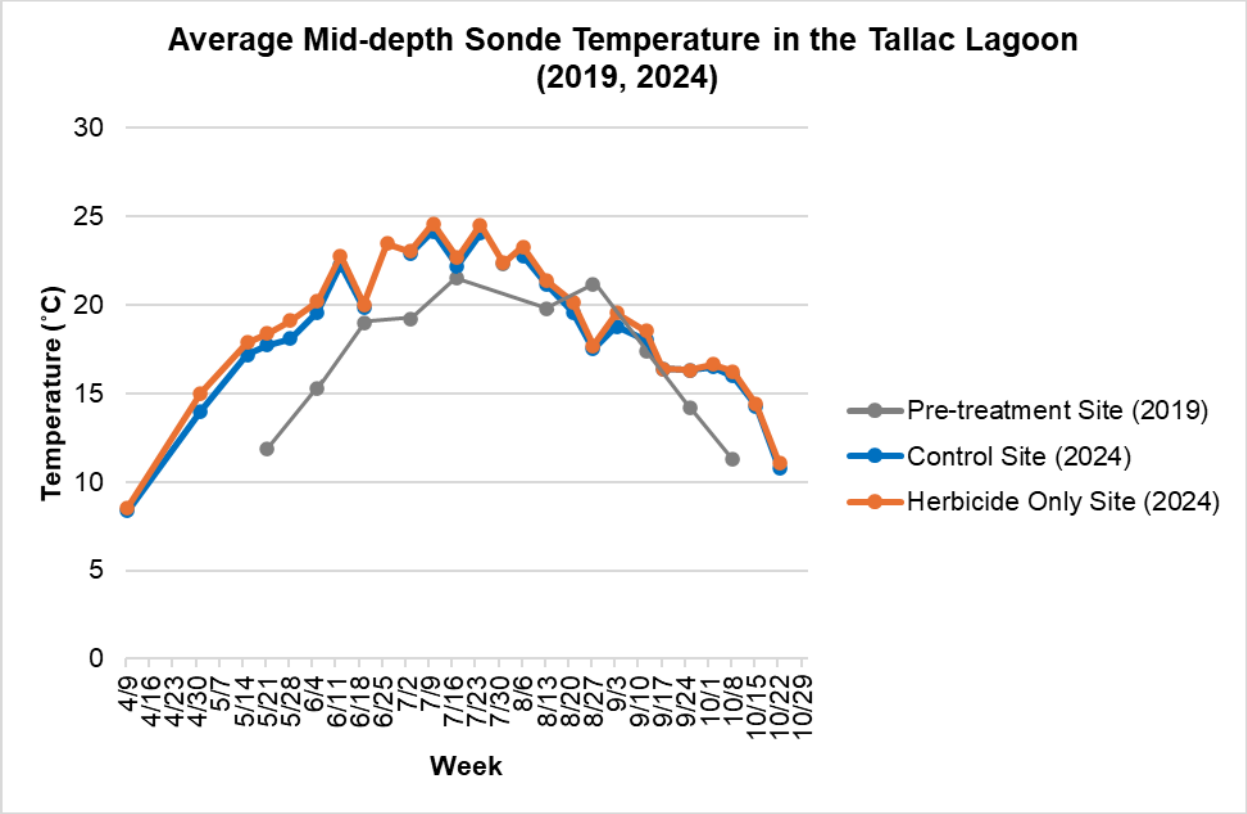

*Herbicide application only occurred in 2022. UV-C treatments occurred from 2022 through 2024.

*Lake Tallac Lagoon*

Figure 9 displays mid-depth sonde temperature in the Lake Tallac Lagoon for the 2019 pre-treatment locations, and 2024 data for Control and 2022 herbicide application locations. Like the West Lagoon, pre-treatment values display a similar pattern as those in the 2024 Control and post-treatment locations but are generally lower than values in 2024.

The 2019 pre-treatment sonde values ranged from approximately 11 to 22 degrees. However, less data was collected in 2019 due to resource limitations. In 2019, peak temperatures reached approximately 22 degrees in mid-July. In 2024, both Control and treatment area values are comparable. The peak temperature for all 2024 data occurred in July reaching nearly 25 degrees. The delayed warm-up pattern seen in Figure 8 for the West Lagoon in 2019 can also be seen in Figure 9 for the Lake Tallac Lagoon. These observations indicate that the 2019 and 2024 temperature values displayed are considered similar for the Lake Tallac Lagoon and restoration for temperature has been achieved.

**Figure 9. Average Mid-Depth Sonde Temperature in the Lake Tallac Lagoon (2019, 2024)**




*Herbicide application only occurred in 2022.

#### 3.2.3.2 pH

pH, a value ranging from 0 to 14, is an important characteristic of water quality that expresses how acidic (low pH) or basic (high pH) water is and can be an indicator of changes in an aquatic environment. Note that the daytime photosynthetic activity of aquatic plants and algae can greatly increase pH as carbon dioxide and bicarbonates. In contrast, during the night, pH can decrease when photosynthesis stops. Thus, in typical aquatic ecosystems with submersed plants and algae, there is fairly regular, diurnal fluctuations in pH. These changes can easily exceed 2 to 3 pH units between day and night, and between sunrise and sunset on the same day. Therefore, comparisons of pH need to be made during specific period of the day- typically within two hours of midday (noon).

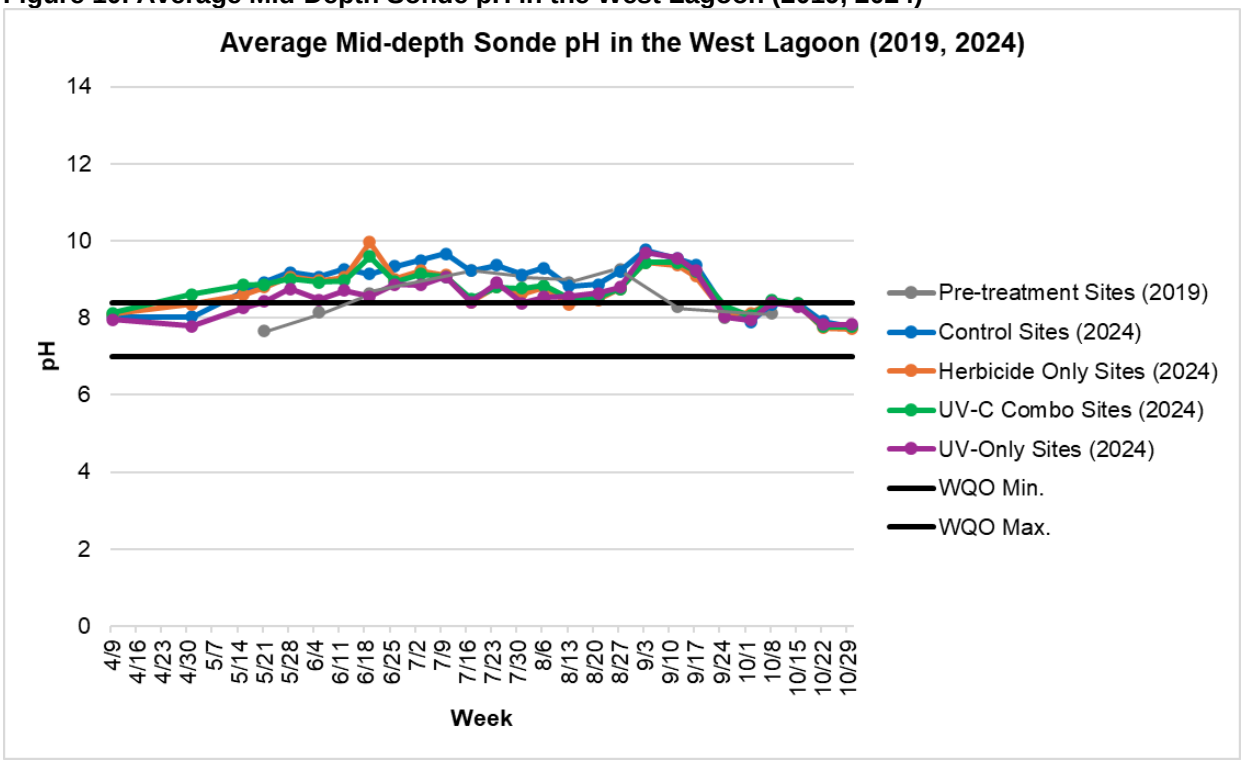
The WQO for pH in beneficial use of waters with the COLD classification states that changes in normal ambient pH levels shall not exceed 0.5 unit (Lahontan 2021), however, the NPDES Permit for the CMT Project states that pH must not drop below 7 nor rise above 8.4. Therefore, NPDES Permit WQO for pH is included on the graphs presented below. A comparison of pH pre- (2019) and post- (2024) treatment is described below for the West and Lake Tallac lagoons.

*West Lagoon*

Figure 10 displays mid-depth sonde pH in the West Lagoon for the 2019 pre-treatment locations and 2024 data from Control, 2022 herbicide application, and 2022 through 2024 UV-C treatment locations. The WQO for pH is presented below with black lines for the minimum (7.0) and maximum values (8.4). Attachment A contains the pH data presented below with highlighted values to signal measurements that are outside of the WQO for the CMT Project.

In the West Lagoon, pre-treatment (2019) pH levels are comparable to the 2024 data for the herbicide application, UV-C treatment, and Control site locations. In 2019, pH values ranged from about 7.5 to just over 9, peaking in August. In 2024, both Control and treatment area values ranged from 7 to 9.5, never exceeding 10. In 2024, treatment site values peaked at different times, with Herbicide Only and UV-C Combo sites peaking in June, and UV-C Only sites peaking in September. UV-C Only treatment site values are somewhat, but not substantially, lower from April through August. Control site values appear to be slightly higher compared to the data collected at treatment sites from mid-June through early September, however the 2019 data closely resemble the Control site data during this time period. As a result, pH conditions in the application/treatment areas are deemed to be comparable to or better than 2019 pre-treatment/2024 Control site conditions and restoration has been achieved for pH in the West Lagoon. Note that as submersed aquatic plant abundance is decreased, the mid-day pH level and the diurnal fluctuation in pH typically decreases.

**Figure 10. Average Mid-Depth Sonde pH in the West Lagoon (2019, 2024)**



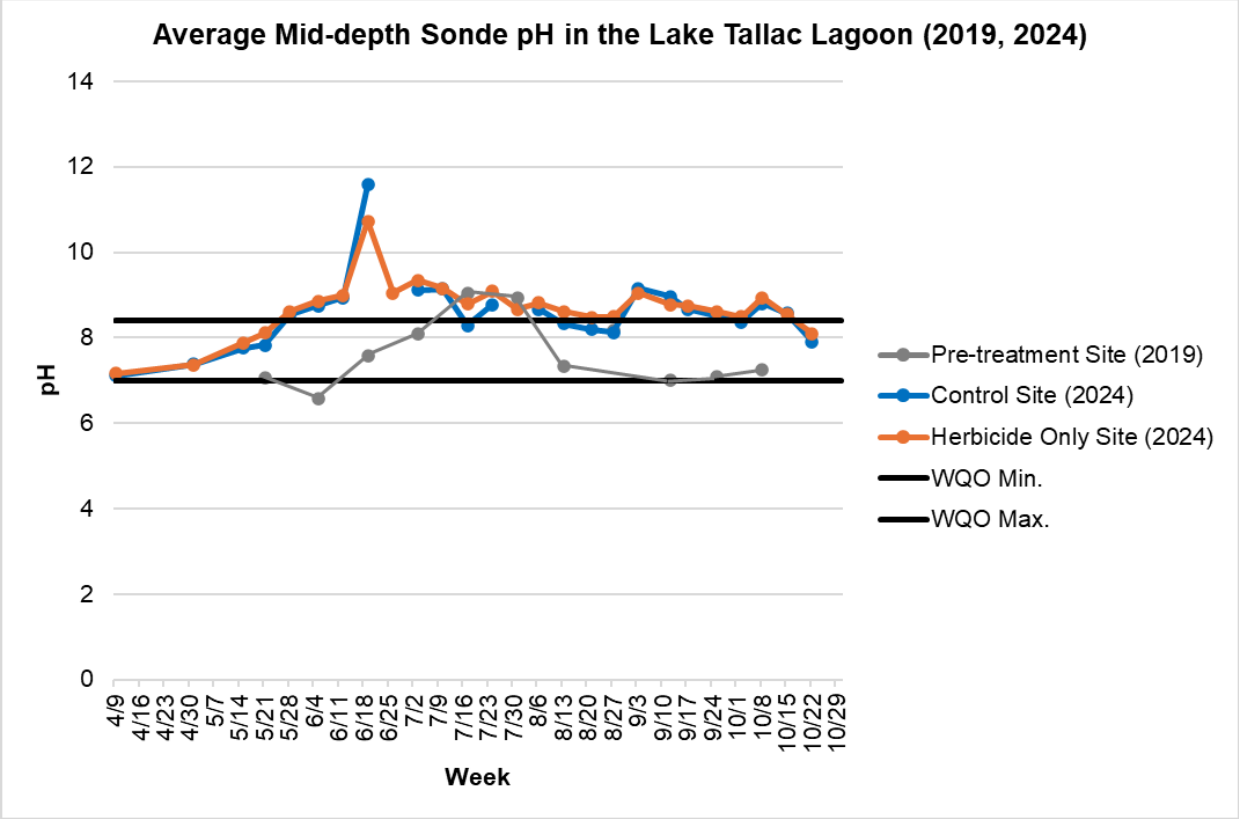

*Herbicide application only occurred in 2022. UV-C treatments occurred from 2022 through 2024.

*Lake Tallac Lagoon*

Figure 11 displays mid-depth sonde pH in the Lake Tallac Lagoon for the 2019 pre-treatment locations and 2024 data for Control and 2022 herbicide application locations. The WQO for pH is presented below with black lines for the minimum (7.0) and maximum values (8.4). Attachment A contains the pH data presented below with highlighted values to signal measurements that are outside of the WQO for the CMT Project.

In the Lake Tallac Lagoon, pre-treatment (2019) pH levels are lower than the post-application (2024) values. In 2019, pH values ranged from approximately 6.5 to just over 9, reaching peak values in mid-July. In 2024, Control and treatment area values show similar patterns of increasing and decreasing, both reaching peak values in mid-June. However, the 2024 Control site data increased above the Herbicide Only data during the same time frame, reaching nearly 12. Although the 2019 dataset varies from the 2024 datasets, the 2024 Control and Herbicide Only values remain relatively consistent, indicating that the data shows relatively similar pH values for that year. As a result, restoration has been achieved for pH in the Lake Tallac Lagoon.

**Figure 11. Average Mid-Depth Sonde pH in the Lake Tallac Lagoon (2019, 2024)**




*Herbicide application only occurred in 2022.

#### 3.2.3.3 Turbidity

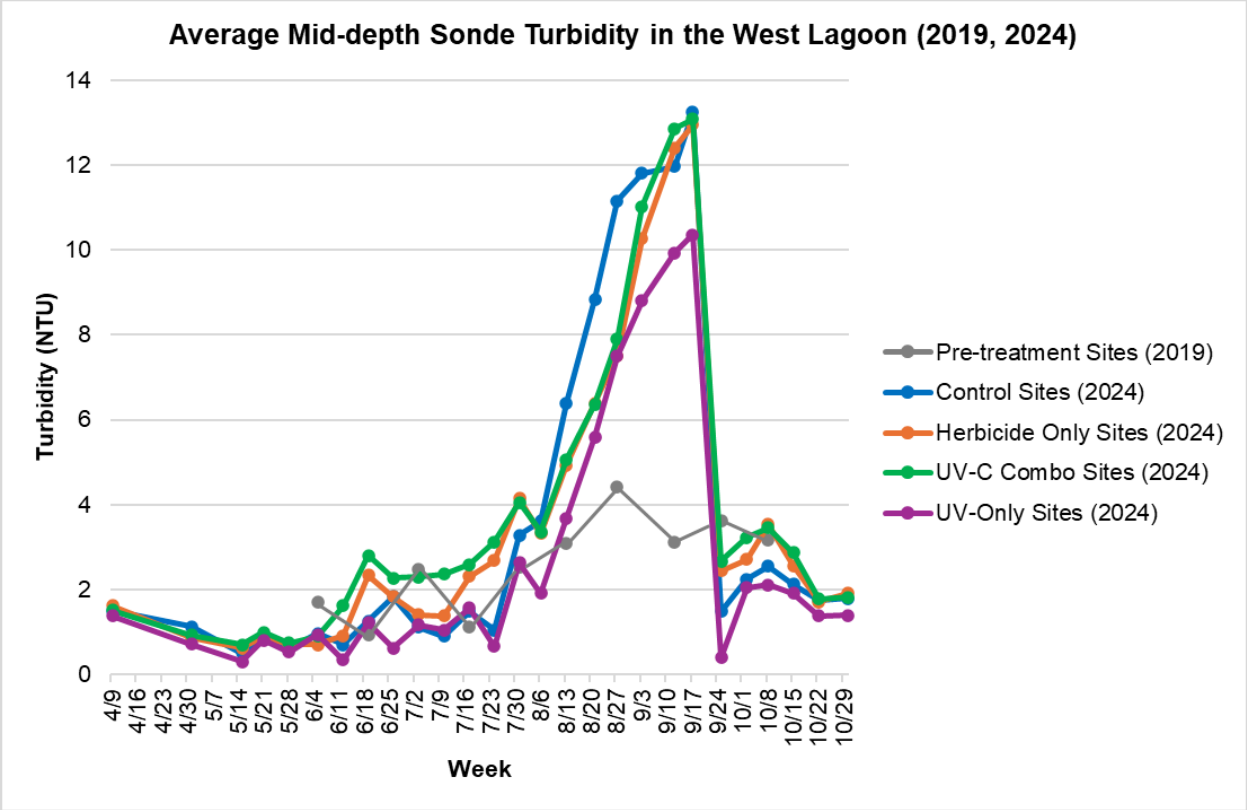
Turbidity, the relative clarity of a liquid, is a property of water that is measured to help determine its quality. Turbidity measurements in this report are presented as Nephelometric Turbidity Units (NTU), where lower values signify a lesser number of suspended particles in a water body and, therefore, a higher level of clarity. The NPDES Permit for the CMT Project states that increases in turbidity must not exceed natural levels by more than 10%. Since the WQO is relative to 'natural levels', all data points above 4 NTU are highlighted on Attachment A. A description of turbidity comparisons pre- (2019) and post- (2024) herbicide application and UV-C treatment are described below for the West and Lake Tallac lagoons.

*West Lagoon*

Figure 12 displays mid-depth sonde turbidity in the West Lagoon for the 2019 pre-treatment locations and 2024 data from the Control, 2022 herbicide application, and 2022 through 2024 UV-C treatment locations. In the West Lagoon, the 2019 pre-treatment turbidity values have a similar range to the 2024 Control and herbicide application/UV-C treatment datasets in June, July and October. During this time period, the range for all datasets is between approximately 0 to just over 4 NTU.

However, there is a significant difference between the 2019 and 2024 peak values from mid-August to late September. In 2019, peak turbidity measurements were recorded in August and reached nearly 4.5 NTU. In 2024, peak values in UV-C Only treatment locations were somewhat lower compared to the rest of the 2024 data, only reaching about 10 NTU. While peak turbidity values for all locations in 2024 far exceeded peak values in 2019, the pre-treatment peak values were close to the same time as 2024. Since the 2024 Control sites, which contained no CMT treatments, show values similar to the 2024 herbicide application/ UV-C treatment sites, the turbidity conditions from August through September must be caused by factors unrelated to CMT treatments. This data indicates that restoration has been achieved for turbidity in the West Lagoon.

**Figure 12. Average Mid-Depth Sonde Turbidity in the West Lagoon (2019, 2024)**

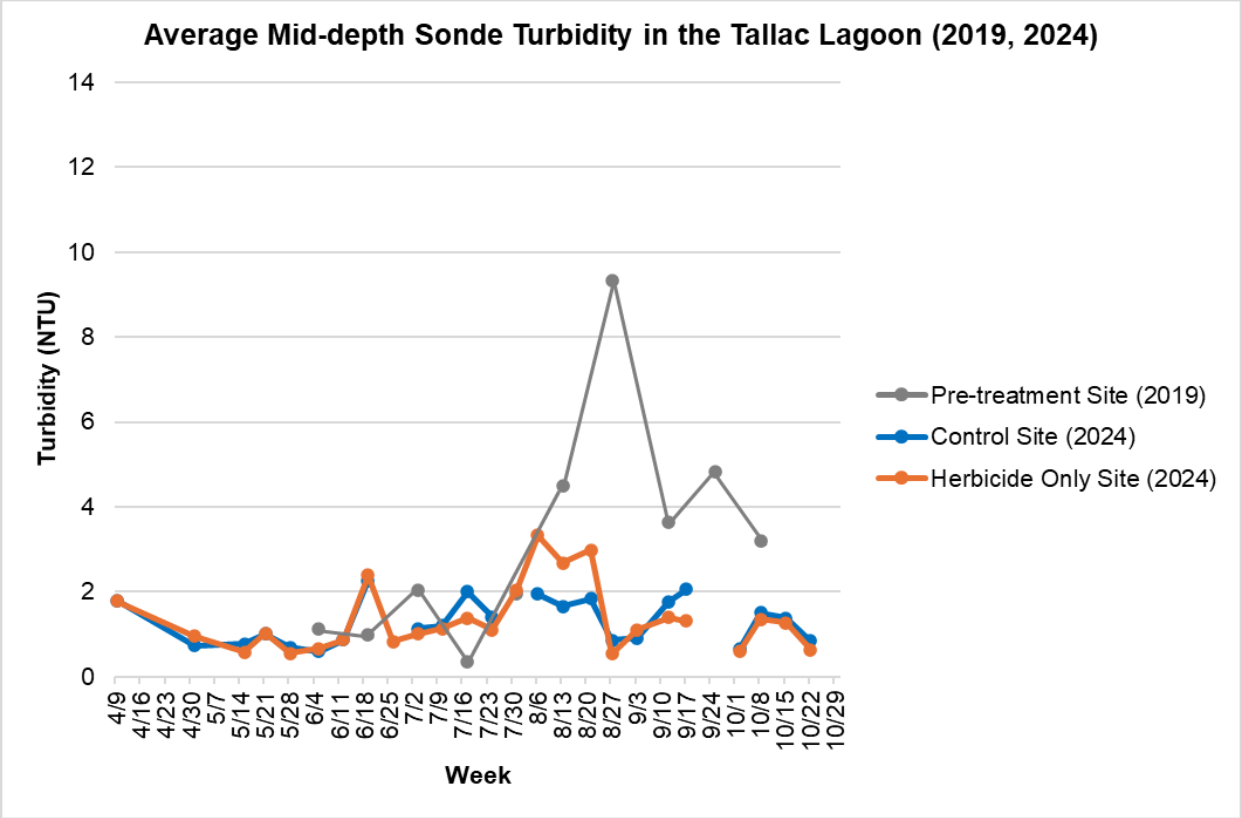



*Herbicide application only occurred in 2022. UV-C treatments occurred from 2022 through 2024.

*Lake Tallac Lagoon*

Figure 13 displays mid-depth sonde turbidity in the Lake Tallac Lagoon for 2019 pre-treatment locations and 2024 data from Control and 2022 herbicide application locations. In the Lake Tallac Lagoon, the 2019 pre-treatment turbidity values have a similar range to the 2024 post-herbicide application and Control site values in June and July but show much higher values after early August. The 2019 pre-treatment data ranged from just above 0 to approximately 9.5 NTU, peaking in late August. The 2024 Control and post-application data shows a similar range, except that the 2024 post-application site depicts a higher peak value compared to the Control site, and peaks are reached at different times. The 2024 data from the Herbicide Only site peaked at approximately 3.5 NTU in early August, while the Control site data peaked at just over 2 NTU in mid-September. Since the 2024 Control and post-application data follow similar patterns throughout the season (except in August), and the 2019 pre-treatment data includes higher values during peak months, the data shows restoration for turbidity in the Lake Tallac Lagoon.

**Figure 13. Average Mid-Depth Sonde Turbidity in the Lake Tallac Lagoon (2019, 2024)**




*Herbicide application only occurred in 2022.

#### 3.2.3.4 Dissolved Oxygen (DO)

DO is measured to determine the amount of oxygen that is dissolved in the water column. The DO analyses below are presented relative to the WQO for waters with the COLD classification of beneficial use. The WQO for DO in beneficial use of waters with this class states that the minimum seven-day average must not drop below 5 milligrams per liter (mg/L) and the one-day minimum is 4 mg/L (Lahontan 2021). A description of DO comparisons pre- (2019) and post- (2024) treatment are described below for the West and Lake Tallac lagoons.

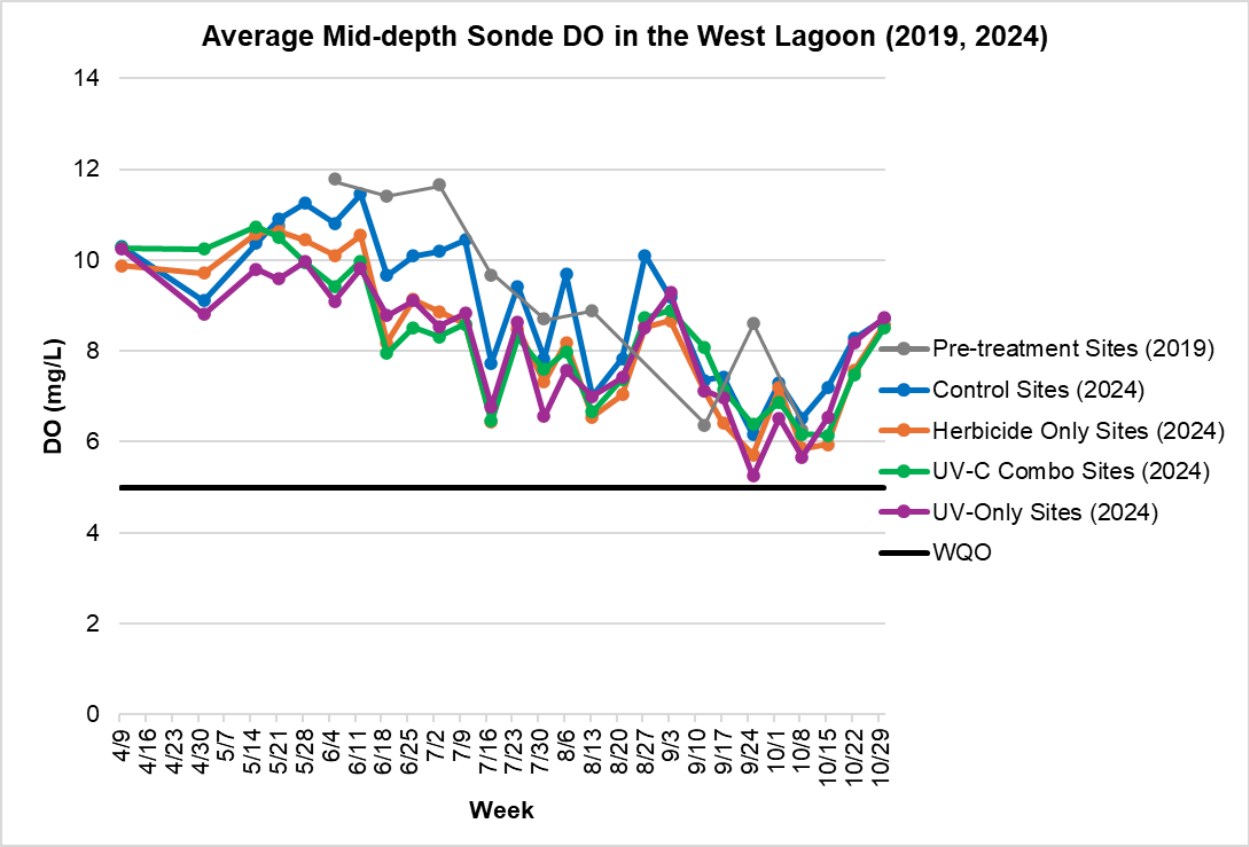
*West Lagoon*

Figure 14 displays mid-depth sonde DO in the West Lagoon for the 2019 pre-treatment locations, and 2024 data from Control, 2022 herbicide application, and 2022 through 2024 UV-C treatment locations. Also displayed is the WQO for DO (5 mg/L) as stated in the Lahontan Water Quality Control Plan (2021).

In the West Lagoon, DO values between the 2024 datasets vary but have similar patterns and ranges. While the 2019 pre-treatment dataset depicts a different pattern throughout the season, the range of measurements is similar to the 2024 Control site dataset. From late May to late July, DO values in the 2024 Control site locations are 1 to 2 mg/L higher than the 2024 data collected at 2022 herbicide application and 2022 through 2024 UV-C

treatment locations. However, all the 2019 and 2024 DO values remain above the WQO. The 2019 pre-treatment dataset includes periods with both higher and lower values, especially during the aquatic plant senescence period. Since the herbicide application and UV-C treatment area data are above the WQO and similar to the range of values of the 2019 pre-treatment and 2024 Control site data, and the application/treatment area data remain within 1 to 2 mg/L of the 2024 Control site data, restoration for DO in the West Lagoon has been achieved.

**Figure 14. Average Mid-Depth Sonde DO in the West Lagoon (2019, 2024)**




*Herbicide application only occurred in 2022. UV-C treatments occurred 2022 through 2024.

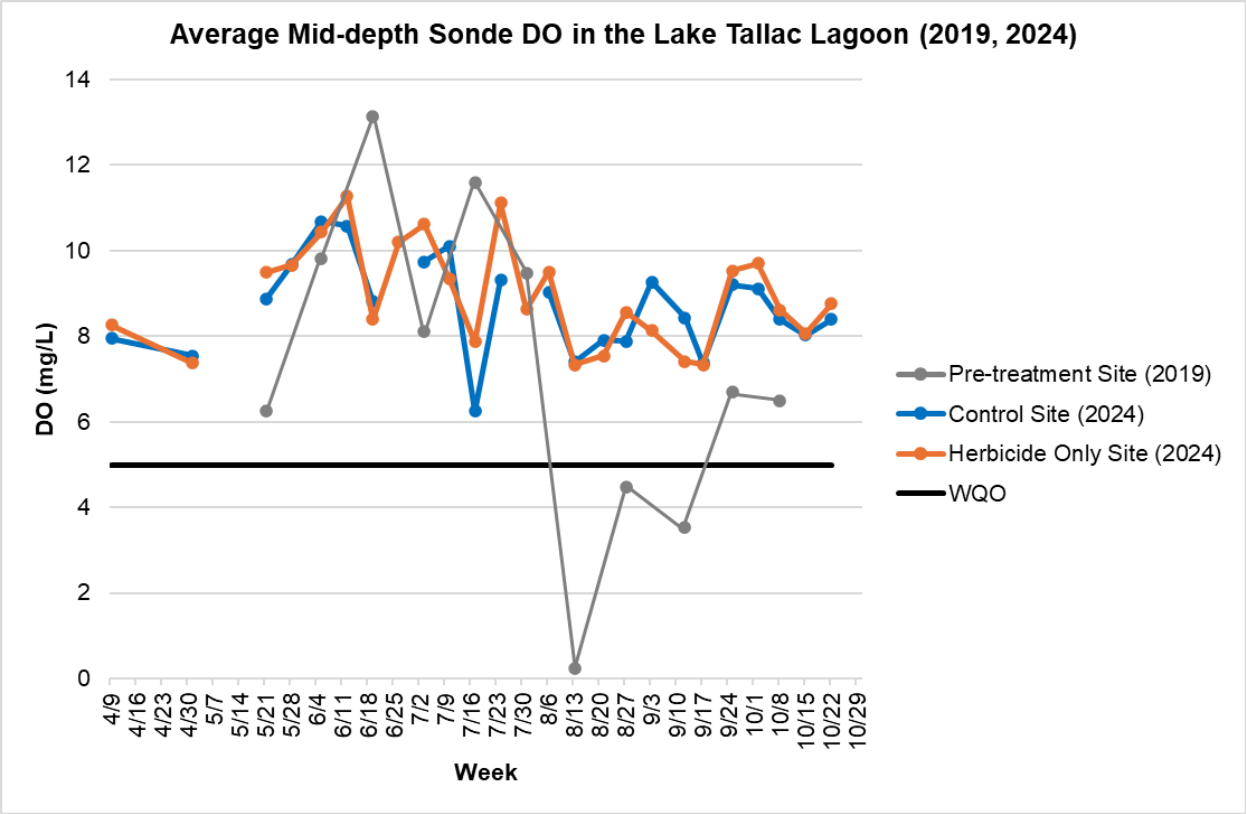
### *Lake Tallac Lagoon*

Figure 15 displays mid-depth sonde DO in the Lake Tallac Lagoon for the 2019 pre-treatment location, and 2024 data from the Control and 2022 herbicide application locations. Also displayed is the WQO for DO (5 mg/L) as stated in the Lahontan Water Quality Control Plan (2021). Attachment A contains the DO data presented below with highlighted values to signal measurements that are outside of the WQO for the CMT Project.

In the Lake Tallac Lagoon, and similar to the West Lagoon, 2019 pre-treatment values vary significantly compared to the 2024 datasets. In mid-August 2019, DO values drop below the WQO, falling to nearly 0 mg/L, then rising above the WQO in September. Both the 2024 Control and post-application datasets follow a similar pattern throughout the

season with more consistent values, whereas the 2019 data display more instability with a wider range of measurements. Since the 2024 datasets (Control and post-application sites) are within 1 to 2 mg/L, show fairly consistent values, and remain above the WQO for DO throughout the season, restoration for DO in the Lake Tallac Lagoon has been achieved.

**Figure 15. Average Mid-Depth Sonde DO in the Lake Tallac Lagoon (2019, 2024)**




*Herbicide application only occurred in 2022.

## 3.3 Benthic Macroinvertebrates (BMI)

ESA has collected BMI data in the Tahoe Keys lagoons periodically over the last few years to track the condition of benthic communities in UV-C treatment and herbicide application areas. An evaluation of BMI restoration post-CMT Project is provided in Section 3.3.3. The evaluation criteria are based on the following datasets:

- 2022 Pre-treatment data,
- 2024 CMT Control site data, and
- 2024 CMT Herbicide Application/UV-C Treatment site data.

The descriptions and data assessments in the following sections are from the Tahoe Keys Lagoons Aquatic Weed Control Methods Test: Benthic Macroinvertebrates Summary Report (BMI Summary Report) prepared by ESA in 2024 (see Attachment B). Although the evaluations described in Attachment B include LFA treatments sites, this report only evaluates data collected at Herbicide Only, UV-C Combo, and UV-C Only sites. The data

collection methods, data evaluation method, and the BMI restoration evaluation are provided below.

### 3.3.1 Data Collection Methods

ESA collected BMI samples using an adaptation of the SWAMP (2015) protocol and using the Aquatic Pesticide Application Plan (CMT APAP and APAP amendments), CMT NPDES, the CMT Monitoring Reporting Program (MRP) and the CMT Quality Assurance Project Plan (QAPP). Shoreline and mid-channel samples were collected at each site. Shoreline samples were collected using a 500-µm mesh D-frame sweep net within three meters of the shoreline. Mid-channel samples were collected using a petite Ponar grab sampler in the center of the CMT herbicide application/UV-C treatment sites.

After collecting the samples, the contents of the net/Ponar sampler were emptied into a clean, labeled bucket of water. Samples from shoreline and mid-channel areas were separated into different buckets. The net/Ponar was then rinsed over the bucket to ensure that any remaining BMI were collected. To form a composite sample for each shoreline and midchannel area, subsequent samples collected within each site were added to the corresponding bucket. A total of three shoreline and three mid-channel samples were collected at each CMT site. The samples were then sent to the lab to be sorted and identified down to a species level.

Samples were primarily collected in the spring of each CMT year (2022-2024) with a limited number of samples collected in fall. For the treatment areas analyzed in this report, samples collected in May 2022 (pre-herbicide application and UV-C treatment) are considered the baseline for comparing post-treatment BMI data. For more information on the methodology regarding BMI sampling, please see Attachment B.

### 3.3.2 Data Evaluation Method

BMI community health was analyzed using common metrics calculated from the processed samples. These metrics include:

- overall richness, a count of all unique taxa,
- Ephemeroptera, Plecoptera, Tricoptera (EPT) richness, a count of unique sensitive taxa,
- relative abundance of the most dominant taxa, a measure of diversity,
- average tolerance of all sampled individuals, and
- functional feeding group composition (a measure of trophic diversity).

#### 3.3.2.1 Adapted Index of Biological Integrity

The BMI analysis for lagoons restoration was modeled after the Index of Biological Integrity (IBI) for Eastern Sierra Streams and Rivers. A 6-metric IBI was used for the study area. The metrics and index scores are provided below in Table 3. As stated in the BMI Summary Report, the indices for the IBI were developed by calculating the raw values for each metric for all sites during 2022 pre-treatment conditions. The lower $10^{th}$ percentile

value was used as the lowest possible index (0), while the 90th percentile of these raw values was used as the highest possible index score (10) (ESA 2024). The indices are scaled based on values between the 10th percentile and 90th percentile. For example, the lower 10th percentile had 3 species for Total Taxa Richness while the 90th percentile had 23 species. Therefore, 3 species or less would be scored 0, 23 species or more would be scored 10, and 6 species would be scored on the 0-10 scale according to the equation below (ESA 2024). For more information on the adapted IBI used for this analysis, see the Summary BMI Report (Attachment B).

$$10 * \frac{6\ (\text{species}) - 3\ (\text{the } 10^{th}\ \text{percentile})}{23(\text{the } 90^{th}\ \text{percentile}) - 3\ (\text{the } 10^{th}\ \text{percentile})} = 10 * \frac{3}{20} = 10 * 0.15 = 1.5$$

**Table 3. BMI Metrics**

| Tahoe Keys CMT IBI – Scaled Calculations | | |
|---|---|---|
| **Metric** | **Score & Scaled-Metric Calculation** | **Metric Value Range** |
| **Richness** | | |
| Total Taxa Richness | 0 | If ≤ 3 |
| | 10 | If ≥ 14 |
| | 10*(*Richness* – 3) / (14 – 3) | If between 3 - 14 |
| **Composition** | | |
| Chironomidae (midge) Abundance (relative to total sample) | 0 | If ≥ 67% |
| | 10 | If ≤ 29% |
| | 10*(67 - *Midge Relative Abundance* ) / (67 – 29) | If between 29% - 67% |
| Abundance of top 3 most dominant taxa (relative to total sample) | 0 | If 100% |
| | 10 | If ≤ 47% |
| | 10*(100 – *Dominant Taxa Relative Abundance* ) / (100 – 47) | If between 47 – 100% |
| **Tolerance** | | |
| Abundance of most tolerant taxa (TV = 7 -10) (relative to total sample) | 0 | If ≥ 65% |
| | 10 | If ≤ 33% |
| | 10*(65 – *Tolerant Taxa Relative Abundance* ) / (65 – 33) | If between 33 – 65% |
| Average tolerance value of individuals in the sample | 0 | If ≥ 8.1 |
| | 10 | If ≤ 6.0 |
| | 10*(8.1 – *Average Tolerance* ) / (8.1 – 6.0) | If between 6.0 – 8.1 |
| **Function** | | |
| Predator Taxa Richness | 0 | If ≤ 1 |
| | 10 | If ≥ 9 |
| | 10*(*Predator Richness* – 1) / (9 – 1) | If between 1 - 9 |

#### 3.3.2.2 Statistical Analysis

ANOVA, an analysis of variance, was used to determine if significant differences exist between the pre-treatment (2022) and post-treatment (2024) datasets for each metric listed above. ANOVA uses the means of the groupings to test if meaningful differences exist between them (ESA 2024). Significant differences in the ANOVA for a grouping would indicate that the treatment effected the metric. For more information on the

statistical methodology used for this analysis, see the Summary BMI Report (Attachment B).

### 3.3.3 BMI Restoration Evaluation

Evaluation of BMI to determine the restoration status of the lagoons involves analyzing the function of benthic communities based on metrics related to trophic levels and analyzing the structure of benthic communities based on metrics related to richness and diversity (TKPOA 2022a). Restoration of BMI in the lagoons has occurred if:

- the function and structure of taxa is equal to or shows improvement from 2022 pre-treatment conditions, or
- there is a "lessening trend in tolerant species, showing conditions in lagoons have become less degraded and able to support more diverse species" (TKPOA 2022a).

These conditions/metrics are evaluated below relative to pre- and post-treatment conditions. A more detailed evaluation of BMI results can be found in Attachment B.

#### 3.3.3.1 Overall Richness

The data for taxa richness across all species showed minimal change post-treatment (2024) compared to pre-treatment (2022). Although overall richness was found to be significantly different between sampling location habitats (mid-channel and near-shore), no significant differences were found between time periods (ESA 2024). In both the Lake Tallac and West lagoons, richness in the treatment and control sites increased in 2024 above the 2022 pre-treatment values. It appears that near-shore habitats had consistently higher richness than mid-channel habitats in both lagoons and all treatments. No changes in richness between years were found to be statistically significant (ESA 2024).

#### 3.3.3.2 EPT Richness

EPT-taxa were rare in all sites within the study area, especially in mid-channel habitats (preferred habitat), where they were generally absent. Similar to overall richness, differences in EPT richness among habitats and waterbodies are significant. The interactions between waterbody and habitat, site and habitat, and time period and habitat were also significant (ESA 2024). This was likely due to the presence of additional species in the nearshore areas of the Lake Tallac Lagoon in 2024 (post-treatment) compared to 2022 (pre-treatment) in all sites. Considering these observations, it appears that EPT richness has increased in the Lake Tallac Lagoon. In the West Lagoon nearshore areas, EPT richness increased slightly in 2024 compared to 2022 for all treatment and Control sites.

#### 3.3.3.3 Diversity

Dominant taxa in the lagoons appears to have increased slightly post-treatment. In the Lake Tallac Lagoon, average percent abundance for the dominant taxa in the pre-

treatment samples was 37% for the Control and herbicide application site, while values increased to 46% and 40% for the Control and herbicide application sites post-treatment, however, no statistical differences between pre- and post-treatment values across the treatment types are noted (ESA 2024). In the West Lagoon, average percent abundance for the dominant taxa in the post-treatment samples also increased in both the Control and treatment sites compared to the pre-treatment values.

#### 3.3.3.4 Tolerance

Tolerance varied between time period, site, and habitat, however, only the differences among sites were found to be statistically significant (ESA 2024). Despite non-significance between pre- and post-treatment datasets, many sites showed a visible decrease in average tolerance in post-treatment samples. For figures and more details regarding tolerance, see Attachment B.

#### 3.3.3.5 Trophic Diversity and Function

Relative abundance of various functional feeding groups, called trophic diversity, showed trends that are relative to each feeding group (ESA 2024). Each feeding group is discussed in greater detail below.

Gatherers appear to be the most common macroinvertebrates. Gatherers comprise 54% of the total macroinvertebrate abundance on average. They also showed the most significant difference between pre- and post-treatment, with abundances almost doubling from an average of 40% pre-treatment to an average of 60% post-treatment (ESA 2024). Average mid-channel gatherer abundances increased (pre-treatment: 31%, post-treatment: 63%) more than near-shore gatherer abundances (pre-treatment: 49%, post-treatment: 58%) when compared across habitat type and time period.

On average, predators comprise 22% of the macroinvertebrates and showed significant differences between waterbodies and time periods. Predators occurred more frequently in the Lake Tallac Lagoon (33%) compared to the West Lagoon (21%). They also were more abundant in pre-treatment samples (30%) compared to the post-treatment samples (18%) (ESA 2024). However, no significant differences are noted pre- and post-treatment.

Scrapers are rare in the lagoons, resulting in the relative abundance showing little difference between pre- and post-treatment. Although a significant difference in scraper abundance between pre- and post-treatment was noted by the ANOVA, the difference is less than 0.1% and likely represents sampling bias more than a true difference (ESA 2024).

Filterers comprised 11% of the sampled macroinvertebrates and showed differences between pre- and post-treatment samples. Significant differences were seen between habitat types pre- and post-treatment as mid-channel filterer abundances dropped from 13% to 6% between pre- and post-treatment, while near-shore abundances increased, from 11% pre-treatment to 13% post-treatment (ESA 2024). In the UV-C treatment sites,

filterer abundances decreased from pre- to post-treatment sampling events with values at 27% and 9%, respectively. This is the largest change in abundance (66% change), while other sites, including the Control sites, contained more modest changes of 20-30% (ESA 2024).

#### 3.3.3.6 BMI Restoration Discussion

The 2024 post-treatment sampling event showed species richness and relative abundance of the dominant taxa as statistically equivalent to pre-treatment conditions. In some cases, overall richness appears to have increased. The general decrease in average tolerance across most sites between pre- and post-treatment, though not significant, may indicate an improvement in water quality post-treatment. Changes in the trophic diversity also point to a potentially beneficial shift as evidenced by the increase in gatherer abundances and decrease in filterer abundances. BMI responses to the CMT treatments varied but generally represents a trend toward “recovery” as defined within the APAP Amendment 1 (TKPOA 2022a) (ESA 2024).

# 4.0 OTHER DATA CONSIDERED FOR RESTORATION

To further assess restoration in the Tahoe Keys lagoons, other ecosystem parameters relating to the CMT Project and data comparisons are described in the following sections. Sediment sampling in herbicide test sites pre- and post-application was conducted by Blankinship and Associates, on behalf of TRPA in accordance with the NPDES and QAPP to determine whether herbicide remains in the sediment of the test sites. For the lagoons sediment to be fully restored post-CMT Project, both endothall and triclopyr must be non-detect for residual herbicides (Lahontan 2022, TKPOA 2022a).

Lake Tahoe water levels also have a critical role in aquatic habitat for macrophytes and influence water quality conditions in the West Lagoon. Water levels are described below to depict the factors that may be involved in differences between pre-treatment years (2019 and 2020) and CMT treatment years (2022 herbicide application and 2022-2024 UV-C treatments). As mentioned in Section 1.4, APAP Amendment 1 indicates that the lagoons restoration status evaluation will be based on comparisons of both pre-CMT and post-CMT conditions in untreated Control sites due to the variable water levels present year-to-year. Each of these topics are discussed in greater detail below.

## 4.1 Herbicide Sediment Sampling

Between May 25 and May 31, 2022, the aquatic herbicides endothall and triclopyr were applied to 13 application sites in the West and Lake Tallac lagoons. Sediment monitoring was conducted once before herbicide application and twice after herbicide application at each treatment site and analyzed for degradants and residue of herbicide (Blankinship. a Bowman Company 2024). For information on the locations and sampling method for sediment, please see the Tahoe Keys Lagoons Control Methods Test Sediment Sampling Report.

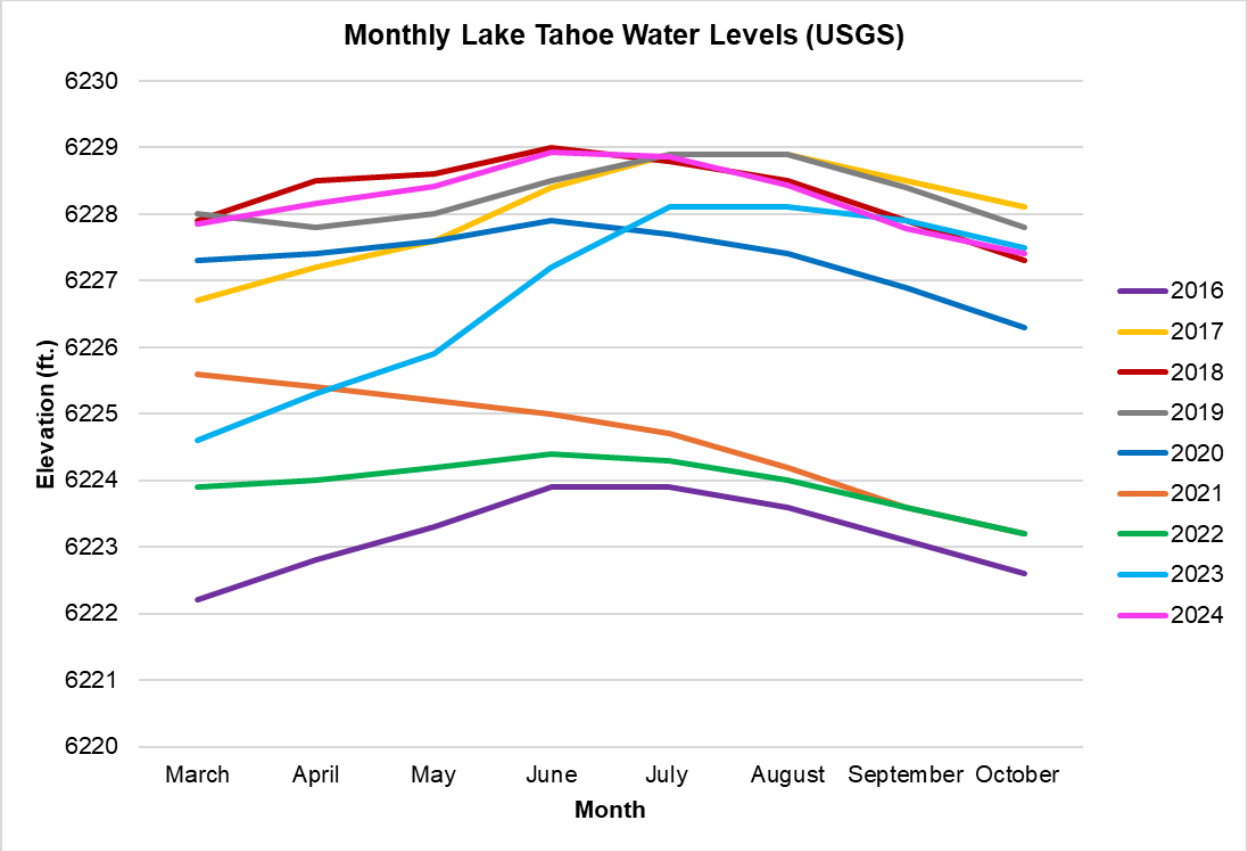
The first post-application sediment sampling event occurred in late September 2022 and showed no detections of triclopyr, TCP, or TMP, whereas endothall was detected in 42% of samples at concentrations ranging from 50 to 740 mg/kg. The second post-application sediment sampling event occurred in late August 2024 and showed no detections of endothall (Blankinship. a Bowman Company 2024). The results from all sediment samples collected both pre- and post-application can be found in Attachment C.

## 4.2 Water Level Conditions

Water level conditions have changed dramatically over the past 9 years as shown in Figure 16. The range in water levels can change lagoon water volumes by a factor of 2, altering habitat conditions significantly for different aquatic plant and animal species. Low water years can change deep water aquatic habitat to near shore shallow habitat that favors different species such as Eurasian watermilfoil. Near shore aquatic habitat can change into emergent wetland habitat in low water years. High water years can increase favorable habitat conditions for curlyleaf pondweed and free-floating aquatic plants such as coontail.

Water levels are primarily impacted by spring snowmelt with lake levels dependent on the type of water year (e.g., dry, average, or wet water years). Wet water years with above average snowpacks produce higher water levels that can reduce water temperature or delay warm-up of lagoon waters. Water year types also impact the timing and volume of aquatic plant growth as high-water levels create more habitat for the aquatic plants to occupy. Additionally, differences across water year types can cause changes in temperature, nutrients availability, availability of sunlight, and turbidity, which all affect aquatic plant growth.

**Figure 16. Monthly Lake Tahoe Water Levels**



## 5.0 CERTIFICATION OF LAGOONS RESTORATION STATUS

The NPDES states that upon conclusion of all aquatic herbicide treatment events for the aquatic weed control methods test project, the Discharger must provide certification by a qualified biologist that beneficial uses of receiving waters have been restored to pre-project conditions. Annual biological monitoring must be conducted until a qualified biologist certifies that beneficial uses of receiving waters have been restored to pre-project conditions. The certification must be accompanied by a report detailing the pre-project and post-project monitoring (Lahontan 2022). Requirements from the NPDES for the "biological assessment" report are:

- certification that all affected non-target biological communities have been restored,
- a detailed description of pre-project and post-project monitoring,
- an explanation of assessment methods used, and
- rationale for certification.

I, Jeremy Waites, certify that the statements furnished above present the data and information required for this Biological Restoration Report, and that the facts, statements, and information presented herein are true and correct to the best of my knowledge and belief. I certify that restoration of, or improvements in, water quality, non-target aquatic life, and benthic communities within treatment areas two years post-treatment (post-herbicide application) have occurred in the Tahoe Keys lagoons.

Jeremy Waites, Senior Ecologist
Sierra Ecosystem Associates

2/27/2025
Date

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## 7.0 LIST OF PREPARERS

The following individuals prepared the text presented in this report.

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Contributors for this report also included Dr. Lars Anderson and staff from Environmental Science Associates (ESA), and Blankinship. a Bowman Company.

# Attachment A.

## Raw Data

- Macrophyte Data - 2020 (Sierra Ecosystem Associates)
- Macrophyte Data - 2024 (Sierra Ecosystem Associates)
- Macrophyte Data - 2024 (ESA | Environmental Science Associates)
- Macrophyte Data Tables (Sierra Ecosystem Associates)
- Water Quality Data Tables (Sierra Ecosystem Associates)
- Other Raw Data (Biobase) (*zipped folder)*

*Link provided to Lahontan Water Board.*

# Attachment B.

## Tahoe Keys Lagoons Aquatic Weed Control Methods Test: Benthic Macroinvertebrates Summary Report

*Prepared by Environmental Science Associates*

*Link provided to Lahontan Water Board.*

# Attachment C.

## Tahoe Keys Lagoons Control Methods Test Sediment Sampling Report

*Prepared by Blankinship. a Bowman Company*

*Link provided to Lahontan Water Board.*