2020 TKPOA Lake Tallac Control Projects

End of Season Report

Tahoe Keys Property Owners Association

South Lake Tahoe, California

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TAHOE KEYS INTEGRATED MANAGEMENT PLAN

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1.0 2020 INTRODUCTION

The Tahoe Keys Property Owners Association (TKPOA) has been working with leading experts on aquatic invasive species (AIS) from around the country to create an adaptive, integrated plan to significantly reduce the bio volume of the infestation in the Tahoe Keys. The TKPOA has been using every tool in the toolbox, measuring success, and adapting to new methods and changing results. In addition, the TKPOA is trying to get every property owner and visitor to do their part.

Lake Tallac Lagoon (a storm water collection basin for South Lake Tahoe) is a waterbody owned and managed by the TKPOA. There are 5 dominant macrophyte species in Lake Tallac. These species are Eurasian watermilfoil (*Myriophyllum spicatum*), curlyleaf pondweed (*Potamogeton crispus*), and the native coontail (*Ceratophyllum demursum*), water shield (*Brasesnia schreberi)* and yellow pond lily (*Nuphar lutea).* These species thrive during the summer when growing conditions are ideal.

During 2020 the TKPOA conducted several projects in Lake Tallac in an attempt to improve water quality and reduce nuisance aquatic macrophytes. The first project was removing the yellow pond lilies in the Lake Tallac canal with diver assisted hand-pulling. Another project conducted in Lake Tallac was the installation of the Floating Treatment Wetlands. These were installed on the East side of the lake (near Dover Street) as well as in the canal. Along with these projects, TKPOA AIS staff monitored water quality biweekly within Lake Tallac.

2.0 TKPOA WASTE DISCHARGE REQUIREMENTS (WDR)

The TKPOA conducts water quality improvement operations in Lake Tallac, within the bounds of the WDR permit, to ensure that the lagoon is able to fulfill its recreational potential. The WDRs issued to the TKPOA state objectives that the Integrated Management Plan (IMP) is to accomplish and guidelines on how to achieve these objectives; therefore, the first Goal of the IMP is to fulfill the objectives named in the WDRs.

2.1 Section 15: Non-Chemical Control of Aquatic Invasive Plant Species

Hand-pulling of invasive aquatic weeds is encouraged. If continued use of mechanical aquatic weed harvesting is proposed, then TKPOA must develop and implement Best Management Practice control measures to limit the spread of viable plant fragments. This Order requires submission and implementation of an Integrated Management Plan (IMP) to address aquatic invasive plant species management.

2.2 Section 18: Integrated Management Plan for Aquatic Invasive Weeds (IMP) Objectives

a. Eliminate the spreading of aquatic invasive species from the Tahoe Keys to greater Lake Tahoe.
b. Enhance overall water quality of the Keys Lagoons and Keys Marina, thereby improving Lake Tahoe water quality and associated clarity.
c. Reduce habitat for non-native fish and enhance habitat for native fish in the Keys Lagoons and Keys Marina.
d. Restore and maintain established beneficial recreational uses, including water contact safety, in the Keys Lagoons and commercial uses in the Keys Marina.

e. Implement a combination of cost-effective control measures that are feasible for long-term management of aquatic invasive plants.

3.0 2020 LAKE TALLAC WATER QUALITY DATA COLLECTION

AIS staff continued collecting water quality data for the IMP and required permits during the 2020 season. The sampling programs are conducted to ensure that the TKPOA is meeting requirements set by the LRWQCB WDRs and meeting the Water Quality Objectives (WQO) stated in the WDRs. Samples and data were also collected for the State Water Board funded Laminar Flow Aeration (LFA) project and one stormwater sampling event

3.1 Summary

The Lake Tallac Sampling Program was conducted for the 2020 season. During the 2020 season, AIS staff collected water quality chemistry data from 14 locations in Lake Tallac. Data was collected at 5 different depths in the water column to characterize water in the lagoons.

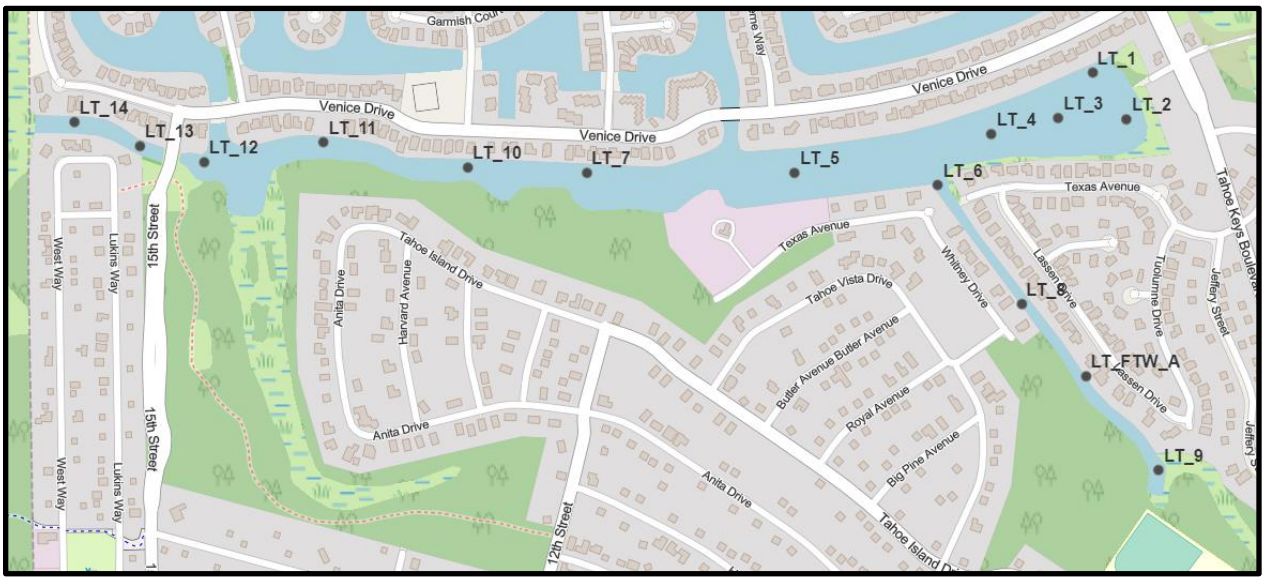

Figure 1: 2020 Lake Tallac Sampling Sites Map for Lake Tallac

Figure 1 displays the locations of the 14 sites where water quality measurements were taken during 2020.

3.2 2020 Lake Tallac Sampling Overview

In 2020, the AIS staff sampled the sites shown in figure 1 every other week. Nine water quality parameters were measured during seven sampling events at 14 sites over the course of the aquatic plant growing season from late May through November. Due to budget constraints the TKPOA did not sample for nutrient contents at the Lake Tallac sites.

Parameter	Method of Measurement	Description
Depth	YSI ProDSS or Water Sounder	Depth in meters of water at each site. Used to determine the 5 sampling points in the water column.

Temperature	YSI ProDSS and YSI 1020	Measure of acidity or alkalinity of water, with pH 7 being neutral. Surface, mid-point, and bottom were collected during the season to monitor effects of plant biomass on overall pH.
Specific Conductance	YSI ProDSS	Measure in micro Siemens per centimeter (µS/cm) of dissolved ionic particles in the water. Acts as a good indicator of Total Dissolved Solids.
Dissolved Oxygen	YSI ProDSS and YSI 1020	Amount (in parts per million) of oxygen present in water. An important parameter in water quality assessment due to its influence on aquatic organisms. Concentrations of DO that are either too high or too low can be harmful to aquatic life and can affect water quality (Fondriest Environmental Inc. 2016).
pH	YSI ProDSS	Measure of acidity or alkalinity of water, with pH 7 being neutral. Surface, mid-point, and bottom were collected during the season to monitor effects of plant biomass on overall pH.
Phytocyanin (PC)	YSI ProDSS	A measure of Phytocyanin in the water column. Phytocyanin is a blue-copper containing pigment found in harmful algae.
Chlorophyll (CHL)	YSI ProDSS	Chlorophyll content in the water column.
Ammonium	YSI ProDSS	Measure of Ammonium in the water column. Ammonium is a key nutrient for plant growth.
Oxidation Reduction Potential	YSI ProDSS and YSI 1020	Oxidation Reduction Potential (ORP) recorded in millivolts. This is a key component in water quality to determine the health of an ecosystem.
Turbidity (FNU)	YSI ProDSS	Measurement of water clarity using Formazin Nephelometric Units

Table 1: List of Monitored Parameters

3.3 Methods and Materials

a. Equipment The following list includes the equipment that was utilized for each sampling:
   - YSIProDSS
   - YSI Calibration Log
   - Pen/ Pencil/ Sharpie
   - Site Map (Figure 2)
   - Calibration Solutions
   - Water Quality Data Sheet
   - Water Level Sounder (Weighted rope with half meter increments to measure depth)
   - 250 milliliter (mL) bottle
   - Cooler
   - Ice packs

Figure 2: YSI ProDSS

a. Calibration

Calibration was conducted prior to each sampling event. Calibrations were done using the calibration solutions for ammonium (1 mg/L, 100 mg/L), pH (4, 7, and 10), turbidity (0 FNU, 12.4 FNU), Oxidation Reduction Potential (Zobelle Solution, mV), PC (RFU), Chlorophyll (RFU), DO (ppm), and conductivity (1000 mS/cm). The calibration data was logged and kept on file for that sampling event. Appendix A contains the calibration record.

b. Methods

On the day of collection, once all equipment was loaded onto the boat the AIS staff filled out the Data Sheet, indicating the date, sampling type, wind speed and direction and air temperature.

Data was collected at each site using the YSI ProDSS and a YSI Pro 1020. Depth of each site was determined using measured markings on the YSI ProDSS cable. The cable has measured marks every 0.1 meters so depth was only accurate to the nearest tenth of a meter. The depth was used to determine the sampling depth for the 5 different points in the water column. These points included bottom (B), quadrant 1 (1), middle (M), quadrant 3 (3), and surface (S).

Once depth was determined the instruments were raised 6 inches off the bottom and left to run for roughly a minute, to ensure the reading had stabilised. The temperature, DO, turbidity, electrical conductivity, pH, oxidation reduction potential (ORP), ammonium, were then recorded onto the data sheet along with the site number and time. These measurements were repeated at each quadrant. Additional data for turbidity and conductivity was collected at the mid point. Data from the data sheet was entered into the database workbook and the original hardcopy was scanned to be saved as an electronic copy.

3.4 Results

The WDR permit issued by LRWQCB states "Tahoe Keys Lagoons are physically connected to Lake Tahoe and have no site-specific water quality objectives (WQOs) of their own, so Lake Tahoe WQOs apply." Meaning, that even though the environment of the Tahoe Keys Lagoons is drastically different from Lake Tahoe Proper, they still need to meet the same objectives. As

displayed in the figures above the chemistry inside the lagoons is much different than in Lake Tahoe proper. (WDR, 2014)

Year	Total Nitrogen (TN), mg/L	Total Phosphorus (TP), mg/L	Total Dissolved Solids (TDS) (mg/L)	pH	Turbidity (NTU)
2007	0.28	0.030	74	9.16	0.75
2008	0.15	0.033	84	7.67	1.46
2009	0.33	0.043	87	9.15	7.97
2010	0.20	0.019	101	8.87	1.20
2011	0.18	0.023	71	8.31	1.72
2012	4.57	0.019	No data	8.88	No data
2013	0.24	0.026	81	7.97	1.88
2016	0.397	0.025	25.8	9.12	1.56
2017	0.647	0.033	31.39	7.84	2.27
WQO	**0.15**	**0.008**	**60**	**7.0-8.4**	**3.00**

Table 2: Water Quality Objectives and past years results (WDR 2014)

Results from the Lake Tallac Sampling events are shown in the sections below. Results from Site 3, 7, 8, 11 and 14 were selected to show the range of conditions that are in Lake Tallac. Site 3 is close to Dover ramp in an area that is believed to be mostly stagnant. Site 7 is in the middle of Lake Tallac after waters from the east end and the canal have mixed. Site 8 is located in the Lake Tallac Canal. Site 11 is closer to 15th street and represents water quality conditions observed in the western end of Lake Tallac. Site 14 is on the west side of 15th street.

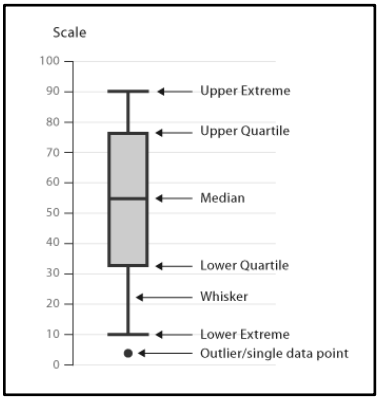

Figure 3. Box and whisker plot description

a. Temperature

As expected, the warmest temperatures were observed mid July through early September. Lowest temperatures were observed at the bottom of the water column while highest were at the surface.

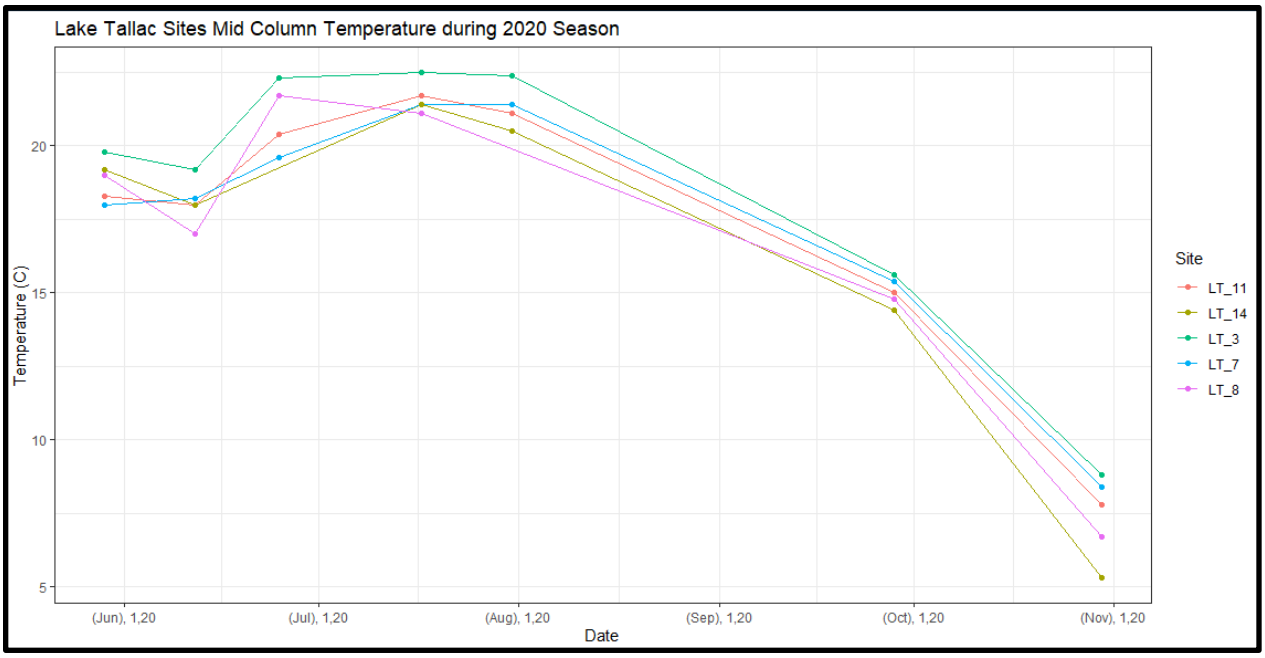

Figure 4. Mid Column Temperature Levels for Lake Tallac Sites during 2020 Season

b. pH

pH levels are lower at the bottom of the water column compared to the surface but are on average higher in the middle and surface due to photosynthesis of the plants.

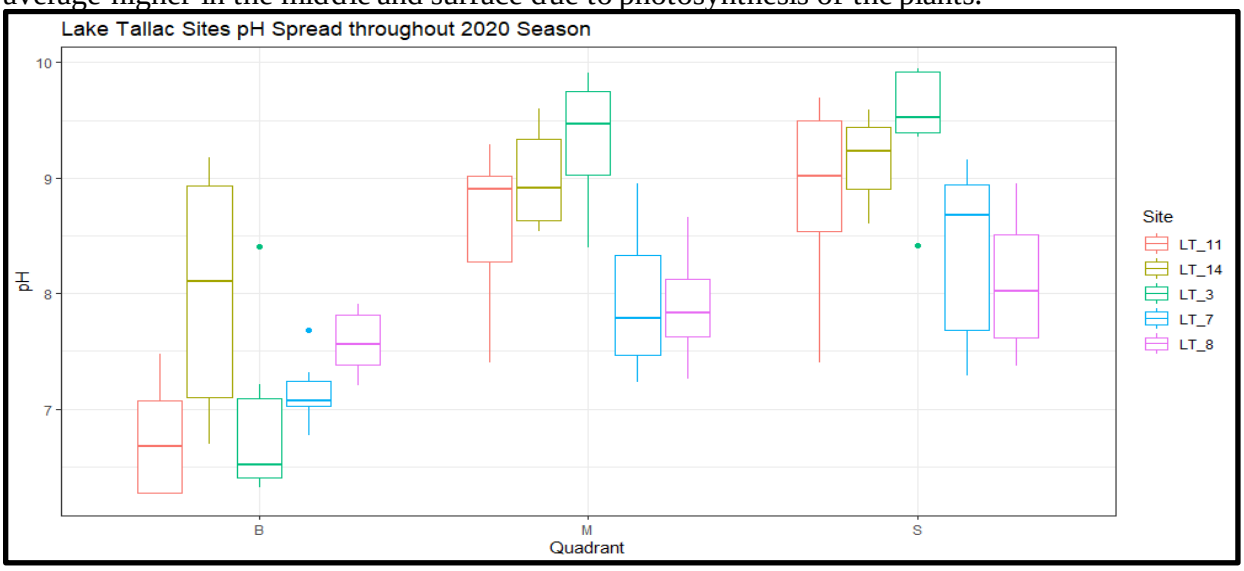

Figure 5. pH Spread for Lake Tallac Sites during 2020 Season

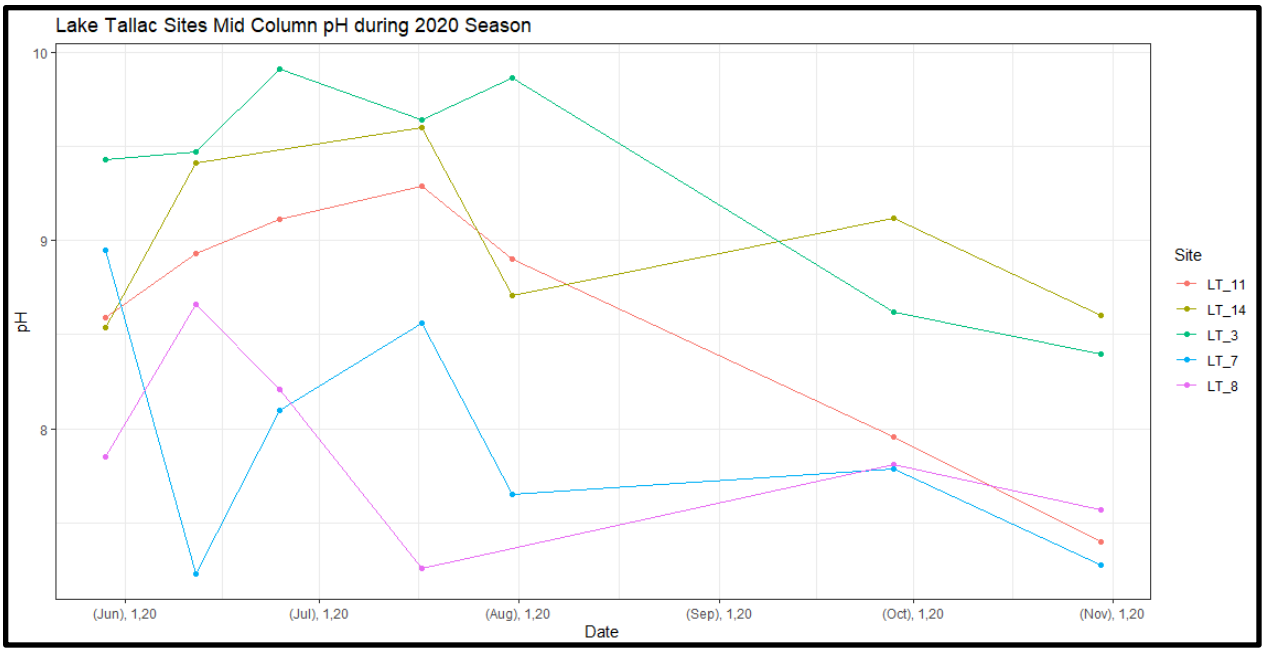

Figure 6. Mid Column pH Levels for Lake Tallac Sites during 2020 Season

c. <u>Dissolved Oxygen</u>

The dissolved oxygen content varied by what depth and where the measurement was taken. The bottom often had low dissolved oxygen while the mid point and surface had higher content.

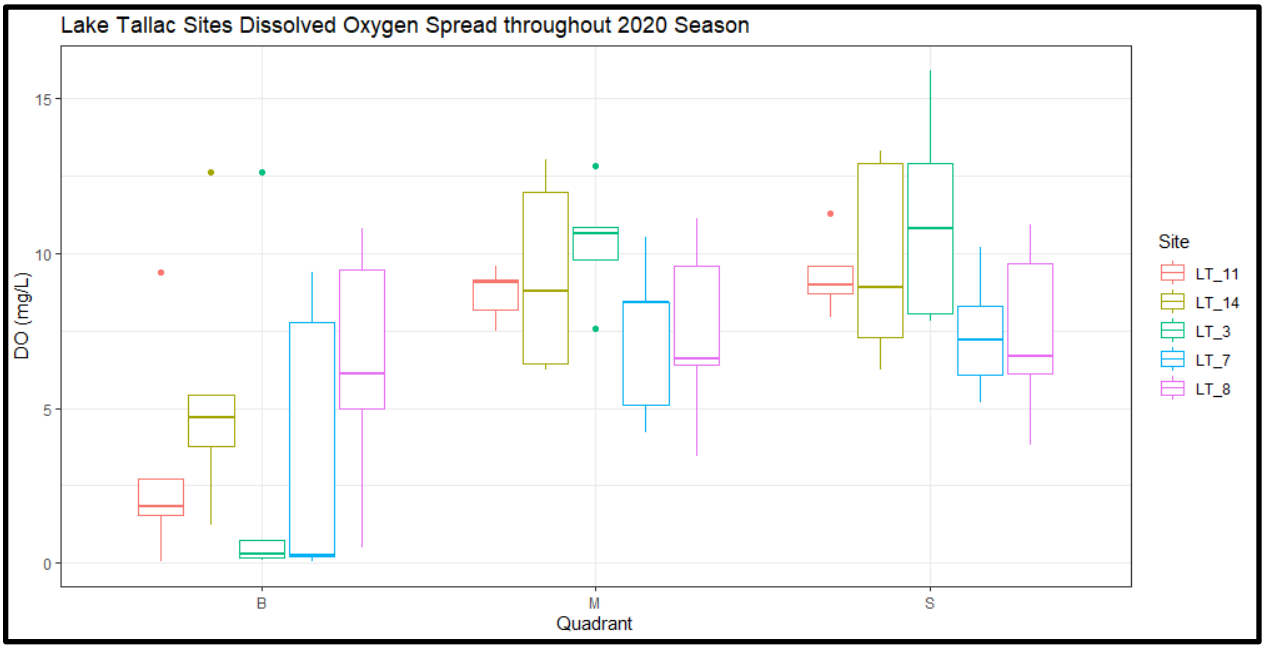

Figure 7. Dissolved Oxygen Spread for Lake Tallac Sites during 2020 Season

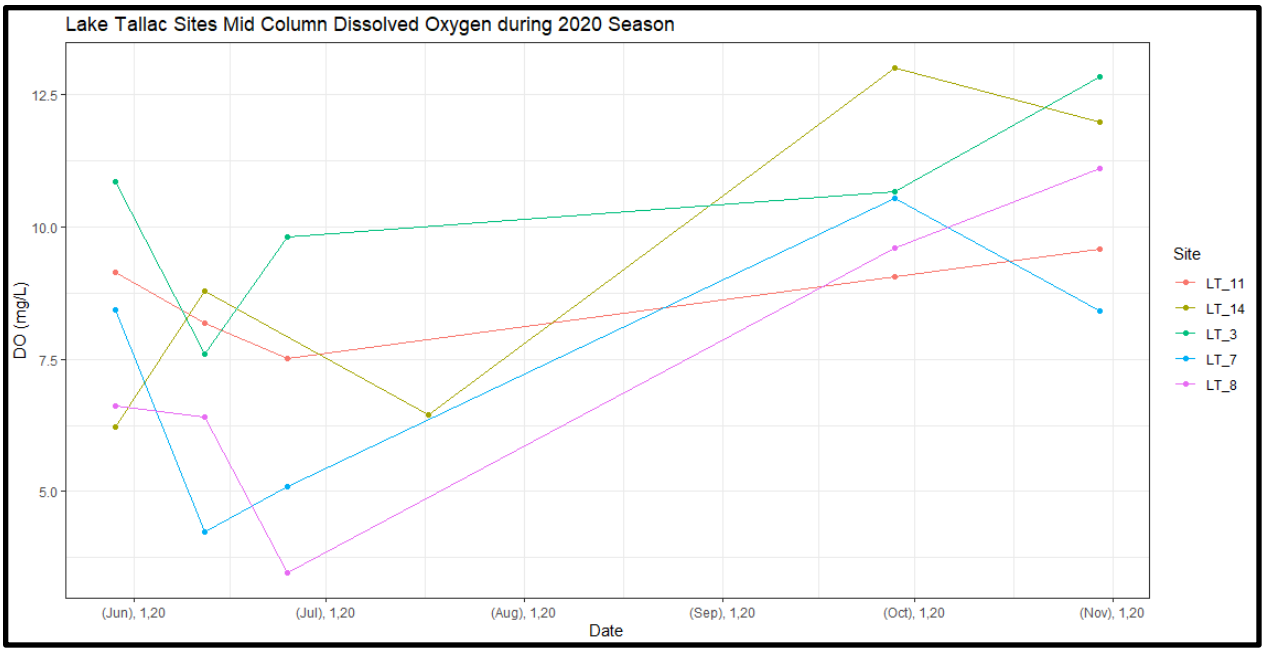

Figure 8. Mid Column DO throughout 2020 Season

d. <u>Turbidity</u>

Figures 9 and 10 show turbidity results from WQ sampling. Turbidity readings were recorded in the middle of the water column. Turbidity was higher during the summer months, likely due to increased suspension of organic material and algae growth.

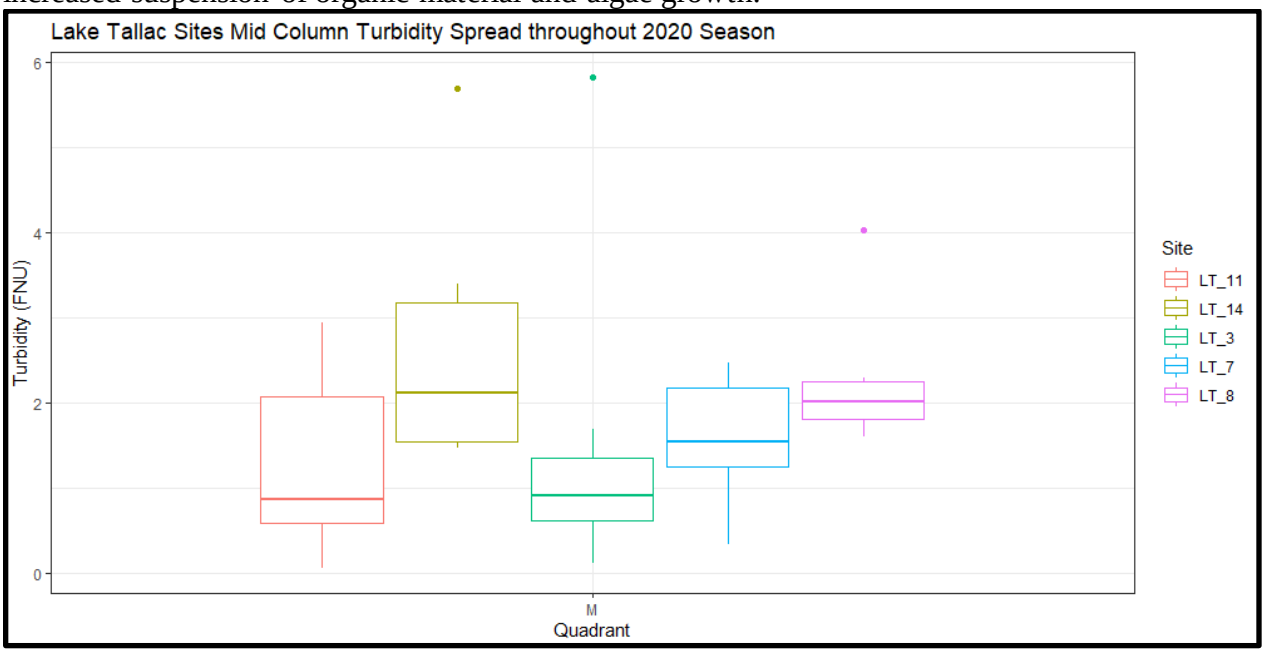

Figure 9. Turbidity spread for Lake Tallac Sites during 2020 Season

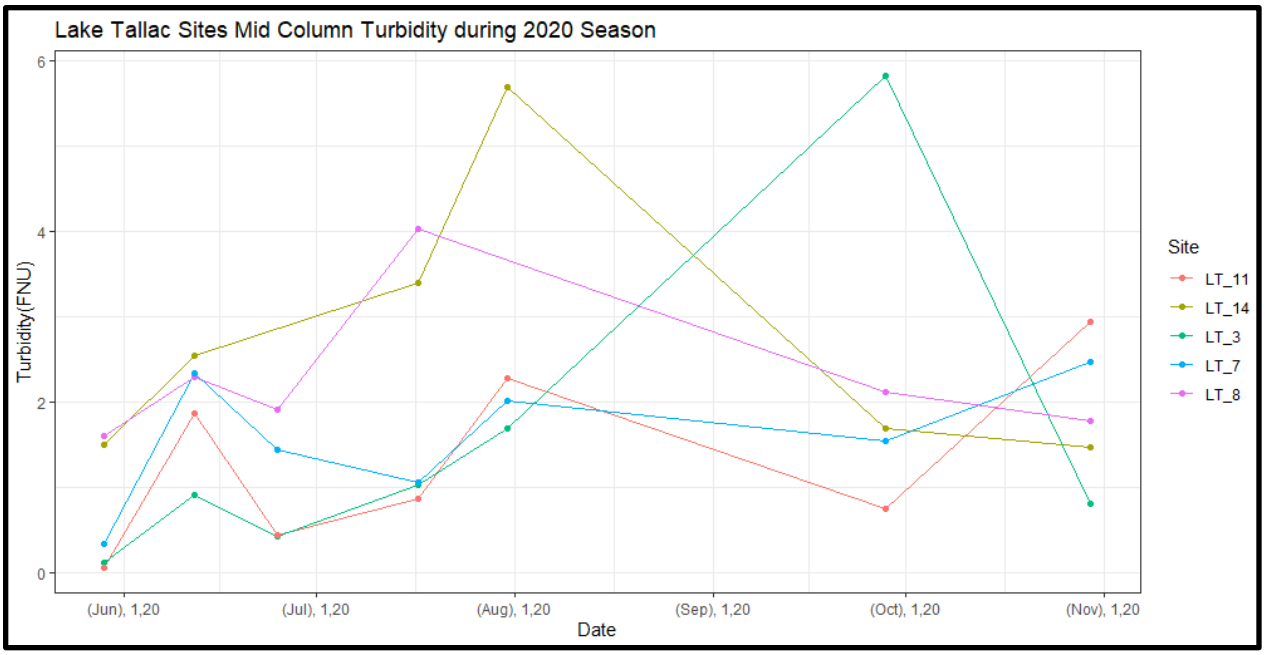

Figure 10. Turbidity levels for Lake Tallac Sites during 2020 Season

e. <u>Conductivity</u>

The conductivity of the lagoons is a good indicator of the overall health of the water column. Figure 11 depicts observed conductivity throughout the lake and shows higher conductivity later in the season.

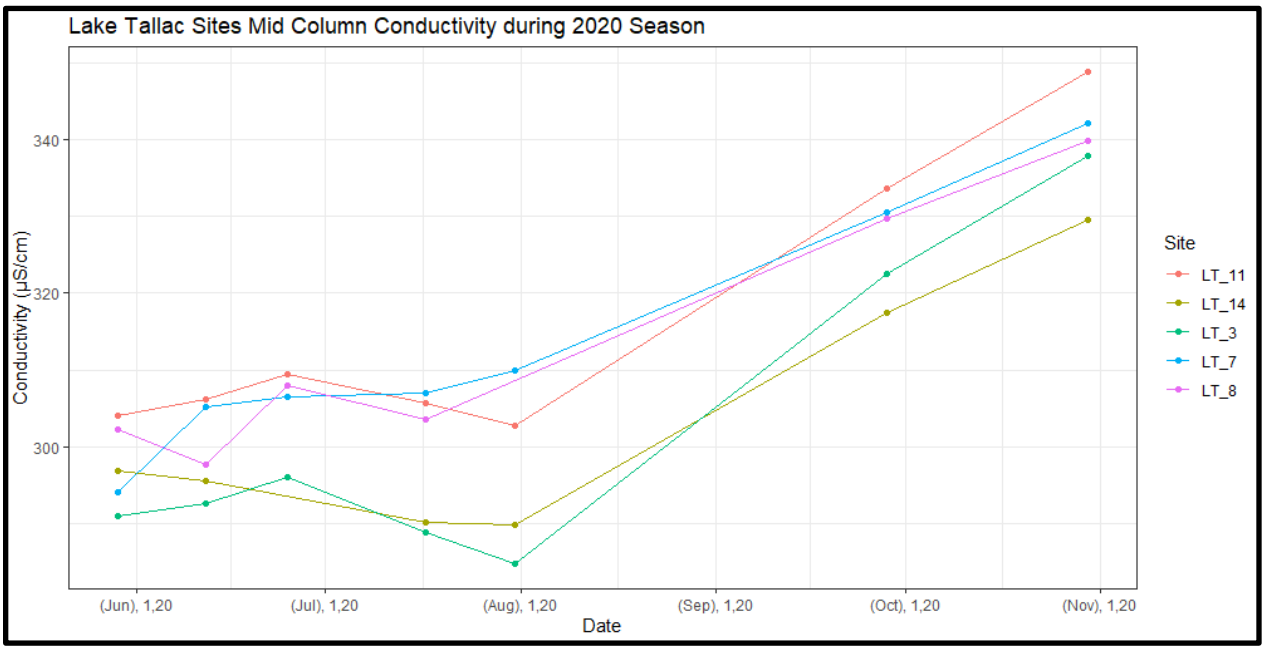

Figure 11. Conductivity Levels for Lake Tallac Sites during 2020 Season

<u>3.5 Discussion</u>

Even though the environment of the Tahoe Keys Lagoons is drastically different from Lake Tahoe proper, they still need to meet the same objectives. The poor water quality in Lake Tallac

is caused by several different factors. Lake Tallac experiences nutrient loading from stormwater runoff. The nutrient influx fuels aquatic macrophyte growth each year, exacerbating water quality problems caused by excess nutrients and vegetation.

There are some trends in pH and conductivity worth noting. Conductivity increased later in the season likely due to increased water temperature causing faster evaporation rates, which in turn increased total dissolved solids within the water column. When harvesting occurs it mixes the water column causing the average pH to drop on the surface and middle and increase on the bottom. Figure 6 shows a decrease in pH at site 8 around the middle of July when the Yellow Pond Lily project was ongoing and site 8 saw a decrease near the beginning of August when West of 15th St. was being harvested. Turbidity values occasionally rose above the objectives set by the WDR but mostly stayed within the defined range. pH values stayed consistently above the maximum WQO stated in the WDR, likely due to excessive biomass within the lagoon.

4.0 2020 YELLOW POND LILY WEED ABATEMENT PROJECT

The Lake Tallac Canal is home to many species of aquatic vegetation, the majority non-native or invasive. One of particular concerns is the nuisance aquatic plant, Yellow Pond Lily (*Nuphar lutea*). This aquatic plant spreads rhizomes and roots in the bottom substrate. To completely eliminate Yellow Pond Lily, all rhizomes must be removed. If any portion of a rhizome remains, the plant can quickly regrow. This species is already overtaking portions of Lake Tallac, making it a top priority for the Water Quality Department to eliminate it to restore native habitat and prevent it from spreading into the Keys' canals and lagoons and potentially Lake Tahoe.

The YPL Abatement Project was implemented in the Summer 2020 to reduce the amount of This project aligns with the TKPOA WDR and the first through the fourth objective of the IMP which state:

a. Eliminate the spreading of aquatic invasive species from the Tahoe Keys to greater Lake Tahoe.
b. Enhance overall water quality of the Keys Lagoons and Keys Marina, thereby improving Lake Tahoe water quality and associated clarity.
c. Reduce habitat for non-native fish and enhance habitat for native fish in the Keys Lagoons and Keys Marina.
d. Restore and maintain established beneficial recreational uses, including water contact safety, in the Keys Lagoons and commercial uses in the Keys Marina.

4.1 Project Overview

The TKPOA AIS Program conducted the YPL Project with the goal of removing and reduce YPL in the canal section of Lake Tallac. The WDR states, "hand-pulling of invasive aquatic weeds is encouraged". The TKPOA contracted a team of divers, using experimental tools and techniques to conduct this project. The project lasted for a two-and-a-half-week period during July and August of 2020. The contracted technical dive team was assisted by the TKPOA AIS and harvesting staff through both equipment and laborers. One harvester continuously harvested the Lake Tallac canal to clear the targeted area of surface invasive aquatics so that the divers could more easily remove the YPL rhizomes. A crew of skimmers were on-site as well to assist the harvester and divers, they removed any plant fragments that the harvester was not able to

collect while also retrieving and removing the rhizomes that the divers cut away from the bottom and brought to the surface.

4.2 Project Objectives:

The objectives for the Lake Tallac Yellow Pond Lily Weed Abatement Project were:

a. Reduce and control the Yellow Pond Lily (YPL) nuisance aquatic weeds in Lake Tallac, the Tahoe Keys waterways and prevent their spread into Lake Tahoe
b. Protect and enhance habitat for native "non-nuisance" species in the Key's lagoons.
c. Protect recreation in the Tahoe Keys lagoons which are available for public access and use.
d. Help prevent public health issues through reducing an environment for harmful and dangerous algae blooms as well as mosquito infestations.
e. Improve the City of South Lake Tahoe – Storm Water Management of this important waterway.
f. This abatement project will be allowed under the TKPOA Waste Discharge Requirements with the Lahontan Regional Water Quality Control Board

4.3 Methods & Materials

4.3.1 Materials

- Technical Dive Team & Associated Equipment
- Harvester
- Skimmer Boat
- Skimmer Poles
- Pitchforks
- Wet Suit
- Waders
- Work Gloves
- Turbidity Curtains (Required by WDR Permit)
- Offloader Vehicle

4.3.2 Methods

a. Installed two turbidity curtains downstream of the removal area prior to the start of the removal project. These turbidity curtains will be used as a method for preventing debris and water disturbance from impacting Lake Tallac. Turbidity curtain installation requires use of one harvester machine, 5 anchors per turbidity curtain, and 3-4 laborers.
b. Deploy a harvester to begin clearing out aquatic macrophytes from around the YPL to make access easier for divers.
c. Direct technical divers to the area where YPL is present.
d. Divers remove the YPL rhizomes using professionalized diving gear and equipment.
e. Skimming crew in place throughout the project to provide assistance to divers, collecting and removing rhizomes and other debris throughout the duration of the project. Simultaneously, assist dive crew with the harvester by continuously clearing areas ahead of them.
f. Process was completed throughout the Lake Tallac Canal.

4.5 Results

The figures below display before and after photos of the Lake Tallac Canal taken from a drone.

Figure 12. Pre-Treatment taken July 20, 2020 (left), and Post-Treatment taken August 14th, 2020 (right)

Initially, after the removal of the rhizomes, there appeared to be no more YPL within the Lake Tallac Canal. However, a few weeks following the removal, YPL could be seen reemerging within the canal. WQ Staff removed around ~3500 lbs of rhizomes and ~210 cubic yards of plant material from the area but the infestation still remains. Figure 13 below shows the pile of rhizomes that the divers and skimmers removed. Figure 14 shows the reinfestation post project.

Figure 13. Rhizomes and other vegetation removed from Lake Tallac Canal.

Figure 14. September 15th 2020, Yellow Pond Lily presence post project.

4.6 Discussion

Due to the remaining presence of the YPL it is apparent that the project was not successful at removing all of the plant rhizomes. This is likely due to problems such as locating the rhizomes and poor visibility. When the divers pulled up the rhizomes from the bottom of the channel the turbidity increased due to stirred up sediment to the point where they could not see inches in

front of them. This made locating more rhizomes nearly impossible. It is also possible that the rhizomes were rooted deeper in the sediment than anticipated. Clearly the divers had missed some rhizomes due to the presence of YPL post project. If this project is to be conducted again it is recommended that rotovating be utilized. Rotovating would possibly reach deeper into the sediment allowing for a greater number of rhizomes to be unearthed and removed.

5.0 2020 LAKE TALLAC FLOATING TREATMENT WETLANDS PROJECT

5.1 Project Overview

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. The AIS Program at TKPOA installed 15 Floating Treatment Wetlands in two locations within Lake Tallac in an effort to improve water quality conditions. This project acts as a pilot study to determine the effectiveness of FTW and if they are viable in the main lagoon.

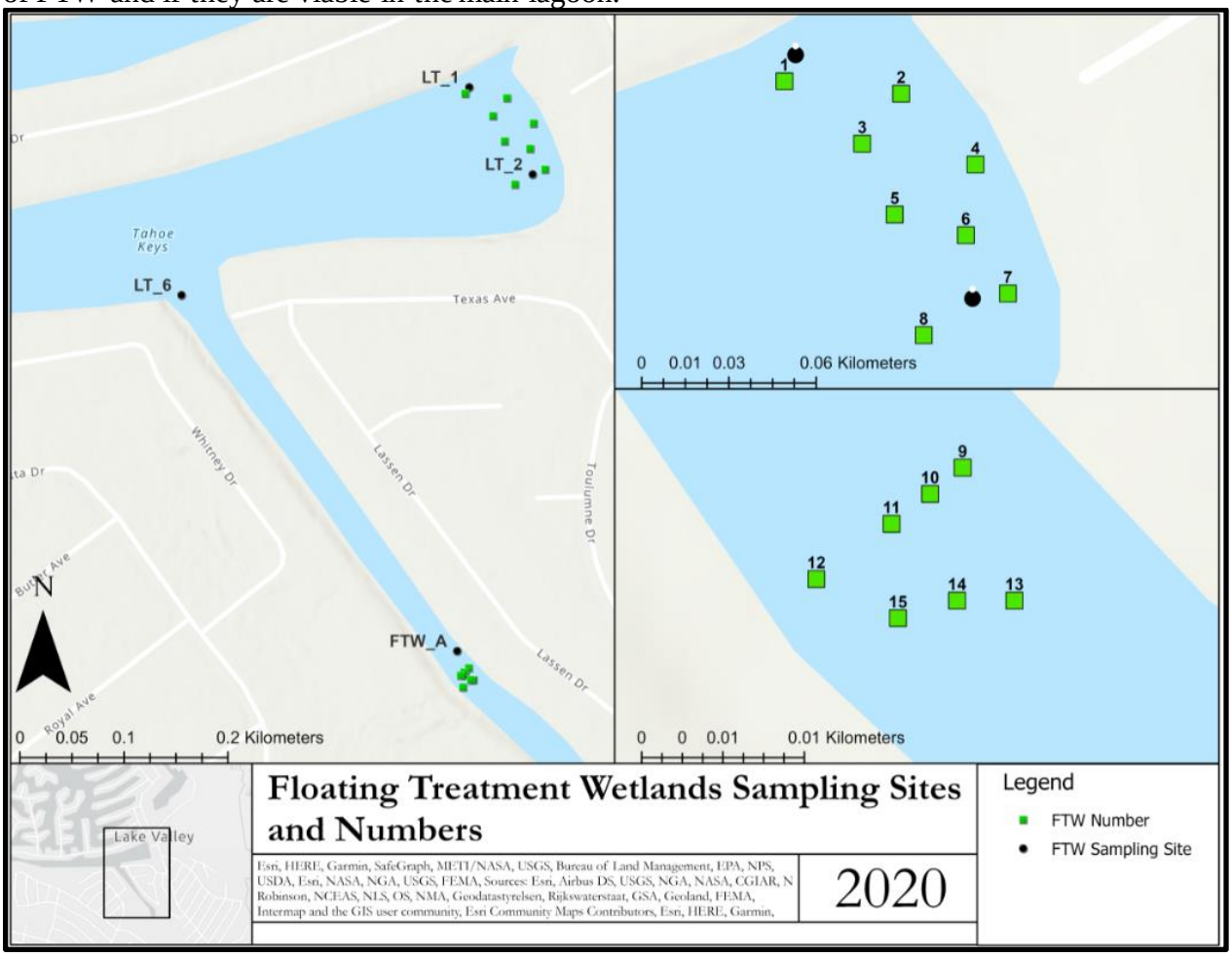

Figure 15. Floating Treatment Wetlands Project Map

5.2 Project Objectives

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

5.3 Materials and Methods

The TKPOA was responsible for assembling and installing the FTW. The materials required and methods used to assemble and install the FTW are listed below.

5.3.1 Materials

- FTWs (5ft. X 5 ft.)
- Coconut Coir Substrate
- PVC Pipe
- Pipe Cutter
- Plastic Fencing
- Metal Fencing (Chicken Wire)
- Scissors
- Zip Ties
- 30, 3.5-gallon buckets
- 30, 50lb bags of fence post concrete
- 30 I bolts with washers
- Rope (water-durable)
- Shovels
- Gardening shears.
- Electric drill and ¼ inch drill bit

5.3.2 Methods

Floating Treatment Wetland Assembly

a. Order and receive Floating Treatment Wetlands from Floating Islands West, LLC.
b. Prepare and create 2 anchors per FTW. We used 3.5-gal. buckets filled with ~45 lbs of cement with an I bolt set into the cement to tie a rope to. 30 anchors were used for the 15 FTW.
c. Locate and gather local, native wetland vegetation. The wetland vegetation used in the project was gathered from around the shoreline of Lake Tallac. Various species of native wetland grasses, shrubs and small trees were gathered for this project. Staff were provided with a list of native vegetation to locate and gather for this project.
d. Deposit around an inch of coconut coir substrate into the bottom of each planter compartment. Our 5ft-by-5ft FTWs each had 36 planter compartments.
e. Place vegetation into each of the 36 compartments. Staff needed to separate the vegetation to the appropriate size to fit the species into each compartment. This separation was done using gardening shears or a shovel.

f. Top off all planter compartments with coconut coir substrate, ensuring plants have a firm and sturdy base to optimize growth.
g. Attach one PVC pipe to each corner of the FTW. These four pipes will act as support for the fencing.
h. Install plastic fencing around the perimeter of the FTW. We used fencing which was 3.5ft in height. This plastic fencing prevents local waterfowl from inhabiting the FTWs before they have properly established plant communities.
i. Install chicken wire along the base of fencing. We used fencing that was about 1.5ft in height. This fencing prevents aquatic animals (such as muskrats) from chewing through or otherwise damaging the fencing and FTWs.

Floating Treatment Wetland Installation

a. Clear vegetation from areas where FTWs are to be installed. The TKPOA did this by using a harvester. This made it easier to position the floating treatment wetlands correctly.
b. Tow FTWs to a predetermined site.
c. Attach anchors to two opposite sides of the FTWs and lower to the bottom once the predetermined location has been reached. Be mindful to use extra rope (2-3ft) as water levels may rise.

Water Quality Monitoring

Monitor water conditions by FTWs every other week, specifically turbidity and dissolved oxygen levels. Section 3 of this report has a more in-depth analysis of water quality throughout Lake Tallac.

5.4 Results

See the figures below for results on mortality rate observed at each FTW along with water quality measurements taken at the sampling sites near the FTWs.

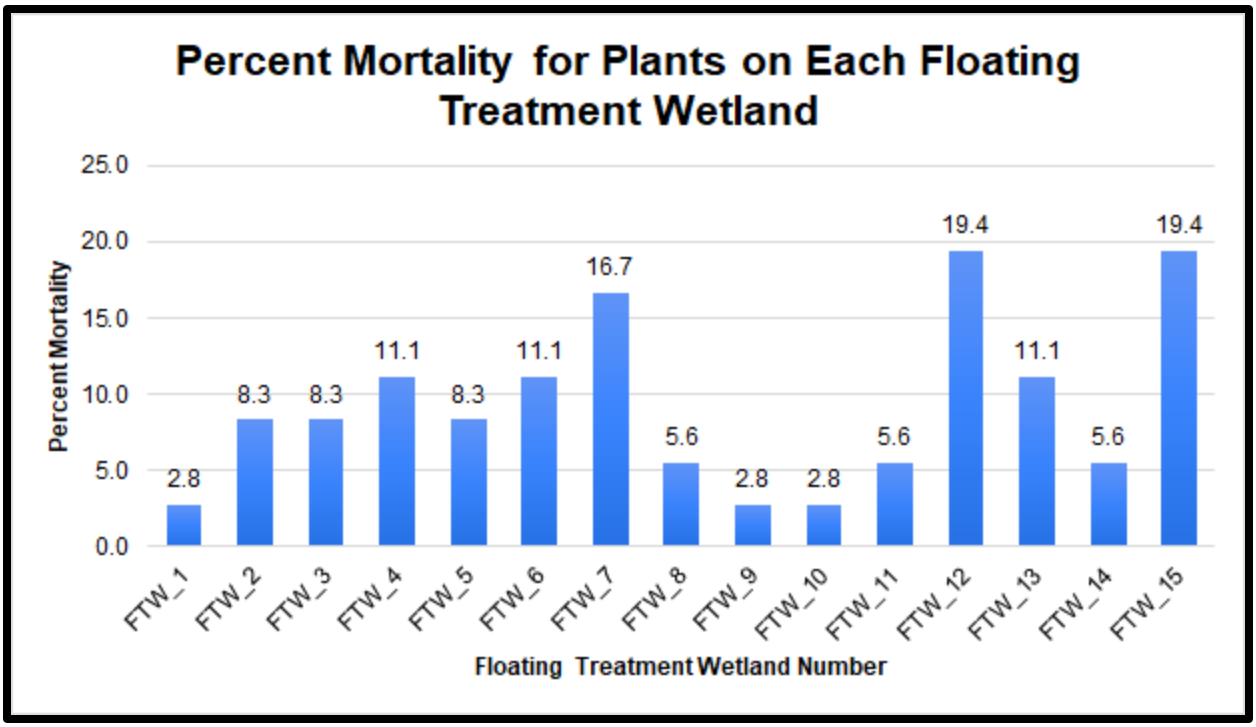

Figure 16. Percent Mortality for Plants on Each FTW

Figure 16 shows the mortality rate observed at each FTW. At FTWs 9-15 there was observable wildlife activity where wildlife dug up and consumed a few of the plants. See figure 15 for where each FTW is located.

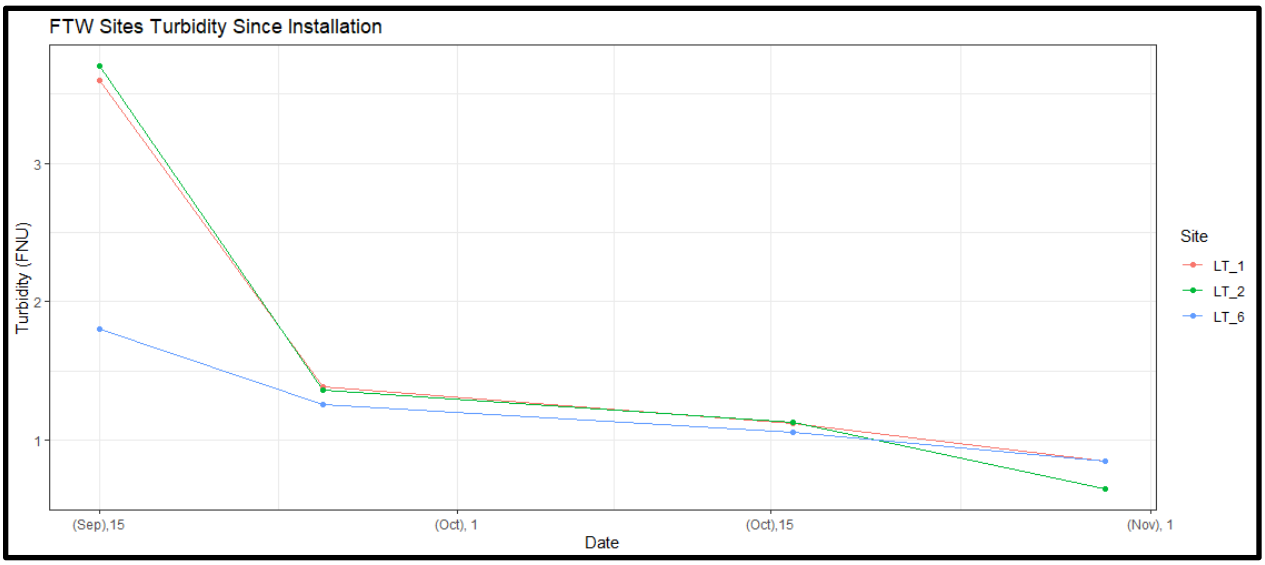

Figure 17. Turbidity at Floating Treatment Wetland Monitoring Sites

Figure 17 shows the turbidity at the 3 sites sampled during floating treatment wetland monitoring. Turbidity readings were taken from the surface at all sites.

5.5 Discussion

The vegetation on each FTW appears to be taking root as of the last monitoring event on 10/30/2020. Roots can be observed on the bottom of each FTW and biofilm appears to be forming on each FTW as well. There have been relatively low mortality rates on the FTW (figure 17), some mortality was to be expected as stated by Floating Islands West LLC. Wildlife had chewed through the fencing of FTWs 9-15 and consumed a couple of the plants. This fencing has been patched with metal mesh to prohibit wildlife from consuming more of the plants.

The water turbidity reduction at the 3 sampling sites may be due to the FTW. However, it is also likely that this reduction is due to water quality improvement later in the year as the aquatic vegetation dies off. Monitoring during the 2021 season will determine if this reduction of turbidity is due to the FTWs.

6.0 2020 CONCLUSION

The projects conducted in Lake Tallac by the TKPOA WQ Department during 2020 offer valuable information for future aquatic macrophyte control projects. The water quality data collected provides valuable baseline information of water quality parameters. This data will be used to determine the effects of future treatments. It will take time to determine whether the FTW project is successful at meeting its objectives, monitoring will continue during the 2021 season. While the YPL project did not produce the desired results, the TKPOA and other agencies can learn from this and improve the methods for future treatments. The TKPOA AIS program will continue to implement innovative solutions for AIS control throughout the Tahoe Keys Lagoons.

7.0 ABBREVIATIONS AND ACRONYMS

AIS	Aquatic Invasive Species
FTW	Floating Treatment Wetlands
GIS	Geographic Information System
GPS	Global Positioning System
IMP	Integrated Management Plan
IWMP	Integrated Weed Management Plan
LRWQCB	Lahontan Regional Water Quality Control Board
TKPOA	Tahoe Keys Property Owners Association
TRPA	Tahoe Regional Planning Agency
WDRs	Waste Discharge Requirements
WQ	Water Quality
WQO	Water Quality Objective
WET Lab	Western Environmental Testing Laboratory
YPL	Yellow Pond Lily

8.0 LIST OF PREPARERS

Name	Education	Role
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9.0 REFERENCES

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