Lake Tahoe Water Quality Investigations

Algal Growth Potential assays • Phytoplankton • Periphyton • Nearshore Network Station Additions

Final Report

July 1, 2016– June 30, 2019

Submitted to:
State Water Resources Control Board
Lahontan Regional Water Quality Control Board

By:

UCDAVIS
Tahoe Environmental Research Center

June 27, 2019

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Disclosure Statement

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Executive Summary

This document provides a report of work completed by the U.C. Davis – Tahoe Environmental Research Center (TERC) between July 1, 2016 and June 30, 2019 under Agreement No. 16-076-160: Lake Tahoe Water Quality Investigations. Primary areas of investigation or tasks presented in this report include: (1) algal growth potential assays; (2) phytoplankton identification and enumeration; (3) quantification of periphyton (attached algae) in the littoral zone; (4) nearshore network station additions; (5) project quality assurance.

Algal Growth Potential Assays

With increasing focus on the environmental health of the nearshore the Algal Growth Potential (AGP) test was included with monitoring work beginning in August 2013 to evaluate algal growth potential at different nearshore and offshore stations around Lake Tahoe. The purpose of the Algal Growth Potential (AGP) assay task is to compare levels of algal growth potential in the nearshore to identify emerging problem areas.

The Algal Growth Potential (AGP) assay test was first conducted as part of the California-Nevada-Federal Joint Water Quality Investigations in the late 1960's and early 1970's (California Department of Water Resources "DWR", 1970-75) to assess the maximum amount of algal growth supported by available nutrients in sampled waters. The Lahontan Regional Water Quality Control Board has an existing water quality standard which states that *mean annual AGP at a site should not be greater than two times the mean annual AGP at a mid-lake reference station"*. Sites with samples having repeatedly high AGP, or which exceed this standard repeatedly would deserve closer scrutiny of algae growth levels and the environmental factors contributing to that growth. This report presents the results of AGP assay tests that were done June, 2016 – April, 2019.

Data from 12 experiments done 2016 to 2019 is summarized in this report. The results from these experiments indicated that the Lahontan standard was not exceeded at any sites during this period. When data from the previous three years (2013-2016) were also included, the Lahontan standard was exceeded only in one year, (in 2015) at two stations: Tahoe City and Timber Cove.

AGP levels were ranked from highest to lowest for each experiment done Aug. 2013 to April 2019 and the number of times the sites were in the "top 3" or "bottom 3" determined. Emerald Bay, Tahoe Keys and Timber Cove were sites most frequently among the top 3 (highest algal growth potential levels). Mid-lake North, Rubicon Bay and Mid-lake South were most frequently among the bottom 3 AGP levels. No sites were always among the highest or lowest with respect to AGP.

Some AGP tests were done during periods when inputs of nutrients from increased stream flows or lake upwelling or mixing potentially had impacted the lake preceding the tests. In a portion of these experiments, AGP was elevated at some sites, possibly associated with nutrient inputs from these sources. For instance in a bioassay done using water collected from the sites on March 10, 2017, elevated NO3-N was observed at many AGP sites possibly associated with lake mixing or upwelling due to recent wind events. Several large storms had also contributed large amounts of stream inflow during the winter. Tahoe City, Timber Cove, Tahoe Keys, Camp Richardson and Emerald Bay AGP was higher than for other sites. Several of these sites had lower specific conductance than typical lake specific conductance, suggesting a stream influence. AGP responses may have been influenced by tributary inputs at these sites. In other experiments, conditions which might be expected to result in elevated AGP were not associated with an increase in AGP. For instance, in an experiment done 6/28/17, water collected outside a plume of turbid water entering the lake at the Crystal Bay AGP site, did not have much elevated AGP relative to the other nearshore sites.

The AGP tests produced results that were difficult to interpret in some cases. The AGP assays were set up to use chlorophyll *a* as an indicator of biomass and changes in chlorophyll *a* were to represent changes in biomass or growth. However, since chlorophyll *a* levels in the phytoplankton can be affected by light intensity, nutrient stress and species composition, changing chlorophyll *a* may not always directly relate to changing biomass and growth. In one bioassay done 6/21/16 we suspect levels of chlorophyll *a* in cells may have increased in response taking the phytoplankton out of the high light and UV environment near the surface of the lake and moving to the lab incubator where light is much less intense with no UV. The increase in chlorophyll *a* may have been a photoadaptation response rather than a growth response. This 6/21/16 bioassay was very interesting in that there was an unusually large amount of one type of diatom, *Cyclotella gordonensis* present at many of the sites. This is a small centric diatom which when present in large numbers has been shown to impact lake clarity. The samples with large proportions of *Cyclotella gordonensis* had very low chlorophyll *a* per unit biovolume initially when collected from the lake. During lab incubation, chlorophyll *a* levels increased and showed a good association with initial biovolume. This may provide evidence for photoadaptation or adjustment of chlorophyll *a* levels in cells based on light intensity.

Enough AGP data has been collected during 2013-2018 to test the utility of this method as an indicator of growth potential in the nearshore. The lack of consistent patterns across sites or through time, and potential difficulties in interpretation of results when using chlorophyll *a* as an estimate of biomass and growth, indicates the approach does not provide sufficient information to definitively identify nearshore areas at risk of increased algal productivity.

Other methods to assess algal growth potential may provide more useful information to allow comparison between sites and through time and should be considered by Lahontan. A more appropriate measurement may be to evaluate rates of primary production directly in samples collected from the sites. Advances in optical dissolved oxygen instruments have opened new possibilities for relatively rapid determination of rates of gross primary production (GPP) and ecosystem respiration (ER).

<u>Phytoplankton Enumeration</u>

Characterization of phytoplankton species and abundance provides important data with regard to the base of the food web and nearshore condition in Lake Tahoe. Changes in the number and biodiversity of phytoplankton are indicators of nutrient loading, eutrophication and trophic status. Additionally, data and information generated through this task helps managers to determine if new and undesirable species (e.g. bloom-forming organisms, taste and odor species, or species that indicate a move away from the lake's current ultra-oligotrophic status) are colonizing the lake. Furthermore, these organisms influence lake clarity.

In this year's report, phytoplankton data from eleven near-shore sites and two open water (mid-lake) sites collected Mar. 23, 2016 to Dec. 4 2018 are presented. Data for phytoplankton biovolume and abundance by group (i.e. diatoms, chrysophytes, dinoflagellates, cryptomonads, greens (chlorophytes), cyanophytes and haptophytes) are summarized in figures for each sampling date.

Phytoplankton showed successional patterns in abundance and community composition throughout the year. On each sampling date, similar groups of phytoplankton were often found at many of the stations. The proportion of total biovolume or abundance contributed by each group however, could vary by site. Between dates, phytoplankton taxonomic groups changed as new successional communities were established. For instance, in March 2018, biovolume was dominated by diatoms, with a lesser contribution by cryptomonads at many sites; in June 2018, the cryptomonads disappeared and were replaced by dinoflagellates, while diatoms still dominated the biovolume; in Oct. 2018, a mix of groups contributed to biovolumes and total biovolumes were low; in December 2018, diatoms, dinoflagellates and cryptomonads dominated the biovolumes.

Some sites had noticeably higher biovolumes than other sites on select dates. Emerald Bay biovolume was noticeably higher than the other sites on several dates during 2016-2018 including: March 10, 2017 (biovolume = 226.57 mm^3/m^3), June 28, 2017 (biovolume = 103.93 mm^3/m^3), Dec. 8, 2017 (biovolume = 178.24 mm^3/m^3) and Mar. 28, 2018 (biovolume = 591.14 mm^3/m^3). Among the other sites, Tahoe City biovolume on May 23, 2017 was very high (249.17 mm^3/m^3) and the Mid-lake North site had much higher biovolume on 6/21/16 (1506.32 mm^3/m^3) than the other sites.

While Emerald Bay had the highest biovolumes on several dates, it also had a phytoplankton community composition quite different from the rest of the lake on several dates. For instance in March of 2017 the biovolume in Emerald Bay was much higher than other sites around the lake, and 2/3 of the biovolume was due to one species *Synedra acus,* which was only a small portion of the biovolume at the other sites. In May 2017, the biovolume was dominated by dinoflagellates in Emerald Bay while at the other sites, diatoms dominated the biovolume. In June of 2016 Emerald Bay *did not* have the high biovolumes of *Cyclotella gordonensis* observed at most other parts of the lake and overall biovolume was low relative to most other sites.

Species richness (number of different species) at a site can provide some indication of the trophic state of waters. Heyvaert et al., (2013) provide a general characterization of trophic state based on numbers of species. Number of species less than 20 species, are characterized to be associated with ultra-oligotrophic conditions, levels from 20-50 are characterized as oligotrophic, levels 50-100 mesotrophic, and levels with greater than 100 species associated with eutrophic conditions. The mean levels for number of species Aug. 2013 – Dec. 2018 are within the oligotrophic range. Tahoe City had the greatest mean number of species (± std. dev.) for samples, (i.e. 33±7 species), followed by Tahoe Keys nearshore (31±6 species). The lowest number of species per site were measured at the two mid-lake stations (Mid-lake No. and Mid-lake So.) which both had 21 species.

Phytoplankton community structure has the potential to characterize individual nearshore stations. Phytoplankton are highly responsive to changes in the type and concentration of nitrogen-based and phosphorous-based nutrients. If changes occur in lake water quality, the phytoplankton are among the first indicators of that change. The abundance or numbers of the cells will change, the biodiversity may change, and these changes may trigger changes in other parts of the food web. The appearance of new and/or undesirable phytoplankton species may also be foretelling of qualitative water quality problems such as water color change or possibly odor problems.

In an effort to identify some unique characteristics in the phytoplankton community, we looked at the incidence of elevated amounts of cyanobacteria and green algae in the phytoplankton at the sites. Some species of green algae and cyanobacteria can be associated with more nutrient-enriched waters. Generally, levels of cyanobacteria and green algae were low at the sites. However, occasionally elevated levels of biovolume were observed. The Tahoe Keys Nearshore site was one of the sites where elevated levels of these algae were observed on several dates. At the Tahoe Keys Nearshore site slightly elevated biovolumes associated with a cyanobacteria known as *Dolichospermum spiroides* was observed on Sept. 1, 2015 and Sept. 12, 2017. Interestingly, in the summer of 2017, a bloom of cyanobacteria occurred within portions of the Tahoe Keys lagoons. The bloom was a concern due to the potential for the algae involved to produce certain algal toxins. One of the cyanobacteria identified in that bloom was *Dolichospermum.* It is uncertain whether the presence of *Dolichospermum spiroides* in the nearshore area off of Tahoe Keys on Sept. 12, 2017 was associated with the bloom of cyanobacteria inside the Tahoe Keys. This was because low levels of *Dolichospermum spiroides* was also observed elsewhere in the nearshore around Lake Tahoe on the same date, including at Rubicon Bay, Tahoe City and Kings Beach. A cyanobacteria called *Aphanothece* was also present at the Tahoe Keys Nearshore site during sampling in February and May 2015, however, it was also present at many other sites around the lake.

Generally low levels of green algae biovolume were observed at most sites with occasional elevated biomasses. However, at the Tahoe Keys Nearshore site, there were more frequent occurrences of increased biovolume associated with green algae. The species responsible for the increased biovolume were filamentous green algae including *Mougeotia, Zygnema, Spirogyra* and *Cladophora.* These filamentous greens may be stirred up from the shallow bottom, or may originally have been associated with periphyton or metaphyton. *Cladophora* can be associated with nutrient enriched sections of shoreline in lakes and also occur attached to rocks in fast moving streams.

A more comprehensive analysis of the nearshore phytoplankton data compiled for the nearshore sampling since 2013 is recommended to assess for distinct patterns phytoplankton communities which may characterize different sites.

Periphyton Quantification

The purpose of the periphyton quantification task is to assess levels of biomass for nearshore attached algae (periphyton) around the lake. Excessive attached algae biomass coats the rocks in the spring in many areas around the lake and bright green filamentous algae occur along portions of the shoreline in the summer. Nearshore periphyton can adversely impact the aesthetic, beneficial use of the shore zone in areas where thick growth develops. The amount of periphyton biomass can reflect local nutrient loading and also be affected by long-term environmental changes. Monitoring trends in periphyton biomass is important in assessing local and lake-wide nutrient loading trends. In this report we summarize the data collected during the period October, 2016 to June, 2019.

Periphyton biomass at 0.5m was impacted substantially by changes in lake level during 2016-2017. In the fall of 2016, the lake level was very low, below the natural rim of 6223.0 ft. At many sites the heaviest biomass of the year was measured in October, 2016 in part due to the biomass contributed by cyanobacterial periphyton species. These algae tend to be a slow-growing, stable community which often contribute to the periphyton biomass slightly deeper than 0.5m when the lake level is at average or high levels. However, when the lake level is down substantially, as it was in Oct. 2016, these algae may be located at 0.5m or even shallower. Beginning in mid-October multiple very large wet storms impacted the lake (including in notable storms in mid-Oct., mid-Dec., early January and early Feb.). A substantial rise in lake level of over 4 feet occurred during the period from Dec. 2016 to March, 2017, with an additional rise of 2 feet from March to early summer associated with a prolonged spring runoff. Due to the large rises in lake level in 2017, rocks at 0.5m during winter and spring sampling were relatively recently submerged. Periphyton communities had short times to establish on the rocks at 0.5m prior to sampling and this contributed to low measured biomasses at many sites around the lake at that depth. Rising lake levels may also have had an additional impact periphyton in areas where ground water flows may impact the periphyton. In a 2015-2016 study (Naranjo et al., 2019) done at the Pineland site, an increase in lake stage (maximum rise low to high of 0.81m) was found to temporarily reduce the groundwater discharge rates in the nearshore. The lake level rise in 2016-2017 in contrast was much greater (1.98m low to high), it's possible this large rise also temporarily reduced groundwater inputs at Pineland and other sites with groundwater impact in the nearshore. At many routine sites, much heavier periphyton biomass was observed at 1 or 1.5m.

During January to July 2018 moderate to high spring peaks in periphyton biomass were observed at several west shore sites, while biomass at sites along the east shore remained low. By April, 2018 moderate to high spring peaks were observed at three west shore sites: Dollar Pt. (39.14 mg/m^2), Rubicon Pt. (73.41 mg/m^2) and Tahoe City (89.48 mg/m^2). The moderate to heavy periphyton observed along the west shore in 2018 was different than the light biomass observed in 2017 at 0.5m around the lake. This difference may be associated with the sustained high lake levels in 2018. Rock substrate observed at 0.5m in spring had remained continually submerged during the year, allowing development of the periphyton community.

During January to June 2019, the lake level remained relatively high. Frequent snow storms occurred with some low elevation rain events which likely resulted in nutrient contributions to the lake from surface and groundwater inputs along the shoreline. Nutrients may also have been contributed to surface waters associated with lake mixing and/or upwelling in 2019. By March and April 2019 very heavy growth of periphyton developed at some of the west shore sites. Highest levels of chlorophyll *a* at 0.5m were measured at Rubicon Pt. (179.37 mg/m^2), Pineland (156.77 mg/m^2) and Tahoe City (142.85 mg/m^2). Relatively high levels were also observed at Dollar Pt. (71.28 mg/m^2), Incline West (66.36 mg/m^2) and Zephyr Pt. (39.52 mg/m^2). The periphyton biomass at 0.5m in 2019 was the highest in several years at several of the routine sites.

Once each spring an intensive synoptic sampling is done in which levels of periphyton at approximately 50 sites are assessed, using a rapid assessment method called the Periphyton Biomass Index (PBI). Chlorophyll *a* is also assessed at about a third of the sites. This sampling provides essentially a "snapshot" of the levels of periphyton around the lake during the period of peak spring biomass. In the 2017 spring synoptic, generally light PBI was observed at 0.5m around much of the lake. Only a few sites had moderate to heavy PBI, i.e.: Tavern Pt. (PBI=1.62), Tahoe City Boat Ramp (1.47), Lake Forest (1.09) and Brockway (1.20). Heavier PBI was observed at 1.0 m many sites, particularly in the northwest and southwest portions of the lake and at individual sites along the east shore. Very high levels of PBI levels at 1.5m were observed at: South Dollar Cr. (5.0), Tahoe City Tributary (5.0), South Dollar Pt. (4.5) and Pineland (4.5). The generally high levels of biomass at 1.5m may have resulted from these sites being submerged much of the winter and spring allowing for long periods for colonization and growth and exposure to nutrient inputs associated with storms.

During the spring synoptic in 2018, moderate to heavy PBI was measured along much of the west shore and at several locations along the south east shore. The areas with the highest PBI included: South Fleur du lac (PBI=7.0), Tahoe City Tributary (PBI=2.85), So. Dollar Cr. PBI=4.0), Ward Cr (PBI=3.5), Garwoods (PBI=3.4) and the Emerald Bay- Rubicon station (PBI=3.00). Generally light PBI was observed at 0.5m along much of the east shore and at a couple of sites along the southwest shore. The amount of periphyton as represented by PBI was much heavier in 2018 around the lake at 0.5m, compared to 2017.

During the 2019 spring synoptic, moderate-heavy, or heavy PBI was measured along much of the west shore and at a one location along the southeast shore. The areas with the highest PBI included: Ward Cr. (PBI=8.0), Gold Coast (PBI=4.5), So. Dollar Cr. (PBI=3.88), Garwoods (3.5), Tahoe City (PBI=3.33), So. Fleur du lac (PBI=3.00), Kaspian (PBI=3.00). Generally light PBI was observed at 0.5m along much of the northeast shore with one heavy PBI site interspersed at Chimney Beach (PBI=1.96). Nutrient contributions to lake surface waters (likely including contributions from surface and subsurface flows and from lake mixing and/or upwelling) may have helped thick growth of periphyton to develop at many sites in spring 2019. There were several areas along the west shore in the spring where small "mats" of periphyton which had sloughed from rocks were observed floating on the surface. Areas of white, sloughed periphyton could also be seen along the bottom at some sites.

On 6/25/17 and 5/14/19, we had the opportunity to survey portions of the shoreline around Lake Tahoe from helicopter. One highly visible feature of the shoreline observed on the 6/25/17 flight was the heavy periphyton growth in the region of the Ward Cr. mouth and along the shoreline near the Pineland periphyton monitoring site. The periphyton was very apparent as a white coverage over the bottom rocks, extending from slightly south of the Ward Cr. mouth to Sunnyside Marina. On 5/14/19 we again flew the same section of shoreline. Periphyton was not very apparent from the air on that date. It was interesting that periphyton were less discernable from the air on 5/14/19. This may have been due to either generally lighter growth, different coloration of the algae (there was green filamentous algae mixed with the stalked diatoms at 1 and 2m during sampling on 4/23/19), and possibly poor water clarity at the site.

In order to better take into account impacts of fluctuating lake level on periphyton biomass, future periphyton monitoring we will be including sampling of the 0.5m depth along with sampling of deeper substrate by SCUBA, including substrate above and below the depth at which the periphyton community shifts from primarily stalked diatoms to cyanobacteria (with stalked diatoms at some sites). It is hoped this sampling will better represent periphyton biomass in years in which lake level rises rapidly.

Nearshore Network Stations at Timber Cove and Camp Richardson

Two stations were added to the nearshore water quality monitoring network in November 2017. The new station at Timber Cove is located off of the end of the long pier running from the "Boathouse on the Pier" restaurant. The new station at Camp Richardson is located off of the pier extending from the Camp Richardson marina. Both stations were damaged due to lightning strikes in May 2018 but have since been repaired and re-installed.

Together with the existing set of eight Lake Tahoe nearshore stations, these new stations are generating a high-frequency, spatially distributed data set that allows us to quantify temperature, conductivity, wave height, chlorophyll-*a* fluorescence, dissolved organic matter fluorescence, turbidity, and dissolved oxygen patterns at the perimeter of Lake Tahoe.

Some examples of data from the sites was presented in the report. Data from spring 2018 at the Timber Cove site was presented which shows decreased conductivity and increased CDOM at the site associated with significant spring storms and spring snowmelt. Some examples of data from 2019 were presented which show some influences associated with the U. Truckee River inflow and patterns of upwelling in different regions of the lake.

Introduction

This report presents the results of work completed by the U.C. Davis – Tahoe Environmental Research Center (TERC) between July 1, 2016 and June 30, 2019 under Agreement No. 16-076-160: Lake Tahoe Water Quality Investigations. Primary areas of investigation or tasks presented include: (Section I) algal growth potential assays; (Section II) phytoplankton identification and enumeration; and (Section III) quantification of periphyton (attached algae) in the littoral zone; (Section IV) nearshore network station additions; (Section V) quality assurance and quality control details for the investigations. Detailed summaries of AGP data are presented in the appendix.

Section I. Algal Growth Potential Assays

With increasing focus on the environmental health of the nearshore the Algal Growth Potential (AGP) test was included with monitoring work beginning in August 2013 to evaluate algal growth potential at different nearshore and offshore stations around Lake Tahoe. The purpose of the Algal Growth Potential (AGP) assay task is to compare levels of algal growth potential in the nearshore to identify emerging problem areas. Availability of the nutrients, nitrogen (N) and phosphorus (P) in the water, and levels of nutrients previously taken up by phytoplankton (known as luxury uptake) are important factors that contribute to growth.

Methods

AGP assay tests are performed on samples collected from 13 stations (Figure 1, Table 1) four times per year (usually in early winter, late winter/early spring and late spring/early summer, and late summer/early fall). Samples of lake water (usually from a depth between 0.5-1.5m) are collected from a boat, using a Van Dorn water sampler. Many of the current sites are in proximity to sites sampled by DWR in their study of Lake Tahoe in the 1970's (DWR, 1970-1975). Two open-water reference sites are also sampled, one near mid-lake north (U.C. Davis's MLTP station), and the other a mid-lake south site (similar to that used by DWR). A sample for phytoplankton identification and enumeration is also collected directly from the Van Dorn sampler and treated with Lugol's reagent at the time water is collected for the AGP assay. Lake water from each site for the AGP assay is filtered through an 80 µm size mesh netting to remove large zooplankton, and collected in 4 liter HDPE bottles. The samples are kept near lake temperature in the dark in a cooler and returned to the lab at TERC where the experiment is usually started the same day.

In the AGP experiment, lake water from each site is divided into duplicate flasks and incubated under controlled light (CW fluorescent light with intensity ~ 74 μ E m^{-2} sec^{-1}), standardized light cycle (i.e. 16 hour light, 8 hour dark) and at ambient lake temperature.[1] Algal biomass changes are measured by tracking *in vivo* chlorophyll *a* fluorescence in water from the flasks throughout the experiment using a Turner Designs 10AU fluorometer (configured for *in vivo* and extractable

[1] These methods differ slightly from the early DWR studies with respect to: lighting (DWR used a light intensity of 700 foot candles or ~91 μ E m^{-2} sec^{-2}) and temperature (DWR used a constant temperature of 20° C) However, we think incubation at 20° C might adversely affect some cold water species represented in the winter community.

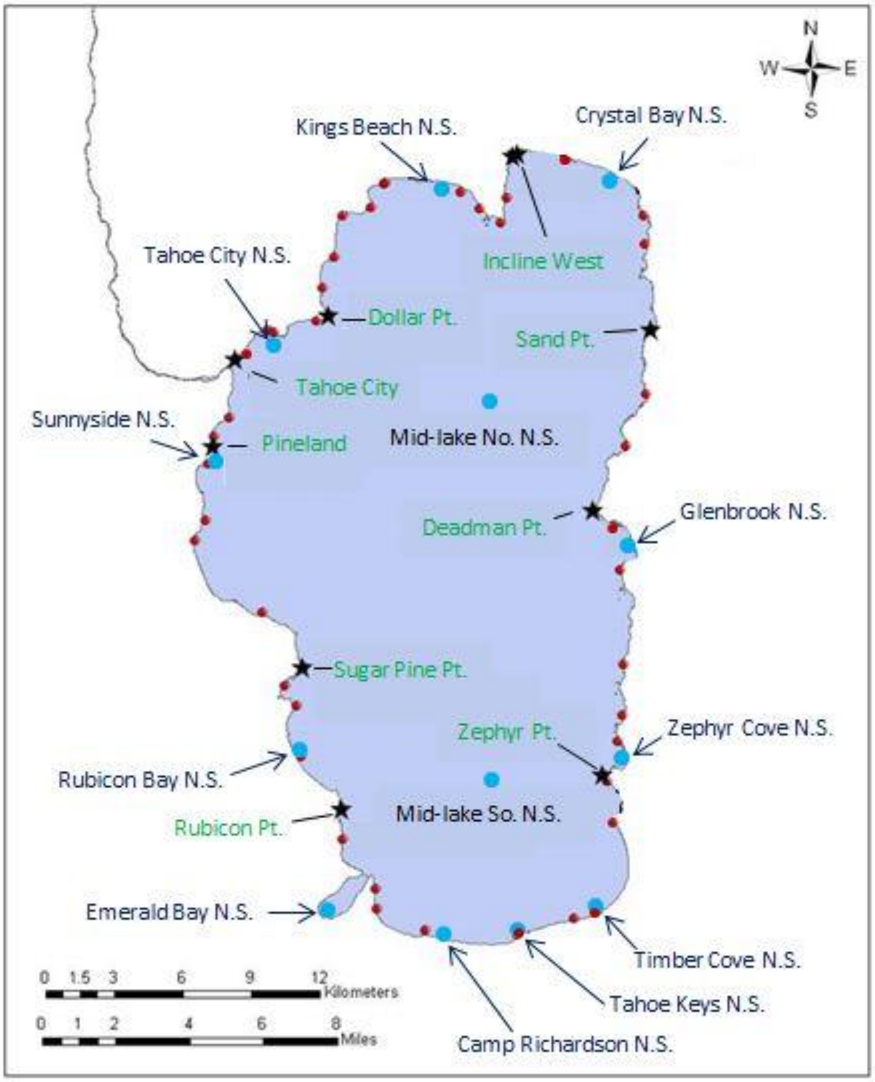


Figure 1. Map showing locations of AGP nearshore stations (light blue dots), routine periphyton monitoring stations (green text, black stars) and spring synoptic periphyton stations (red dots).

Table 1. Description of AGP and phytoplankton monitoring sites.

Site	Coordinates	Site Description	Water Depth at Station
Nearshore Sites			
Sunnyside	N39 07.805 W120 09.216	~ 15 m from first pier just north of Ward Cr.	~ 3-4m
Tahoe City	N39 10.808 W120 07.173	~18-27 m outside of entrance to Tahoe City Boat Ramp area and pier	~2.5-3.5m
Kings Beach	N39 14.179 W120 02.207	~ 70 m from shore, offshore of "Lake Point Pier" slightly east of "Heritage Cove" condominiums	~ 2-3m
Crystal Bay	N39 14.258 W119 56.798	~45 m offshore of mouth of Incline Cr., Crystal Bay	~2.5-3.5m
Glenbrook	N39 05.371 W119 56.489	~ 15 m from right side "T" of old pilings, near piling at boundary of swim area,~70 m from shore, Glenbrook	~2.5-3.5m
Zephyr Cove	N39 00.512 W119 56.993	Off first set of beach stairs north of Zephyr Cove pier, ~27 m outside of swim area boundary, ~90 m from shore.	~2.5-3.5m
Timber Cove	-	~45-70 m northwest of end of Timber Cove pier	~2-3m
Tahoe Keys Nearshore	N38 56.423 W120 00.574	~70 m offshore of lake-side pier at Tahoe Keys, (Note- site for AGP#1 was ~115 m further offshore)	~1.5-3m
Camp Richardson	N38 56.531 W120 03.383	Adjacent to end of Camp Richardson pier	2-4m
Emerald Bay	N38 57.187 W120 06.367	Adjacent to either the pier or near north edge of swim area boundary, both near Vikingsholm	~4-6m
Rubicon Bay	N39 00.875 W120 06.840	~70 m offshore of pier in shallow area	~2-4m
Mid-lake Sites			
Mid-lake North	N39 09.255 W120 00.478	Location of TERC MLTP station in north mid-lake, approx. 10.5 km east of Tahoe City	>450m
Mid-lake South	N38 59.641 W120 00.080	South mid-lake approximately 6.5 km north of Pope Beach.	>400m

chlorophyll *a* measurement). On one or more days of the experiment, typically near the growth peak, subsamples are also filtered for later chlorophyll *a* extraction and analysis. Equations relating *in vivo* fluorescence measurements to extracted chlorophyll *a* are determined. The equations may then be used to calculate chlorophyll *a* on days when *in vivo* fluorescence peaked but extracted chlorophyll *a* was not measured. The peak chlorophyll *a* value achieved during the assay is considered the Algal Growth Potential (AGP).

Extracted chlorophyll *a* is analyzed fluorometrically using a Turner Designs 10AU fluorometer, calibrated with pure chlorophyll *a* from *Anacystis nidulans* algae. Frozen sample filters containing algae are thawed and extracted overnight at 4°C, in 100% methanol, then fluorescence before and after acidification with 0.05ml of 0.3N HCl is measured. Chlorophyll *a* and pheophytin concentrations are determined using the following equations:

Chlorophyll *a* (µg/l) = $(r/(r-1)) \times (R_b-R_a) \times V_{ex}/V_{fil}$
Pheophytin (µg/l) = $(r/(r-1)) \times (rR_a-R_b) \times V_{ex}/V_{fil.}$
R_b= Fluorescence of sample extract before acidification (minus) fluorescence of filter blank
R_a= Fluorescence of sample extract after acidification (minus) fluorescence of filter blank
V_{fil}= Volume of lake water filtered (Liters), usually 0.1 L
V_{ex} = Volume of methanol used for extraction (Liters), usually 0.005L
r = mean of R_b/R_a values for a range of pure chlorophyll *a* standards.

Additional field and lab data collected for these experiments includes: lake surface water temperature at time of collection and background fluorescence of the initial water collected (fluorescence of GF/F filtered water).

AGP assay Results June 2016 – March 2019:

This report presents the results of the AGP tests that were done June, 2016 – March, 2019. Table 2 presents a summary of lake temperature, initial lake chlorophyll *a* and maximum chlorophyll *a* level achieved during the test (AGP). The results for each bioassay are shown in a summary figure for each experiment together with a brief summary of the results. Appendix Tables 1.a. to 1.g. present additional data, including the *in vivo* fluorescence measurements made during the experiments and extracted chlorophyll *a* results.

Table 2. Summary of Lake Tahoe Algal Growth Potential Test results for nearshore and mid-lake sites, for samples 6/21/16-4/4/19.

	Date Collected	Time Collected	Lake Surface Temp. (°C)	Collection Depth (m)	Initial Chl *a* (µg/l)	Final AGP Results (Maximum Chl *a* Achieved) Chl. *a* ± s.d. (µg/l)
AGP#12						
Sunnyside	6/21/2016	13:55	14	0.5	.16±.02	.31 ± .01
Tahoe City	6/21/2016	9:10	13	0.5	.25±.01	.61 ± .02
Kings Beach	6/21/2016	10:00	14.5	0.5	.23±.00	.55 ± .05
Crystal Bay	6/21/2016	10:22	15	0.5	.21±.01	.42 ± .03
Glenbrook	6/21/2016	10:50	15	0.5	.19±.01	.45 ± .01
Zephyr Cove	6/21/2016	11:15	14	0.5	.13±.01	.38 ± .02
Timber Cove	6/21/2016	11:45	15	0.5	.13±.01	.50 ± .04
Tahoe Keys	6/21/2016	12:00	15	0.5	.19±.01	.53 ± .01
Camp Rich.	6/21/2016	12:10	15	0.5	.15±.01	.32 ± .01
Emerald Bay	6/21/2016	12:40	15.5	0.5	.43±.00	.43 ± .00
Rubicon Bay	6/21/2016	13:10	16	0.5	.11±.01	.22 ± .01
Mid-lake North	6/21/2016	9:32	13.5	0.5	.17±.00	.86 ± .07
Mid-lake South	6/21/2016	11:30	14	0.5	.15±.01	.38 ± .04
AGP#13						
Sunnyside	9/14/2016	14:20	17	0.5	.21±.03	.25 ± .00
Tahoe City	9/14/2016	9:20	15	0.5	.20±.01	.23 ± .01
Kings Beach	9/14/2016	10:20	16.5	0.5	.25±.02	.25 ± .02
Crystal Bay	9/14/2016	10:40	17	0.5	.21±.04	.24 ± .01
Glenbrook	9/14/2016	11:17	17	0.5	.24±.01	.24 ± .01
Zephyr Cove	9/14/2016	11:40	17	0.5	.15±.06	.26 ± .01
Timber Cove	9/14/2016	12:15	15.5	0.5	.18±.02	.20 ± .00
Tahoe Keys	9/14/2016	12:30	15.5	0.5	.27±.01	.27 ± .01
Camp Rich.	9/14/2016	12:47	16.5	0.5	.16±.01	.31 ± .01
Emerald Bay	9/14/2016	13:15	17	0.5	.26±.02	.29 ± .02
Rubicon Bay	9/14/2016	13:50	17	0.5	.17±.00	.23 ± .00
Mid-lake North	9/14/2016	9:45	16.5	0.5	.21±.04	.26 ± .01
Mid-lake South	9/14/2016	12:00	16.5	0.5	.19±.02	.20 ± .02

Table 2 Continued

	Date Collected	Time Collected	Lake Surface Temp. (°C)	Collection Depth (m)	Initial Chl *a* (µg/l)	Final AGP Results (Maximum Chl *a* Achieved) Chl. *a* ± s.d. (µg/l)
AGP#14						
Sunnyside	3/10/2017	14:10	5.5	1	0.38	.65 ± .00
Tahoe City	3/10/2017	9:10	5.5	1	.24±.00	1.06 ± .07
Kings Beach	3/10/2017	10:05	-	1	.44±.01	.55 ± .04
Crystal Bay	3/10/2017	10:35	5.5	1	.47±.04	.50 ± .02
Glenbrook	3/10/2017	11:10	5.5	1	.36±.01	.72 ± .05
Zephyr Cove	3/10/2017	11:30	6	1	.59±.04	.65 ± .03
Timber Cove	3/10/2017	12:00	6	1	.37±.01	1.70 ± .05
Tahoe Keys	3/10/2017	12:15	6.5	1	.58±.06	1.38 ± .04
Camp Rich.	3/10/2017	12:25	6	1	.26±.01	.82 ± .01
Emerald Bay	3/10/2017	12:50	3	1	1.49±.01	1.49±.01
Rubicon Bay	3/10/2017	13:45	6	1	.33±.04	.69 ± .06
Mid-lake North	3/10/2017	9:30	5.5	1	.20±.00	.46 ± .03
Mid-lake South	3/10/2017	11:40	5.5	1	.27±.06	.50 ± .01
AGP#15						
Sunnyside	5/23/2017	13:45	14	1	.09±.01	.44 ± .04
Tahoe City	5/23/2017	9:00	9.5	1	.69±.04	.72 ± .05
Kings Beach	5/23/2017	9:45	10.5	1	.36±.03	.64 ± .04
Crystal Bay	5/23/2017	10:15	11.5	1	.21±.04	.49 ± .02
Glenbrook	5/23/2017	10:50	11.5	1	.40±.00	.45 ± .00
Zephyr Cove	5/23/2017	11:15	11	1	.41±.04	.43 ± .01
Timber Cove	5/23/2017	11:45	13.5	1	.21±.01	.48 ± .02
Tahoe Keys	5/23/2017	11:55	13	1	.24±.06	.42 ± .09
Camp Rich.	5/23/2017	12:10	13	1	.14±.04	.33 ± .01
Emerald Bay	5/23/2017	12:45	14.5	1	.29±.01	.54 ± .08
Rubicon Bay	5/23/2017	13:15	15	1	.14±.01	.47 ± .03
Mid-lake North	5/23/2017	9:25	11	1	.12±.01	.40 ± .01
Mid-lake South	5/23/2017	11:30	13	1	.18±.00	.41 ± .04

Table 2 Continued

	Date Collected	Time Collected	Lake Surface Temp. (°C)	Collection Depth (m)	Initial Chl *a* (µg/l)	Final AGP Results (Maximum Chl *a* Achieved) Chl. *a* ± s.d. (µg/l)
AGP#16						
Sunnyside	6/28/2017	14:10	16.5	1	.24±.01	.36 ± .02
Tahoe City	6/28/2017	8:20	16	1	.24±.02	.33 ± .04
Kings Beach	6/28/2017	9:05	17.5	1	.28±.01	.31 ± .04
Crystal Bay	6/28/2017	9:30	NA	1	.29±.02	.33 ± .00
Glenbrook	6/28/2017	10:15	18	1	.22±.01	.33 ± .01
Zephyr Cove	6/28/2017	10:37	18.5	1	.25±.01	.40 ± .02
Timber Cove	6/28/2017	11:25	20	1	.33±.01	.33 ± .01
Tahoe Keys	6/28/2017	11:45	17	1	.29±.01	.29 ± .01
Camp Rich.	6/28/2017	12:20	NA	1	.23±.01	.25 ± .02
Emerald Bay	6/28/2017	13:00	18	1	.39±.01	.39 ± .01
Rubicon Bay	6/28/2017	13:40	18	1	.22±.02	.32 ± .03
Mid-lake North	6/28/2017	8:45	17	1	.21±.03	.34 ± .05
Mid-lake South	6/28/2017	10:55	13	1	.18±.00	.30 ± .01
AGP#17						
Sunnyside	9/12/2017	12:25	20.5	1	.36±.04	.36 ± .04
Tahoe City	9/12/2017	7:55	19.5	1	.58±.04	.58 ± .04
Kings Beach	9/12/2017	8:47	19.5	1	.30±.02	.32 ± .01
Crystal Bay	9/12/2017	9:10	20.0	1	.31±.02	.33 ± .01
Glenbrook	9/12/2017	9:45	19.0	1	.30±.01	.30 ± .01
Zephyr Cove	9/12/2017	10:04	19.0	1	.28±.02	.34 ± .01
Timber Cove	9/12/2017	10:33	19.0	1	.28±.04	.39 ± .01
Tahoe Keys	9/12/2017	10:52	19.5	1	.56±.03	.74 ± .04
Camp Rich.	9/12/2017	11:05	NA	1	.33±.01	.34 ± .01
Emerald Bay	9/12/2017	11:28	20.0	1	.34±.06	.47 ± .01
Rubicon Bay	9/12/2017	12:00	20.5	1	.24±.01	.28 ± .01
Mid-lake North	9/12/2017	8:20	19.0	1	.29±.04	.29 ± .04
Mid-lake South	9/12/2017	10:20	19.5	1	.32±.00	.32 ± .00

Table 2 Continued

	Date Collected	Time Collected	Lake Surface Temp. (°C)	Collection Depth (m)	Initial Chl *a* (µg/l)	Final AGP Results (Maximum Chl *a* Achieved) Chl. *a* ± s.d. (µg/l)
AGP#18						
Sunnyside	12/8/2017	13:44	8.0	1	.67±.04	.67 ± .04
Tahoe City	12/8/2017	9:13	7.0	1	.61±.04	.61 ± .04
Kings Beach	12/8/2017	9:54	7.5	1	.75±.10	.75 ± .10
Crystal Bay	12/8/2017	10:15	8.0	1	.78±.08	.78 ± .08
Glenbrook	12/8/2017	10:50	8.0	1	.74±.03	.74 ± .03
Zephyr Cove	12/8/2017	11:14	8.0	1	.72±.04	.72 ± .04
Timber Cove	12/8/2017	11:44	7.0	1	.60±.01	.60 ± .01
Tahoe Keys	12/8/2017	12:00	7.5	1	.56±.01	.56 ± .01
Camp Rich.	12/8/2017	12:15	8.0	1	.67±.02	.67 ± .02
Emerald Bay	12/8/2017	12:43	6.5	1	1.05±.01	1.05 ± .01
Rubicon Bay	12/8/2017	13:14	8.0	1	.73±.02	.73 ± .02
Mid-lake North	12/8/2017	9:33	8.5	1	.83±.01	.83 ± .01
Mid-lake South	12/8/2017	11:30	8.0	1	.83±.02	.83 ± .02
AGP#19						
Sunnyside	3/28/2018	14:00	NA	1	0.21	.60 ± .05
Tahoe City	3/28/2018	9:10	5.5	1	0.13	.77 ± .01
Kings Beach	3/28/2018	10:10	6.0	1	.28±.01	1.00 ± .00
Crystal Bay	3/28/2018	10:30	5.8	1	0.66	.71 ± .02
Glenbrook	3/28/2018	11:05	6.0	1	.57±.02	.82 ± .01
Zephyr Cove	3/28/2018	11:30	6.5	1	0.71	1.23 ± .00
Timber Cove	3/28/2018	12:00	6.5	1	0.54	1.16 ± .03
Tahoe Keys	3/28/2018	12:20	6.5	1	0.59	.95 ± .04
Camp Rich.	3/28/2018	12:30	6.5	1	0.39	1.00 ± .15
Emerald Bay	3/28/2018	13:00	5.0	1	1.39	1.39
Rubicon Bay	3/28/2018	13:35	NA	1	0.05e	1.20 ± .03
Mid-lake North	3/28/2018	9:34	5.5	1	.33±.01	.48 ± .06
Mid-lake South	3/28/2018	11:50	6.5	1	0.37	.76 ± .00

Table 2 Continued

	Date Collected	Time Collected	Lake Surface Temp. (°C)	Collection Depth (m)	Initial Chl *a* (µg/l)	Final AGP Results (Maximum Chl *a* Achieved) Chl. *a* ± s.d. (µg/l)
AGP#20						
Sunnyside	6/8/2018	13:05	13.0	1	.08±.00	.14 ± .00
Tahoe City	6/8/2018	8:10	12.0	1	.22±.04	.22 ± .04
Kings Beach	6/8/2018	9:10	12.5	1	.17±.01	.17 ± .01
Crystal Bay	6/8/2018	9:35	14.0	1	.11±.01	.12 ± .01
Glenbrook	6/8/2018	10:20	14.0	1	.12±.01	.15 ± .01
Zephyr Cove	6/8/2018	10:40	14.5	1	.13±.02	.20 ± .00
Timber Cove	6/8/2018	11:15	15.5	1	.09±.01	.27 ± .01
Tahoe Keys	6/8/2018	11:30	14.8	1	.12±.00	.29 ± .03
Camp Rich.	6/8/2018	11:43	14.0	1	.12±.02	.14 ± .02
Emerald Bay	6/8/2018	12:15	17.0	1	.25±.01	.25 ± .01
Rubicon Bay	6/8/2018	12:40	15.5	1	.11±.01	.13 ± .00
Mid-lake North	6/8/2018	8:30	12.0	1	.13±.01	.13 ± .01
Mid-lake South	6/8/2018	10:50	14.0	1	.10±.02	.13 ± .00
AGP#21						
Sunnyside	10/16/2018	09:30	13.0	1	.29±.01	.29 ± .01
Tahoe City	10/16/2018	09:10	12.0	1	.26±.01	.27 ± .02
Kings Beach	10/16/2018	13:25	NA	1	.23±.02	.27 ± .01
Crystal Bay	10/16/2018	13:05	13.0	1	.21±.01	.29 ± .05
Glenbrook	10/16/2018	12:20	NA	1	.19±.01	.24 ± .00
Zephyr Cove	10/16/2018	12:00	13.0	1	.20±.00	.28 ± .01
Timber Cove	10/16/2018	11:30	12.5	1	.17±.00	.25 ± .03
Tahoe Keys	10/16/2018	11:15	13.0	1	.22±.00	.26 ± .01
Camp Rich.	10/16/2018	11:00	13.0	1	.24±.01	.24 ± .01
Emerald Bay	10/16/2018	10:25	13.0	1	.45±.02	.45 ± .02
Rubicon Bay	10/16/2018	10:00	13.5	1	.28±.01	.28 ± .01
Mid-lake North	10/16/2018	12:40	13.5	1	.22±.00	.28 ± .01
Mid-lake South	10/16/2018	11:45	NA	1	.28±.02	.28 ± .02

Table 2 Continued

	Date Collected	Time Collected	Lake Surface Temp. (°C)	Collection Depth (m)	Initial Chl *a* (µg/l)	Final AGP Results (Maximum Chl *a* Achieved) Chl. *a* ± s.d. (µg/l)
AGP#22						
Sunnyside	12/4/2018	13:25	9.0	1	.75±.06	.75±.06
Tahoe City	12/4/2018	09:15	8.0	1	.60±.01	.60±.01
Kings Beach	12/4/2018	09:55	8.0	1	.70±.00	.70±.00
Crystal Bay	12/4/2018	10:15	9.0	1	.65±.03	.65±.03
Glenbrook	12/4/2018	10:50	8.5	1	.71±.01	.71±.01
Zephyr Cove	12/4/2018	11:10	8.5	1	.66±.03	.66±.03
Timber Cove	12/4/2018	11:35	8.0	1	.72±.01	.72±.01
Tahoe Keys	12/4/2018	11:50	8.0	1	.63±.00	.63±.00
Camp Rich.	12/4/2018	12:00	9.0	1	.64±.06	.64±.06
Emerald Bay	12/4/2018	12:25	7.5	1	1.48±.00	1.48±.00
Rubicon Bay	12/4/2018	12:55	9.0	1	.78±.02	.78±.02
Mid-lake North	12/4/2018	09:35	9.0	1	.75±.00	.75±.00
Mid-lake South	12/4/2018	11:25	9.0	1	.79±.01	.79±.01
AGP#23						
Sunnyside	4/4/19	13:20	6.0	1	1.80±.12	1.80±.12
Tahoe City	4/4/19	08:40	6.5	1	.69±.09	1.09±.07
Kings Beach	4/4/19	09:40	6.5	1	1.74±.04	1.74±.04
Crystal Bay	4/4/19	10:02	6.5	1	1.21±.04	1.21±.04
Glenbrook	4/4/19	10:30	6.5	1	1.59±.04	1.59±.04
Zephyr Cove	4/4/19	10:50	6.8	1	1.91±.03	1.91±.03
Timber Cove	4/4/19	11:21	7.5	1	1.41±.01	1.41±.01
Tahoe Keys	4/4/19	11:35	6.5	1	1.23±.04	1.91±.01
Camp Rich.	4/4/19	11:52	6.5	1	1.11±.03	1.11±.03
Emerald Bay	4/4/19	12:18	5.0	1	0.78±.01	0.78±.01
Rubicon Bay	4/4/19	12:52	6.8	1	.75±.01	1.28±.02
Mid-lake North	4/4/19	09:05	6.0	1	1.20±.21	1.20±.21
Mid-lake South	4/4/19	11:07	6.0	1	1.11±.04	1.11±.04

Summary of Results by AGP Experiment:

AGP Assay #12 (6/21/16)

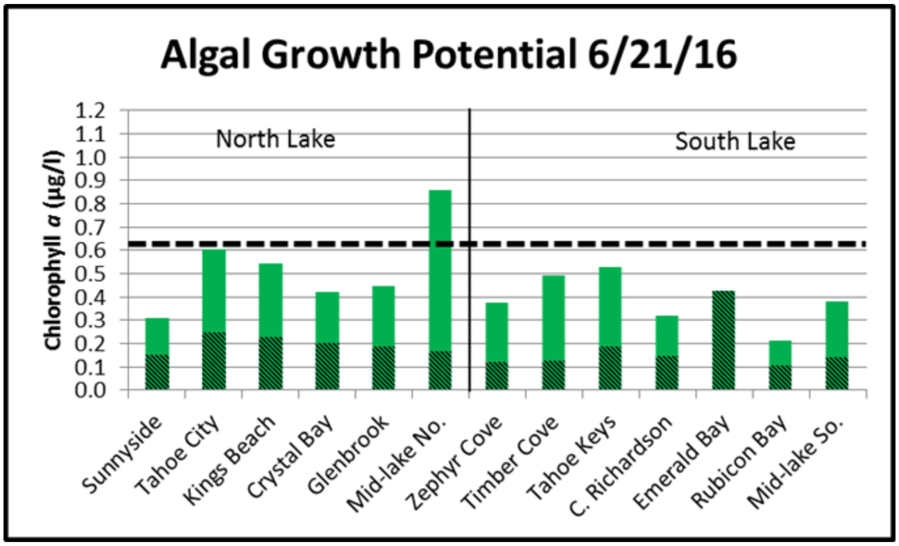


Figure 2. 6/21/16 algal growth potential experiment. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

Stream flows were declining as the spring runoff was nearly over when these samples were collected. It was noted to be very windy the week prior to the sampling with SW or SSW winds. Much pollen was noted on the surface at many of the sites. Lake surface temperature ranged between 13-16 °C. The results for this assay are shown in Fig. 2 above. Lake chlorophyll *a* concentrations were relatively low at most sites (between 0.13 to 0.25µg/l). This was despite there being an unusually high biovolumes of the very small diatom *Cyclotella gordonensis* present at most sites. Highest initial chlorophyll *a* was in Emerald Bay (0.43 µg/l). The results of this experiment showed the highest AGP level occurred at the Mid-lake North station where maximum chlorophyll *a* reached 0.86 µg/l. AGP at the Mid-lake South station was much lower 0.38 µg/l. AGP levels at the shoreline sites ranged from 0.22 µg/l in Rubicon Bay to 0.61 µg/l at Tahoe City.

The 6/21/16 bioassay was very interesting in that there was an unusually large amount of one type of diatom, *Cyclotella gordonensis* present at many of the sites. This is a small centric diatom when present in large numbers has been shown to impact lake clarity. Figure 3 shows the large proportion of *Cyclotella gordonensis* relative to total biovolume at the sites.

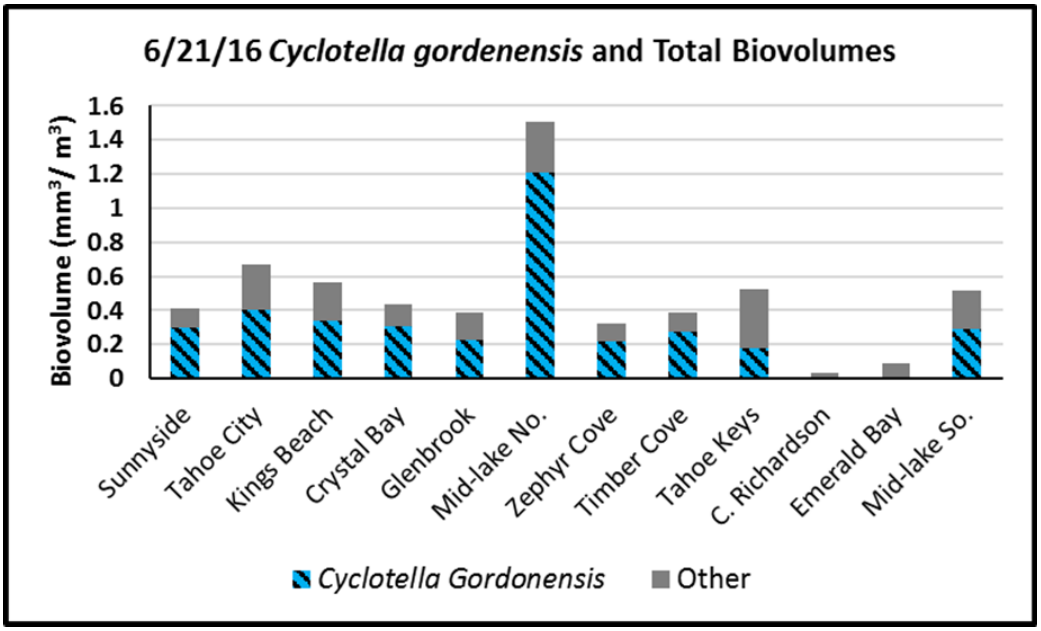


Figure 3. Biovolumes of *Cyclotella gordonensis* (blue-striped bars) and all other algal species (gray bars), the bars added together represent total biovolume.

Figure 4 below shows the initial chlorophyll *a* (green striped bars) and biovolume levels (dark bars) for samples collected on this date. Biovolume was quite variable, while initial chlorophyll *a* was relatively uniform and low among sites. The relationship between initial chlorophyll *a* and initial biovolume was very poor in water collected from the nearshore on 6/21/16 (r^2= 0.04). However, after samples were incubated in the lab for the AGP test, chlorophyll *a* levels increased substantially at most sites. Maximum chlorophyll *a* achieved or AGP is indicated by the solid green bars in Figure 4. Interestingly, the maximum levels of chlorophyll *a* achieved or AGP showed a relatively strong association with the initial biovolumes of samples (r^2= 0.78).

The samples with high *Cyclotella gordonensis* were collected from 1m and had low initial chlorophyll *a*. At this shallow depth, the *Cyclotella gordonensis* would be subject to high light intensities in the summer and UV radiation. When the samples were removed and incubated in the lab, the chlorophyll *a* levels increased during the incubation. It is difficult to say definitively whether this increase was due to growth associated with nutrient availability or due to adjustment in levels of chlorophyll *a* in cells in response to the lower light intensities and possibly absence of UV radiation during incubation in the lab. The fact that maximum chlorophyll *a* levels showed an association with initial biovolume leads us to suspect there was adjustment in chlorophyll *a* levels. However, to definitively say for sure, an assessment of biovolumes at the peak chlorophyll (through follow-up phytoplankton enumeration) would have needed to be done and compared with the initial biovolumes.

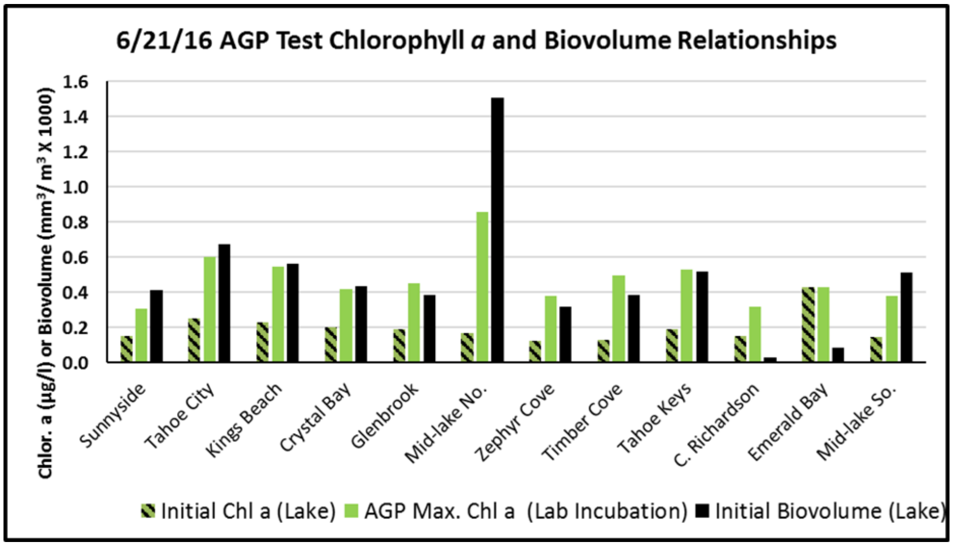


Figure 4. Initial chlorophyll *a* (green striped bars), maximum chlorophyll *a* or AGP (light green bars), and initial total biovolume levels (dark bars), for samples collected 6/21/16. Note the different scales for chlorophyll *a* and biovolume.

Maximum chlorophyll *a* (AGP) showed a good association with initial biovolume at many of the sites in Figure 4 while there was a poor relationship between initial chlorophyll *a* and initial biovolume. One possible explanation for this is that initial levels of chlorophyll *a* in cells was uniformly low (possibly in response to high light intensity and/or UV) and not related closely to biovolume. Chlorophyll *a* may have increased in proportion to initial biovolume during incubation at lower light intensity and no UV.

Finally, figure 5 below shows initial chlorophyll *a* levels for samples collected 6/21/16 relative to levels for lake samples on other dates 2013-2017. The samples with large proportions of *Cyclotella gordonensis* had very low chlorophyll *a* per unit biovolume.

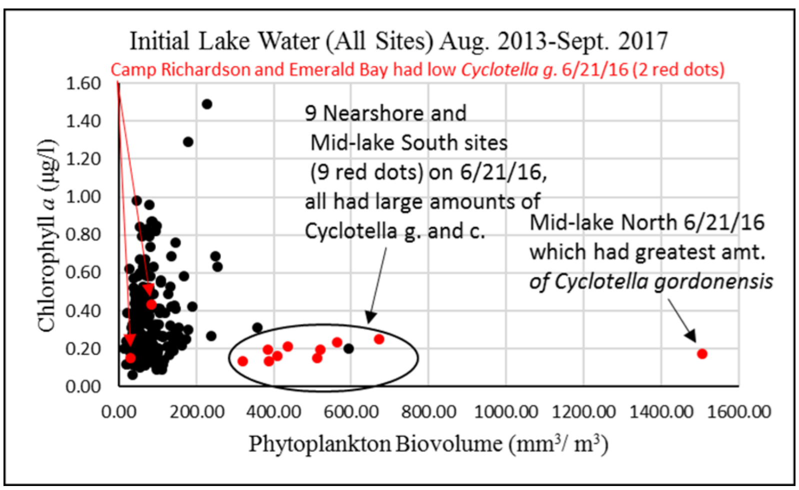


Figure 5. Relationship between phytoplankton biovolume and extracted chlorophyll *a* for samples collected at sites for the AGP experiments. Samples collected on 6/21/16 which had high levels of *Cyclotella gordonensis* had very low chlorophyll *a* relative to biovolume compared with samples on other dates Aug. 2013- Sept. 2017.

AGP Assay #13 (9/14/16)

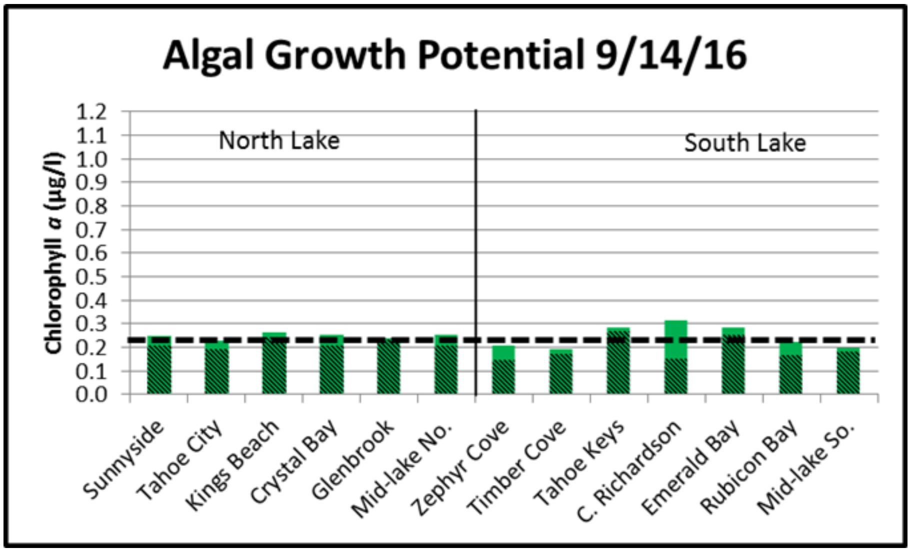


Figure 6. 9/14/16 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

Lake surface temperature was still very warm and ranged between 17-19 °C when when the 9/14/16 sampling was done. Initial lake chlorophyll *a* concentrations were low at all sites (between 0.15 to 0.27 µg/l) (Fig. 6 above). AGP levels were also low at all sites. Little additional growth occurred in samples with AGP ranging between 0.20-0.31 µg/l.

AGP Assay #14 (3/10/17)

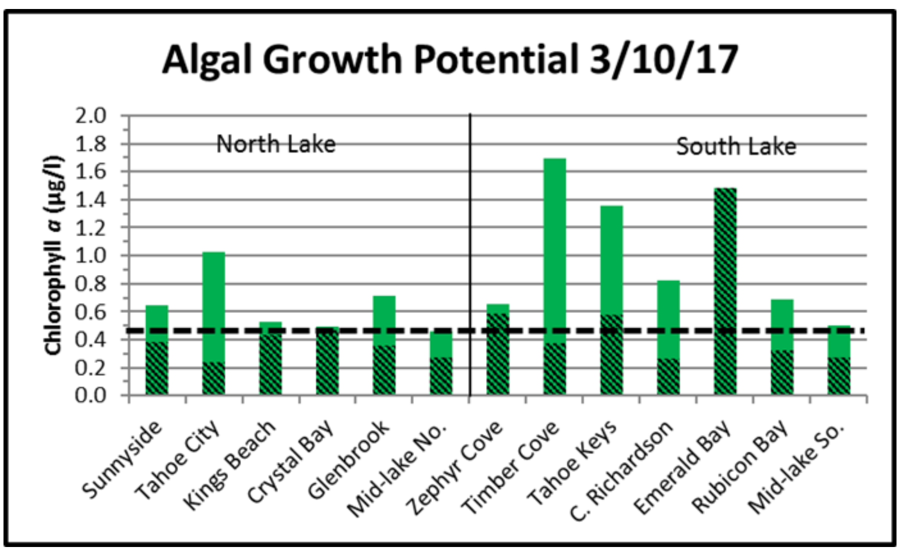


Figure 7. 3/10/17 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

The results for the 3/10/17 bioassay are shown above in Fig. 7. The period preceding this bioassay, December to March, included multiple large storm events. Stream flows were quite elevated during two storm events in December 2016, as well as for large storm events in January and February 2017. Between Dec. 1, 2016 and March 10, 2017 the lake level increased by over four feet due to the storms. A very large snowpack also developed which would fuel a substantial spring runoff and additional lake level rise. The sampling for this AGP experiment just preceded onset of the spring runoff. A very strong SW wind event occurred on March 4. Initial lake chlorophyll *a* concentrations ranged between 0.24 µg/l to 0.59 µg/l in the main body of the lake, while initial chlorophyll *a* in Emerald Bay was relatively high (1.49 µg/l). Three sites in the south portion of the lake showed substantial increases in chlorophyll *a* during the experiment resulting in moderately high AGP chlorophyll *a* levels (i.e. Timber Cove (1.69 µg/l), Tahoe Keys (1.35 µg/l), and Camp Richardson (0.82 µg/l)). Emerald Bay AGP was the initial chlorophyll *a* value (1.49 µg/l). One site in the north portion of the lake had relatively high AGP (Tahoe City (1.03 µg/l)). For comparison, the mean AGP for the mid-lake sites was 0.48 µg/l. The elevated AGP for Emerald Bay, the 3 south shore sites and Tahoe City site may have resulted from tributary inputs in these regions and enrichment of the waters nearby the previous month.

Levels of nutrients (NO_3-N, NH_4-N, SRP and TP) and specific conductance were analyzed in initial lake water from AGP monitoring sites for the 3/10/17 experiment. The results of these analyses are presented in Table 3. Though not part of the contracted work these analyses were done to provide supplementary information to aid in understanding the test results. Some variation in nutrient levels and specific conductance were observed. NO_3-N levels were elevated at many sites. This is consistent with elevated NO_3-N levels observed in lake samples collected during standard LTP profiles on 2/23/17 and 3/9/17 where NO_3-N concentrations ranged between 14 to 16 µg/l. The elevated NO_3-N may have been due to lake mixing during these periods. Specific conductivity is often near 92 µS/cm in lake water. When lake conductivity is less than 92 µS/cm, this may reflect dilution with stream inputs of lower conductivity water.

Table 3. Initial NO_3-N, NH_4-N, SRP and TP concentrations and specific conductance in lake samples collected for the 3/10/17 AGP experiment.

	NO_3-N	NH_4-N	SRP	TP	S.C.
	3/10/17	3/10/17	3/10/17	3/10/17	3/10/17
Sunnyside	14	2	1	13	92
Tahoe City	8	2	1	11	88
Kings Beach	12	2	1	12	89
Crystal Bay	12	2	1	10	89
Glenbrook	11	2	1	11	92
Mid-lake No.	16	2	1	10	92
Zephyr Cove	14	2	1	17	90
Timber Cove	12	2	3	17	87
Tahoe Keys	11	1	1	14	91
C.Richardson	13	2	1	14	88
Emerald Bay	1	2	1	11	62
Rubicon Bay	14	2	1	12	91
Mid-lake So.	14	2	1	12	92

Emerald Bay specific conductivity (62 µS/ cm) was much lower than the main lake (92 µS/ cm) while NO_3-N there was low, (1 µg/l). The Emerald Bay site is near the inflow of Eagle Cr. and inputs of lower conductivity water there may have resulted in the relatively low conductivity readings. This site may not receive the same level of NO_3-N from lake mixing or upwelling as sites in the main body of the lake. Tahoe City, Kings Beach, Crystal Bay, Timber Cove and Camp Richardson had slightly reduced specific conductance relative to the lake, possibly indicating dilution with tributary water. SRP was slightly elevated at Timber Cove. This site may be impacted by inflows from the U. Truckee River and Trout Cr. to the west, and nearby Bijou Cr. The combination of elevated NO_3-N and SRP may have been the cause of the high AGP response at Timber Cove (Figure 7).

AGP Assay #15 (5/23/17)

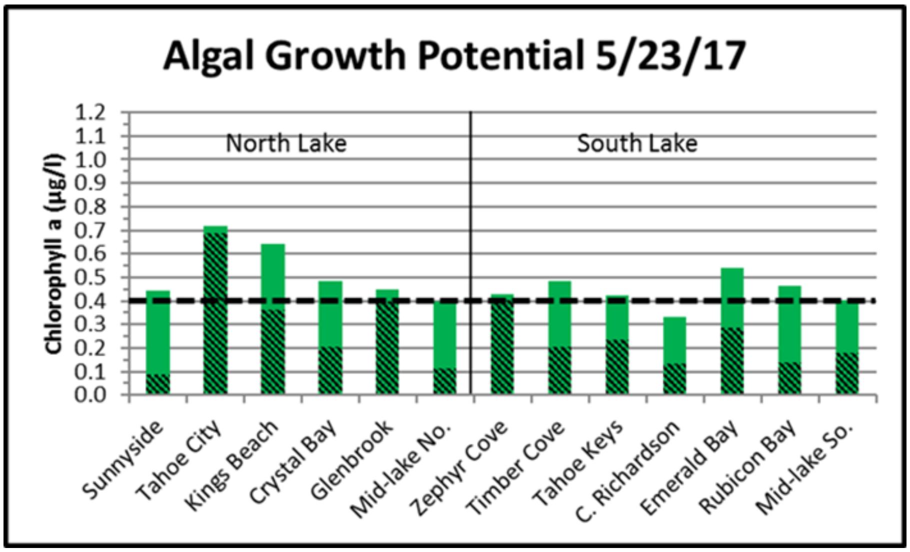


Figure 8. 5/23/17 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

This was a sampling done during the period of higher spring runoff flows for many of the streams. Distinct plumes of turbid tributary water were observed off the mouths of Third and Incline Cr. and the lake water had a slight green color at many sites. Lake surface temperature ranged from 9.5 to 15.0 °C. (The results for this assay are shown in Fig. 8 above). Initial lake water chlorophyll *a* was variable and ranged from a 0.09 µg/l at Sunnyside to 0.69 µg/l at Tahoe City. Chlorophyll *a* increased at most sites during the experiment. Sites with the highest AGP included Tahoe City (0.72 µg/l), Kings Beach (0.64 µg/l) and Emerald Bay (0.54 µg/l). The mean of the two mid-lake AGP levels was 0.40 µg/l.

AGP Assay #16 (6/28/17)

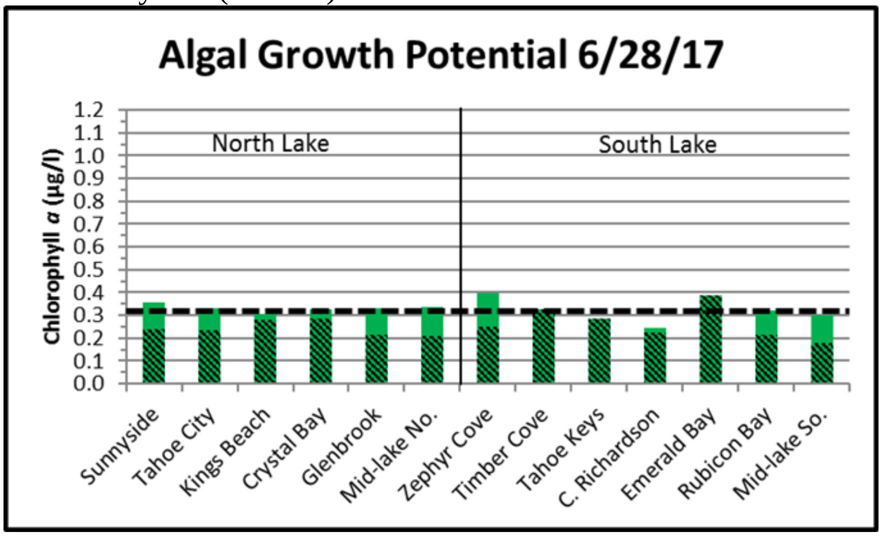


Figure 9. 6/28/17 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

This sampling was done in summer 2017 (Fig. 9 above). Stream flows from many of the tributaries around the lake were declining. Third and Incline Cr. were also on the decline but still producing a sediment plume at the stream mouths (Figure 10 below shows sediment plume at Incline Cr. on 6/28/18, the sample was collected nearby but outside of the plume). The lake surface temperature ranged from 16.0 to 20.0 °C. Initial lake water chlorophyll *a* was relatively low ranging from 0.18 µg/l at Mid-lake South to 0.39 µg/l at Emerald Bay. Six sites showed little or no chlorophyll *a* increase during the experiment. While seven sites showed small increases in chlorophyll *a*. Most sites had AGP near to the mean mid-lake AGP (0.32 µg/l) while two sites had slightly elevated AGP (Zephyr Cove (0.40 µg/l) & Emerald Bay (0.39 µg/l)).

Figure 10. Plume of turbid water flowing into lake from Incline Cr. 6/28/17 at 09:30. Samples were taken slightly offshore of plume.

AGP Assay #17 (9/12/17)

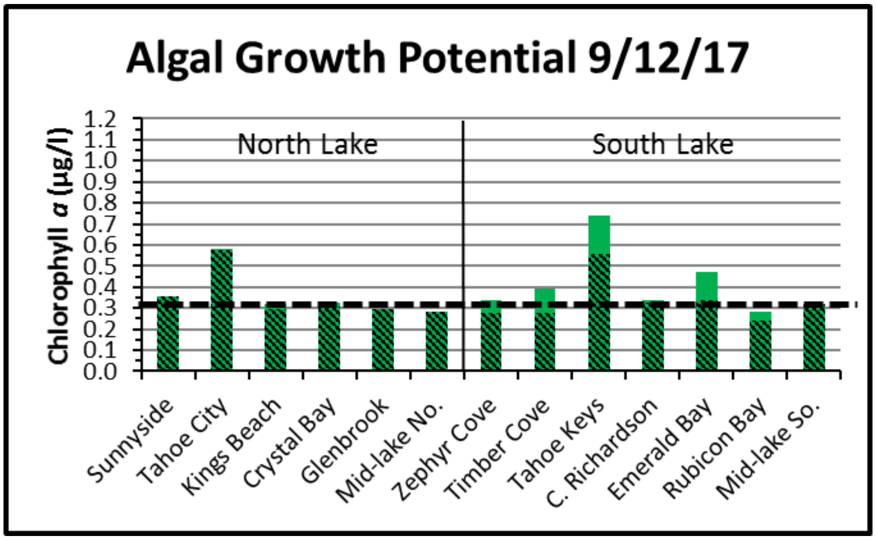


Figure 11. 9/12/17 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

The results for the 9/12/17 test are shown in Fig. 11 above. In the evening prior to the sampling there were strong thunderstorms over portions of the lake with brief strong winds which may have impacted water quality at some sites. Water clarity was noted to be reduced at the Tahoe City and Tahoe Keys nearshore sites during sampling. Lake surface temperature ranged between 19.0-20.5 °C at the sampling sites. Initial lake chlorophyll *a* concentrations were moderately high at the sites (between 0.24 to 0.58µg/l). Highest AGP chlorophyll *a* levels determined in the experiment were found for the Tahoe Keys Nearshore site (0.74 µg/l) and the Tahoe City site (0.58 µg/l).

AGP Assay #18 (12/8/17)

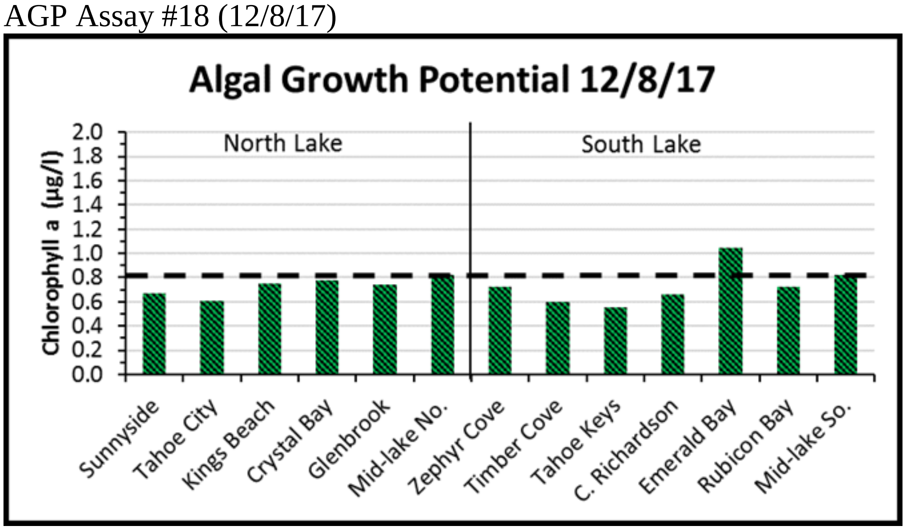


Figure 12. 12/8/17 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

The results for the 12/8/17 bioassay are shown in Fig. 12 above. Lake surface temperature ranged between 6.5-8.5 °C at the sites, with the coldest temperature measured in Emerald Bay. Initial lake chlorophyll *a* concentrations ranged between 0.56 to 0.83 µg/l in the main body of the lake, while Emerald Bay was higher at 1.05 µg/l and noted to have poor clarity. Levels of chlorophyll *a* did not increase during the experiment therefore, the initial chlorophyll *a* in lake water from sites was equivalent to the algal growth potential. This pattern has been observed in previous December AGP experiments.

AGP Assay #19 (3/28/18)

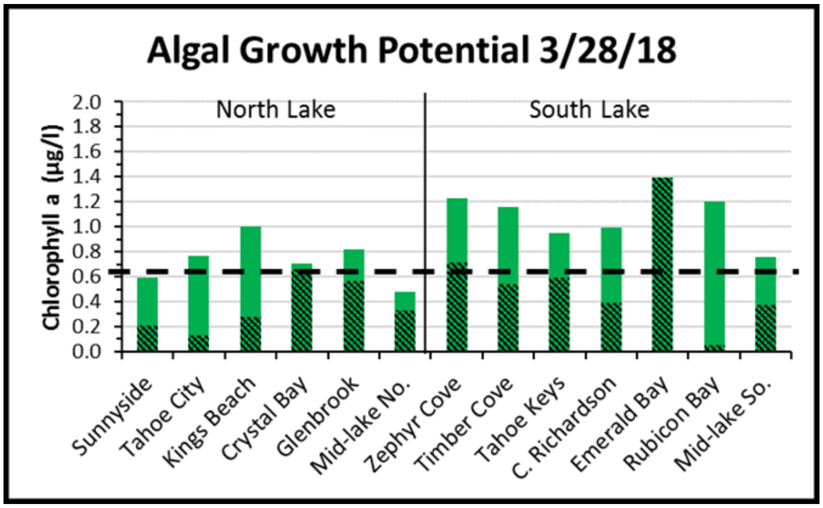


Fig. 13. 3/28/18 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

The 3/28/18 experiment (Fig. 13) followed a rain event the previous week which had resulted in increased stream inputs. Moderate winds accompanied the storm and east winds occurred a couple of days prior to sampling. Lake temperature ranged from 5.0°C in Emerald Bay to 6.5°C at many of the sites. Initial chlorophyll *a* was highly variable among sites. Sites along the west shore (Rubicon, Sunnyside, Tahoe City, Kings Beach) had lowest initial chlorophyll *a* levels ranging from < 0.1 µg/l to 0.28 µg/l; the mid-lake sites and Camp Richardson nearshore were slightly higher 0.33-0.39 µg/l, followed by sites along the north, south (east of Camp Richardson) and east shores ranging from 0.54-0.71 µg/l. Emerald Bay had the highest initial chlorophyll *a* (1.39 µg/l). Sites along the west shore showed substantial increases in chlorophyll *a* from initial levels, especially Rubicon Bay which increased to 1.20 µg/l. Highest levels of AGP were observed at Emerald Bay (same as initial chlorophyll *a* level of 1.39 µg/l), Zephyr Cove (1.23 µg/l), Rubicon Bay (1.20 µg/l) and Timber Cove (1.16 µg/l). It's possible there may have been some impact of stream inputs from the large streams on the south shore (U. Truckee and Trout Cr.) as AGP at most south shore sites were among the higher values in this experiment. The high AGP in Emerald Bay, may reflect influence of inputs from Eagle Creek. The generally low levels of initial chlorophyll *a* along the west shore with subsequent increases during the experiment, may reflect impacts of wind on the distribution of algae and chlorophyll along the west shore.

AGP Assay #20 (6/8/18)

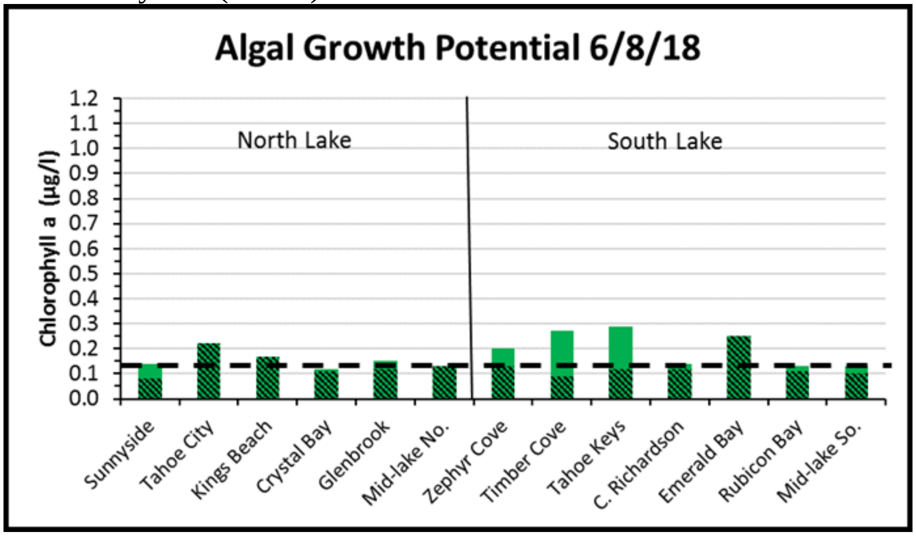


Figure 14. 6/8/18 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

The 6/8/18 experiment (Fig. 14 above) was done near the end of the 2018 spring runoff. The most significant spring stream inputs had long since occurred (two months earlier) associated with a strong storm event in early April. Temperatures ranged from 12.0 to 15.5 °C in the main body of the lake and 17.0° C in Emerald Bay. Initial chlorophyll *a* levels were low at all sites, ranging from 0.08 µg/l at Sunnyside to 0.25 µg/l in Emerald Bay. AGP was also very low at all sites, with most sites showing very little increase in chlorophyll *a*. Timber Cove and Tahoe Keys had the highest AGP (which was still very low, 0.27 and 0.29 µg/l respectively). Reduced stream flows and stratifying lake conditions may have contributed to the generally low chlorophyll *a* in initial lake water at most sites and the generally low AGP.

AGP Assay #21 (10/16/18)

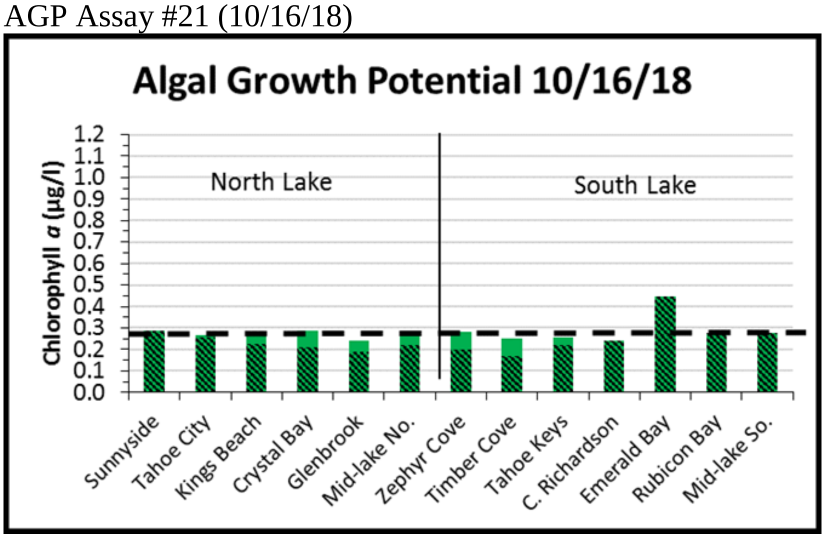


Fig. 15. 10/16/18 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

The results for the 10/16/18 experiment are shown in Fig. 15 above. A strong east wind was noted the previous day and was lighter during sampling, producing a ½ to 1 ½ foot E-NE swell at sites along the west and south shores. The east shore sites were calmer. Temperatures ranged from 12.0 to 13.5 °C. Initial chlorophyll *a* levels were ranged from 0.17-0.29 µg/l at sites in the main lake, while in Emerald Bay chlorophyll *a* was 0.45 µg/l. AGP was the same or only slightly higher than initial chlorophyll levels at the sites.

AGP Assay #22 (12/4/18)

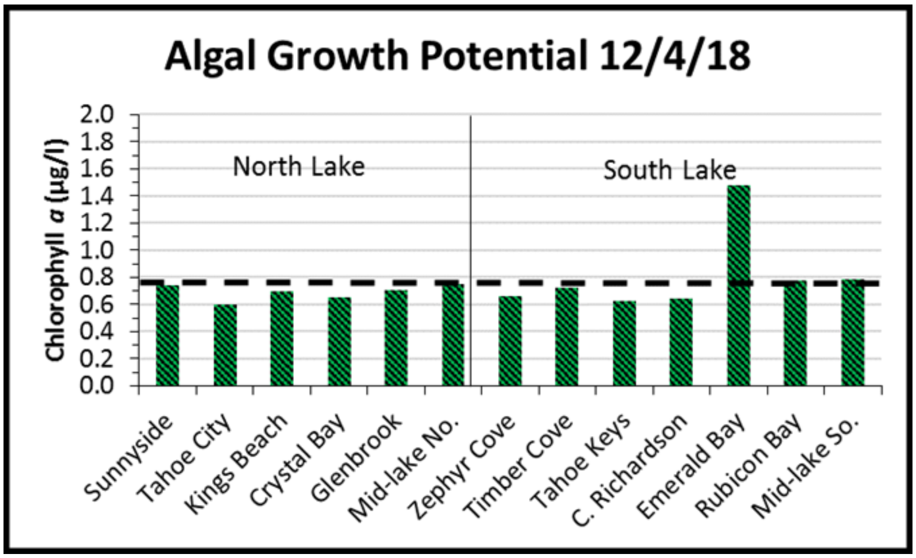


Figure 16. 12/4/18 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

The results for the 12/4/18 bioassay are shown in Fig. 16. Temperatures ranged from 8.0 to 9.0 °C in the main lake and 7.5 °C in Emerald Bay. Initial chlorophyll *a* levels were ranged from 0.60-0.79 µg/l at sites in the main lake, while in Emerald Bay chlorophyll *a* was elevated (1.48 µg/l). The initial chlorophyll *a* levels at all sites also represented the maximum growth or AGP. At most sites chlorophyll *a* declined during the bioassay from initial levels.

AGP Assay #23 (4/4/19)

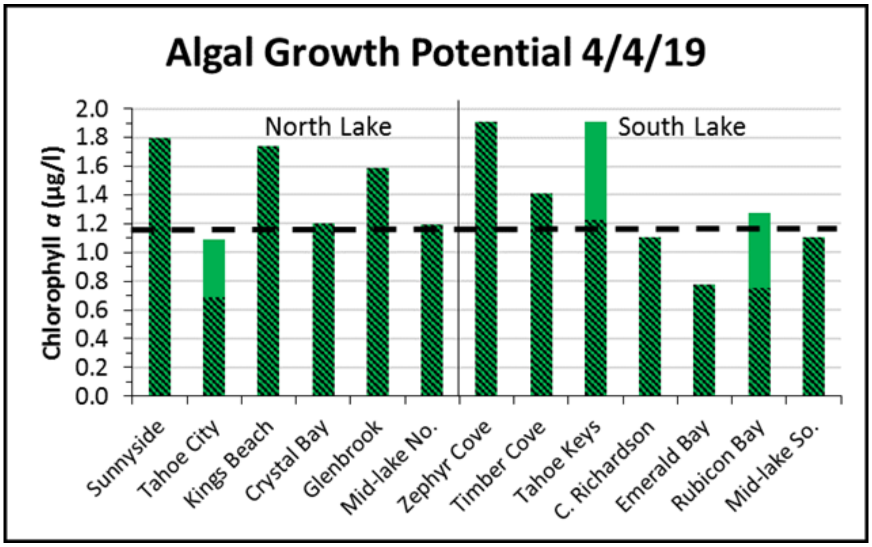


Fig. 17. 4/4/19 algal growth potential experiment results. (Dark shading = initial chlorophyll *a* conc., light green = increase in chlorophyll *a* (if any) during incubation, total height of bar(s) (dark + light green) = AGP, dashed line = mean of Mid-lake North and South AGP levels.)

This 4/4/19 assay (Fig. 17) was done following a strong winter characterized by frequent storms. Particularly frequent snowstorms occurred in February. A couple of days prior to sample collection, another late winter storm occurred, with a mix of rain and snow. The precipitation contributed to increased flows in basin streams. On April 4, when AGP sampling was done, lake water at the Tahoe Keys nearshore station was green and tannin colored (see figure 18) and the shallow lake bottom was not visible (likely a result of inflow from the U. Truckee River nearby). Lake clarity at several other nearshore sites also was noted to have poor clarity or a green color to the water including: Crystal Bay, Zephyr Cove, Timber Cove and Camp Richardson. Temperatures ranged from 6.0 to 7.5 °C in the main lake and 5.0 °C in Emerald Bay. Initial chlorophyll *a* levels were relatively high the majority of sites around the lake (ranging from 1.11 to 1.91 µg/l at all sites - except at Tahoe City, Rubicon and Emerald Bay where initial chlorophyll ranged from 0.69-0.78 µg/l). In the AGP bioassay, most sites did not show additional increases in chlorophyll *a* above the elevated levels observed at sites at the time of collection. Three sites did however show increases in chlorophyll *a*, these were Tahoe City, Rubicon and Tahoe Keys. At Tahoe City and Rubicon, chlorophyll *a* increased to levels similar to those measured at the Mid-lake stations. At Tahoe Keys, the chlorophyll *a* increased above the levels measured at mid-lake to 1.91 µg/l. This high AGP for the bioassay was similar to Zephyr Cove. The elevated chlorophyll *a* levels at many sites and the relatively high AGP levels observed in this experiment were likely a reflection of algal growth in response to a stormy winter, and possibly recent inputs of nutrients associated with storm runoff.

Figure 18. Secchi disc lowered about 0.5m below the water surface at the Tahoe Keys nearshore site to show the coloration of lake water there on 4/4/19.

Levels of AGP and the Lahontan AGP Standard

The Lahontan standard for AGP states that mean annual AGP at a site should not be greater than two times the mean annual AGP at a mid-lake reference station. We evaluated the AGP data relative to the Lahontan Standard for 2018. Table 4 presents the algal growth potential test results by date for monitoring sites, along with the mean annual values (all data for year) and mean annual values for tests done (May – Oct.).[2] The annual means for the nearshore sites were then divided by the annual means for the Mid-lake stations to determine whether the Lahontan standard of 2X the mean annual growth at Mid-lake was exceeded. The Lahontan standard was not exceeded in 2018 for either all annual data or for the data May-Oct. Table 5 presents the results for the AGP standard using May – Sept. data (and May-Oct. data for 2018). During calendar years 2014-2018, the Lahontan standard was only exceeded in one year, in 2015 at two stations: Tahoe City and Timber Cove.

[2] DWR in 1960's and 1970's typically calculated their annual means based on AGP tests during the May to Aug. period.

Table 4. Calendar Year 2018: Algal Growth Potential (AGP) test results by date; Mean Annual AGP; May-Oct. AGP; Station Mean Annual AGP ÷ Mid-lake Mean Annual; May-Oct. Station Mean AGP ÷ May-Oct. Mean Mid-lake AGP. Note for other years we used mean of May – Sept. bioassays, however the late summer bioassay was pushed back to October in 2018.

	AGP Chlorophyll *a* (µg/l)				2018 Annual Mean AGP	2018 May-Oct. Mean AGP	Annual Mean AGP/ Mid-lake Annual Mean AGP	May-Oct. Mean AGP/ May-Oct. Mid-lake Mean AGP
	3/28/2018	6/8/2018	10/16/2018	12/4/2018				
Sunnyside	.60	.14	.29	.75	0.45	0.22	1.00	1.05
Tahoe City	.77	.22	.27	.60	0.47	0.25	1.04	1.19
Kings Beach	1.00	.17	.27	.70	0.54	0.22	1.20	1.05
Crystal Bay	.71	.12	.29	.65	0.44	0.21	.98	1.00
Glenbrook	.72	.15	.24	.71	0.46	0.20	1.02	.95
Zephyr Cove	1.23	.20	.28	.66	0.59	0.24	1.31	1.14
Timber Cove	1.16	.27	.25	.72	0.60	0.26	1.33	1.24
Tahoe Keys	.95	.29	.26	.63	0.53	0.28	1.18	1.33
Camp Rich.	1.00	.14	.24	.64	0.51	0.19	1.13	.91
Emerald Bay	1.39	.25	.45	1.48	0.89	0.35	1.98	1.67
Rubicon Bay	1.20	.13	.28	.78	0.60	0.21	1.33	1.00
Mid-Lake:								
Mid-lake No.	.48	.13	.28	.75	0.41	0.21		
Mid-lake So.	.76	.13	.28	.79	0.49	0.21		
Mean Mid-lk	.62	.13	.28	.77	0.45	0.21		

Table 5. May-Sept. Station Mean AGP ÷ May-Sept. Mean Mid-lake AGP. "*" and highlighted in gray, indicates mean May-Sept. AGP levels exceed the Lahontan Standard where mean annual AGP at a station is not to exceed twice the mean annual AGP at a mid-lake reference station.

	May-Sept. Mean AGP/ May-Sept. Mid-lake Mean				
	2014	2015	2016	2017	2018^
Sunnyside	1.35	1.33	0.66	1.13	1.05
Tahoe City	1.73	2.51*	0.99	1.58	1.19
Kings Beach	1.03	1.43	0.94	1.23	1.05
Crystal Bay	0.99	1.33	0.78	1.12	1.00
Glenbrook	1.02	1.11	0.81	1.05	.95
Zephyr Cove	1.35	1.35	0.75	1.14	1.14
Timber Cove	1.39	2.65*	0.82	1.17	1.24
Tahoe Keys	1.47	1.47	0.94	1.41	1.33
Camp Rich.	1.55	1.25	0.74	0.89	.91
Emerald Bay	1.31	1.31	0.85	1.36	1.67
Rubicon Bay	0.85	1.25	0.53	1.04	1.00

^ -Note- for 2018 mean used June and Oct. bioassays, since there was none done in Aug. or Sept.

Patterns for Highest and Lowest AGP

AGP levels were ranked from highest to lowest for each experiment done Aug. 2013 to April 4, 2019 and the number of times the sites were in the "top 3" or "bottom 3" determined (Table 6). Emerald Bay, Tahoe Keys and Timber Cove were sites most frequently among the top 3 (highest AGP levels). Mid-lake North, Rubicon Bay and Mid-lake South were most frequently among the bottom 3 AGP levels.

Table 6. Number of experiments in which AGP for a site was in the top 3 highest AGP levels for an experiment and number of experiments for which it was among the lowest, in the bottom 3 AGP levels for an experiment. Data includes AGP experiments Aug., 2013 – April, 2019.

	# Experiments in Top 3 (Highest AGP Levels)		# Experiments in Bottom 3 (Lowest AGP Levels)
	Total		**Total**
Emerald Bay	15	Mid-lake North	10
Tahoe Keys	10	Rubicon Bay	10
Timber Cove	9	Mid-lake South	9
Tahoe City	8	Tahoe City	8
Zephyr Cove	7	Camp Rich.	8
Mid-lake North	4	Glenbrook	6
Sunnyside	4	Sunnyside	5
Mid-lake South	3	Timber Cove	5
Rubicon Bay	3	Crystal Bay	3
Kings Beach	2	Tahoe Keys	3
Camp Rich.	2	Zephyr Cove	2
Crystal Bay	2	Emerald Bay	2
Glenbrook	1	Kings Beach	1

Assessment of Value of AGP test in Identifying Areas at Risk of Increased Algal Productivity

AGP tests were done to compare algal growth potential during all seasons over the past 5 years. During calendar years 2014-2018, the Lahontan standard was only exceeded in one year, in 2015 at two stations: Tahoe City and Timber Cove. So of 11 nearshore sites monitored the standard was rarely exceeded, no sites were identified to consistently exceed the standard. The AGP tests produced results that were difficult to interpret in some cases. The AGP assays were set up to use chlorophyll *a* as an indicator of biomass and changes in chlorophyll *a* were to represent changes in biomass or growth. However, chlorophyll *a* does not always show a good association with biovolume (an estimator of biomass for phytoplankton). Chlorophyll *a* in cells can change due to photoadaptation responses, vary among species and be effected by nutrient stress. In a test done 6/21/16 it was difficult to know if the increase in chlorophyll *a* at many sites was a photoacclimation response of the dominant phytoplankton present *Cyclotella gordonensis* or an actual growth response. Enough AGP data has been collected during 2013-2018 to test the utility of this method as an indicator of growth potential in the nearshore. The lack of consistent patterns across sites or through time, and potential difficulties in interpretation of results when using chlorophyll *a* as an estimate of biomass and growth, indicates the approach does not provide Lahontan sufficient information to definitively identify nearshore areas at risk of increased algal productivity.

Other methods to assess algal growth potential may provide more useful information to allow comparison between sites and through time and should be considered by Lahontan. A more appropriate measurement would be to evaluate rates of primary production directly in samples collected from the sites. Advances in optical dissolved oxygen instruments have opened new possibilities for relatively rapid determination of rates of gross primary production (GPP) and ecosystem respiration (ER). Such rates could be determined after 1-3 days rather than the two weeks necessary for the AGP, which greatly reduces the likelihood of bottle artifacts obscuring ecological patterns. A second substantial advantage of the ecosystem metabolism approach is the high degree of replication that can be achieved at comparatively low cost. A total of 5-10 replicate incubation containers can easily be run for each site, providing much greater degree of statistical power and ability to resolve differences between sites or changes through time.

Section II. Enumeration and Identification of Phytoplankton

This section summarizes the results for nearshore phytoplankton monitoring done March 2016-Dec. 2018. Phytoplankton are the free-floating algae in lakes. They typically form the base of the aquatic food web. They utilize energy from the sun, carbon dioxide and nutrients for production of biomass and growth. If changes occur in lake water quality, the phytoplankton are among the first indicators of that change. The abundance or numbers of the cells will change, the biodiversity may change, and these changes may trigger changes in other parts of the food web. When present in too high a level phytoplankton degrade water quality.

Phytoplankton consists of a diverse assemblage of many different major taxonomic groups (e.g. diatoms, chrysophytes, dinoflagellates, cryptomonads, greens, blue-green algae (cyanobacteria), haptophytes, euglenophytes and myocetes occur in Tahoe). The phytoplankton species which make up each of the different groups have characteristics common to the particular group (such as pigment composition, morphological characteristics, resource requirements, growth rates, sinking velocities). Their size can range over several orders of magnitude (~0.2-200 µm) (Heyvaert et al., 2013). As lake conditions change over the course of a year, the phytoplankton experience seasonal succession. Variation in algae may also occur in regions associated with localized nutrient inputs or other factors, resulting in differences in the algal community composition from other sites around the lake. For instance, certain green algae and cyanophytes and presence of euglenoids can be indicative of more fertile lake waters.

With increased interest in the state of the nearshore, nearshore phytoplankton monitoring was included as part of the Lake Tahoe Water Quality Investigations monitoring starting in 2013. Phytoplankton samples were collected at the same time as water collected for the Algal Growth Potential experiments. Eleven near-shore sites and two open water (mid-lake) sites were sampled quarterly for phytoplankton identification and enumeration. Cells were counted and identified to species level when possible following established TERC protocol (see Hackley et al., 2016). Biovolume was used to estimate biomass. Biovolume is a common descriptor used in phytoplankton studies. It is an individual cell metric which requires calculation of cell volume from 3-dimensional geometric forms. Total biovolume of a sample is the collective individual cell volume calculations added together, weighted by population abundance. It can lead to an estimation of phytoplankton biomass. The measurement of biomass is a critical parameter. It helps to characterize an environment by how much mass (weight) of living matter is present in a defined region.

Nearshore Phytoplankton Monitoring Results March 2016 to December 2018

Due to the large numbers of species associated with each sample, the summary of phytoplankton biovolume and abundance data by individual species is located on the TERC website: (go to https://tahoe.ucdavis.edu/lahontan/report-updates and select the link for latest update of TERC Nearshore Phytoplankton data.

These data were used to compile summary graphs of phytoplankton abundance and biovolume data by algal group (i.e. diatoms, chrysophytes, dinoflagellates, cryptomonads, greens, cyanophytes and haptophytes) which are presented in Figures 19.a. – 19.x. below.

Figures 19.a – 19.x are presented in the following pages. Phytoplankton biovolume and abundance at nearshore and mid-lake stations during sample collections March 2016 to Dec. 2018. Stations are shown along bottom in each graph and include: “SS”= Sunnyside; “TC”= Tahoe City; “KB”=Kings Beach; “CB”=Crystal Bay; “GL”=Glenbrook; “MLNo”=Mid-lake North; “ZC”=Zephyr Cove; “TCo”=Timber Cove; “TK”= Tahoe Keys nearshore; “CR”=Camp Richardson; “EB”=Emerald Bay; “RB”=Rubicon Bay; “MLSo”=Mid-lake South.

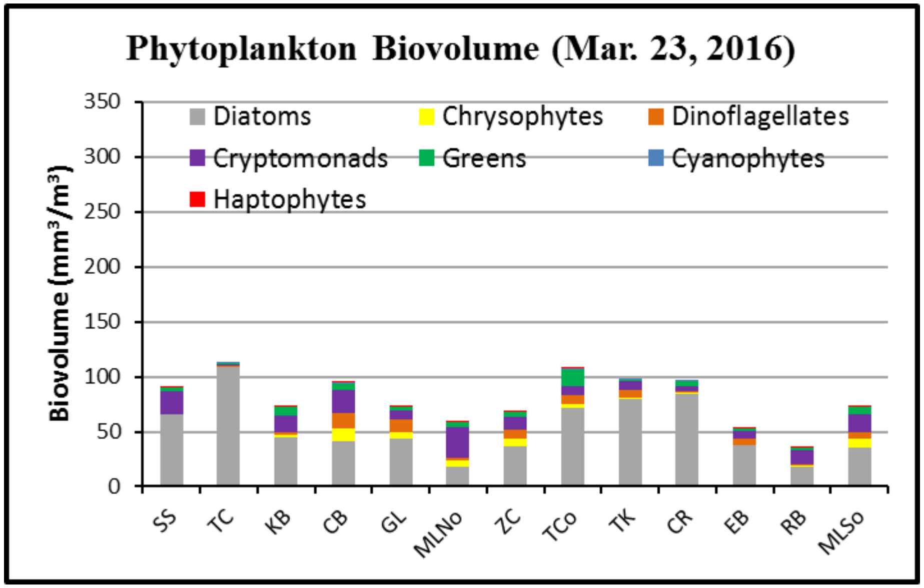


Figure 19.a. Phytoplankton Biovolume at nearshore sites 3/23/16.

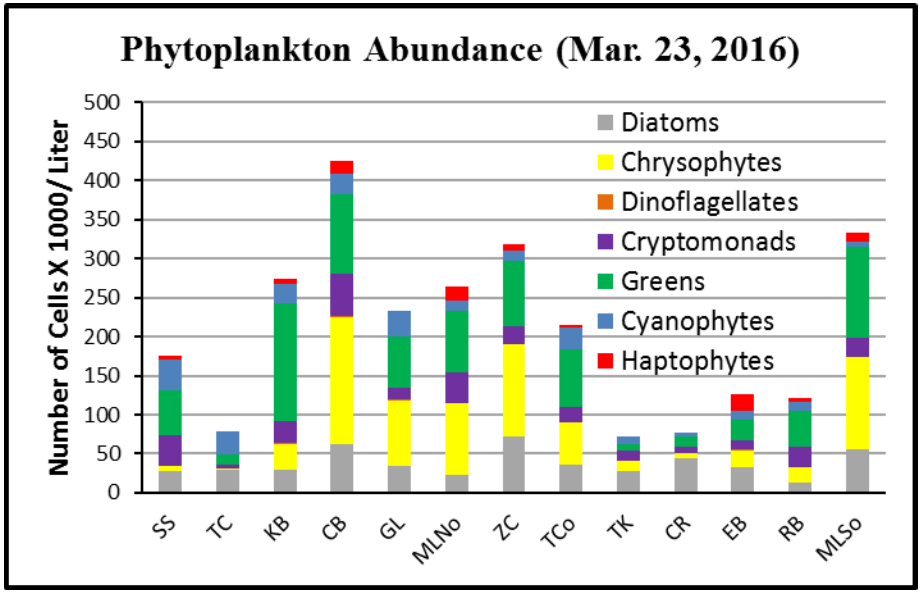


Figure 19.b. Phytoplankton Abundance (cell numbers) 3/23/16.

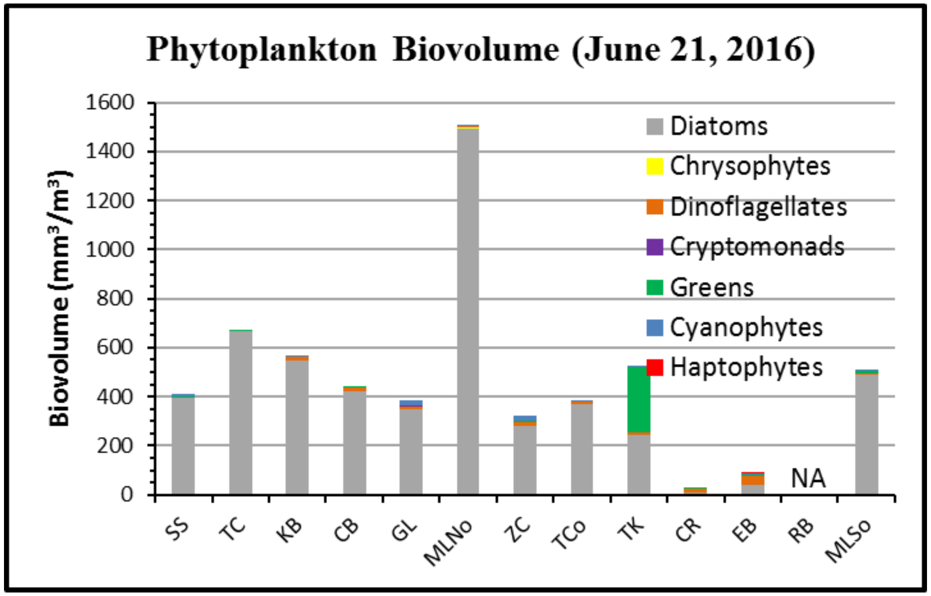


Figure 19.c. Phytoplankton Biovolume at nearshore sites 6/21/16. (Note scale change).

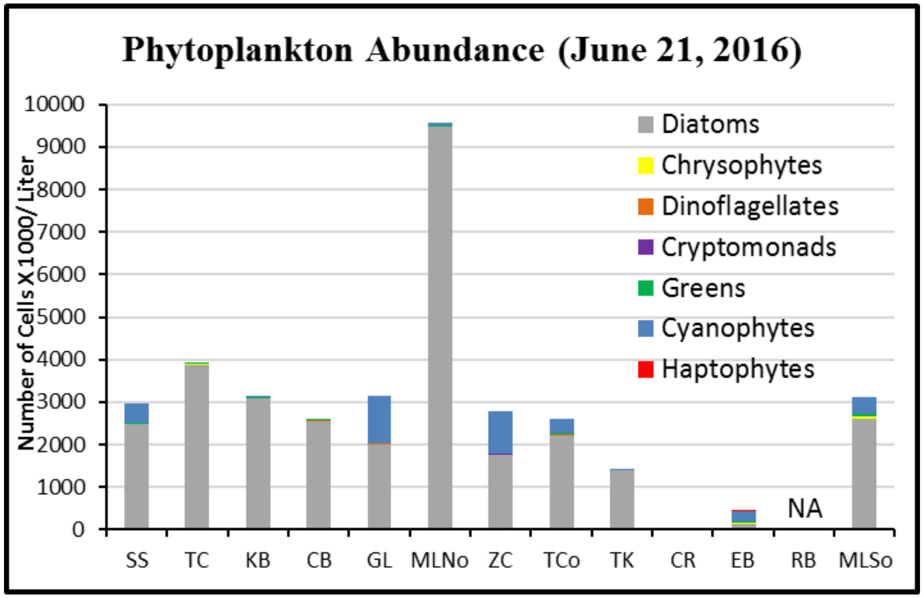
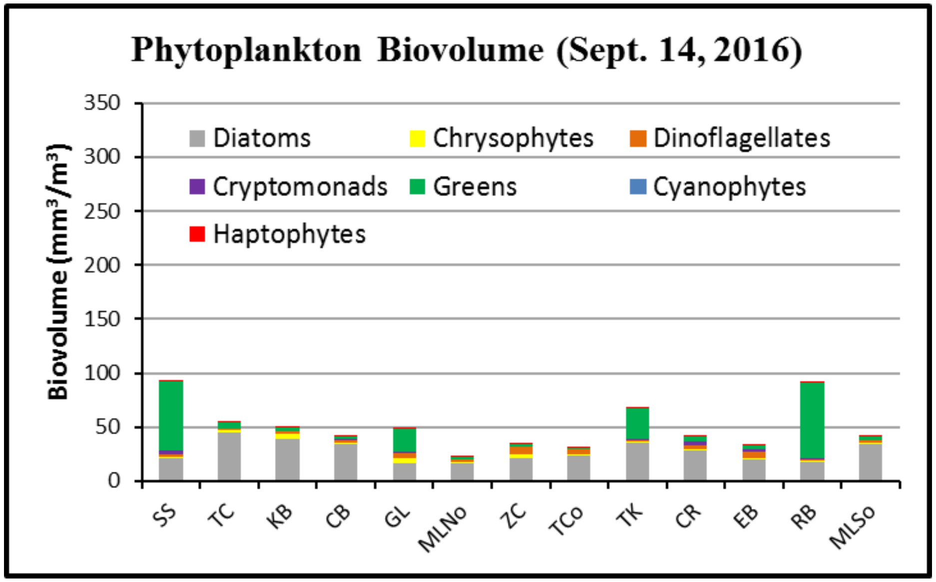


Figure 19.d. Phytoplankton Abundance (cell numbers) 6/21/16. (Note scale change).



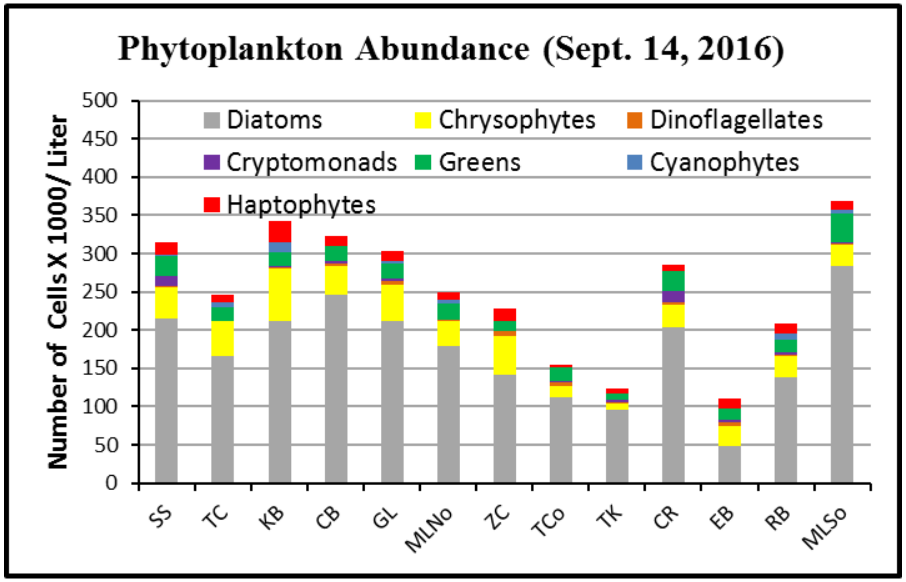
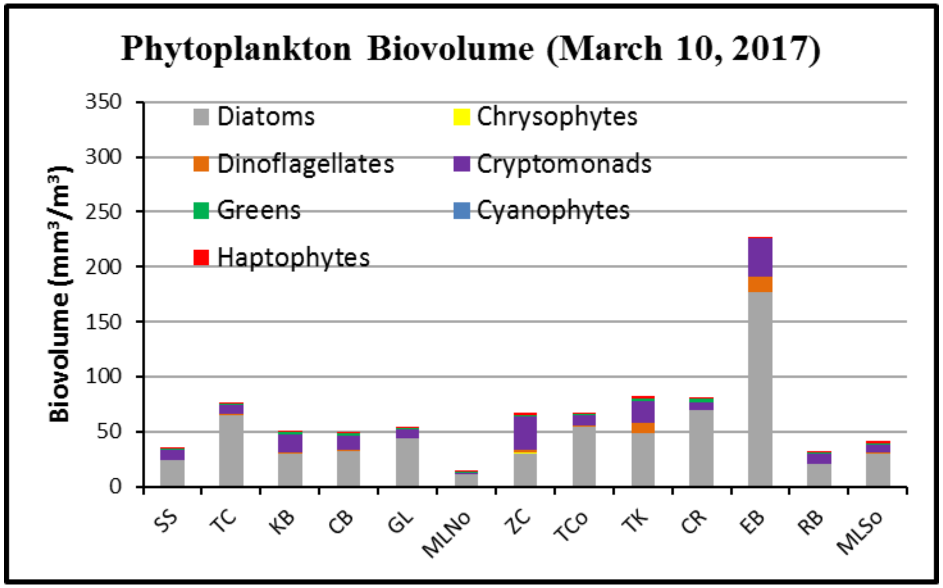


Figure 19.e. Phytoplankton Biovolume at nearshore sites 9/14/16.

Figure 19.f. Phytoplankton Abundance (cell numbers) 9/14/16.



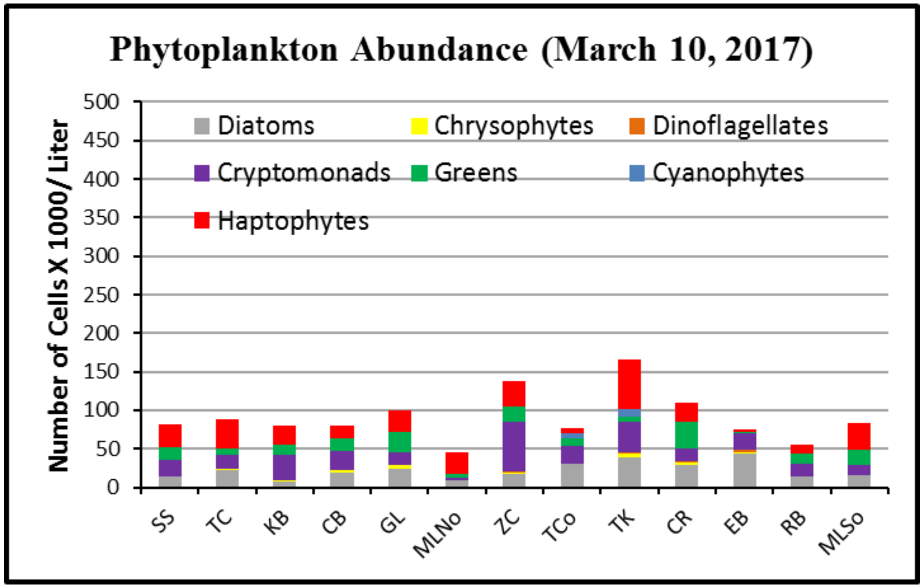


Figure 19.g. Phytoplankton Biovolume at nearshore sites 3/10/17.

Figure 19.h. Phytoplankton Abundance (cell numbers) 3/10/17.

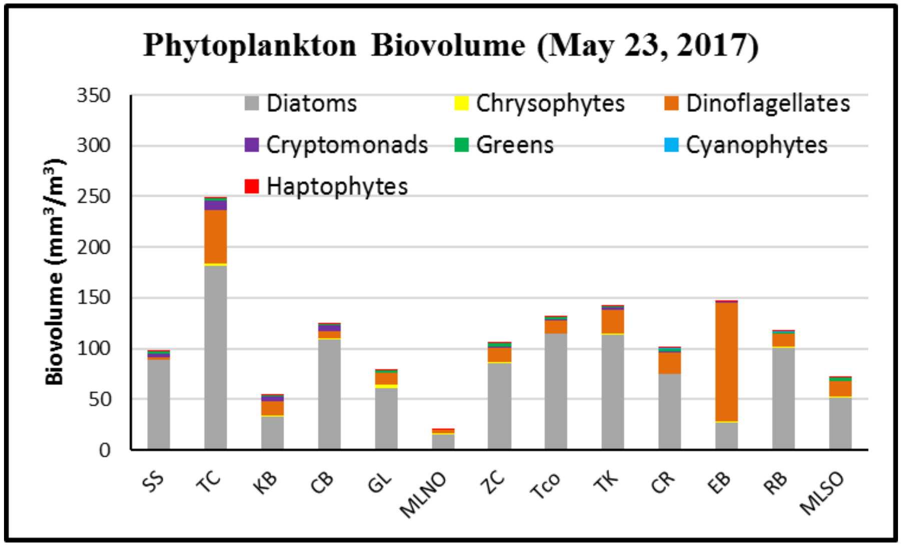


Figure 19.i. Phytoplankton Biovolume at nearshore sites 5/23/17.

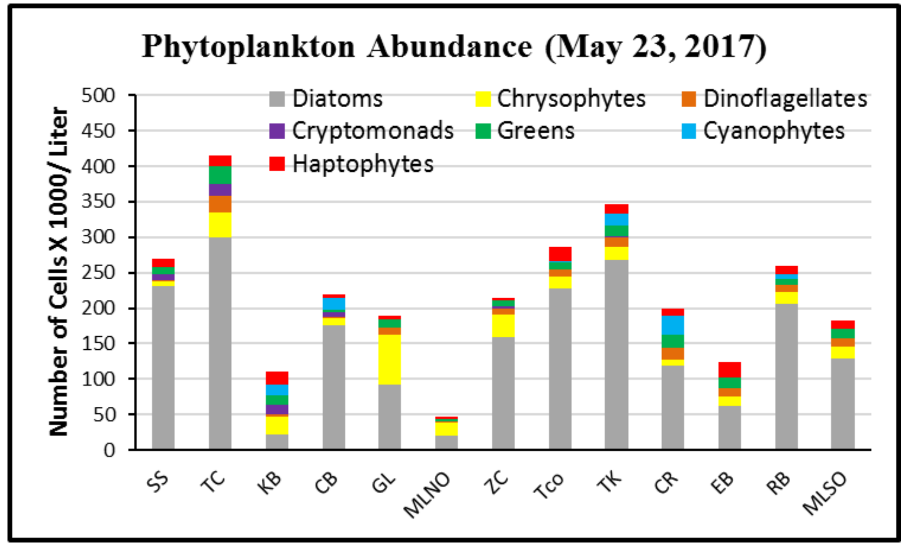


Figure 19.j. Phytoplankton Abundance (cell numbers) 5/23/17.

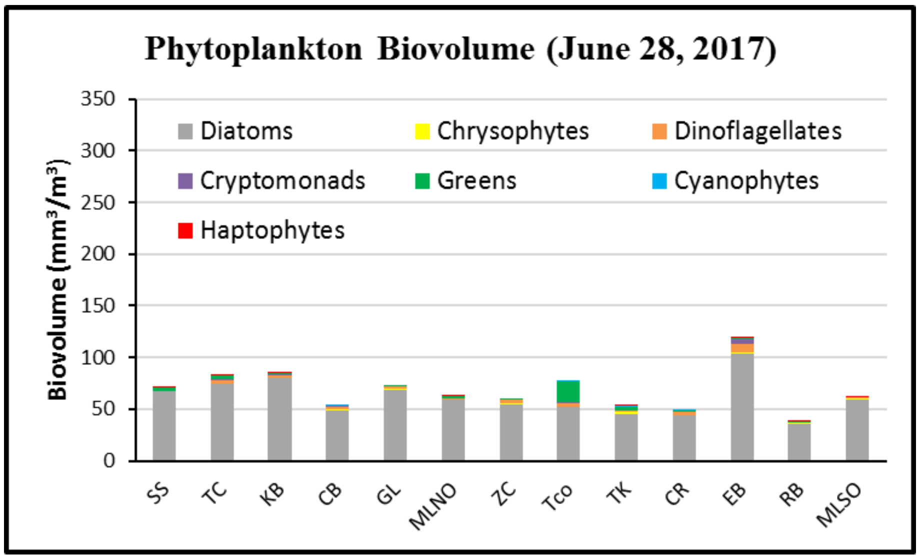


Figure 19.k. Phytoplankton biovolume at nearshore sites 6/28/17.

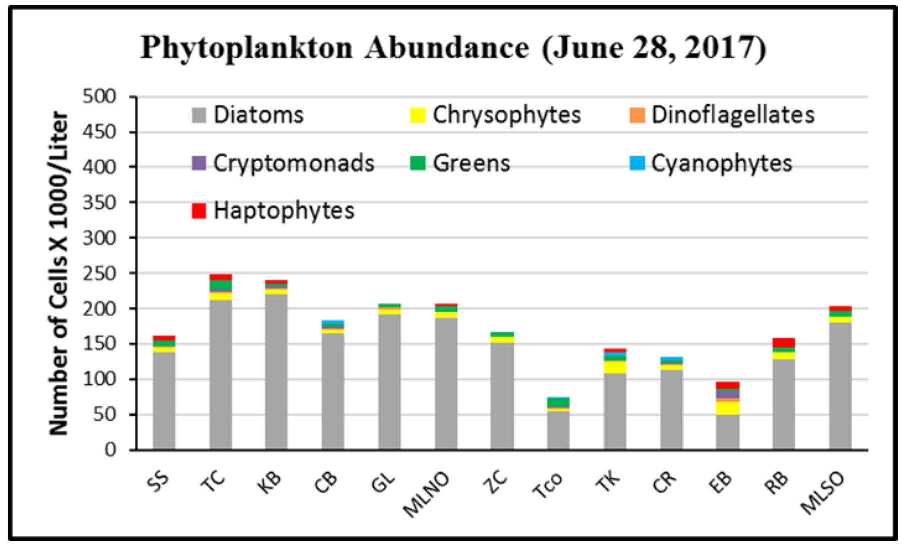


Figure 19.l. Phytoplankton abundance at nearshore sites 6/28/17.

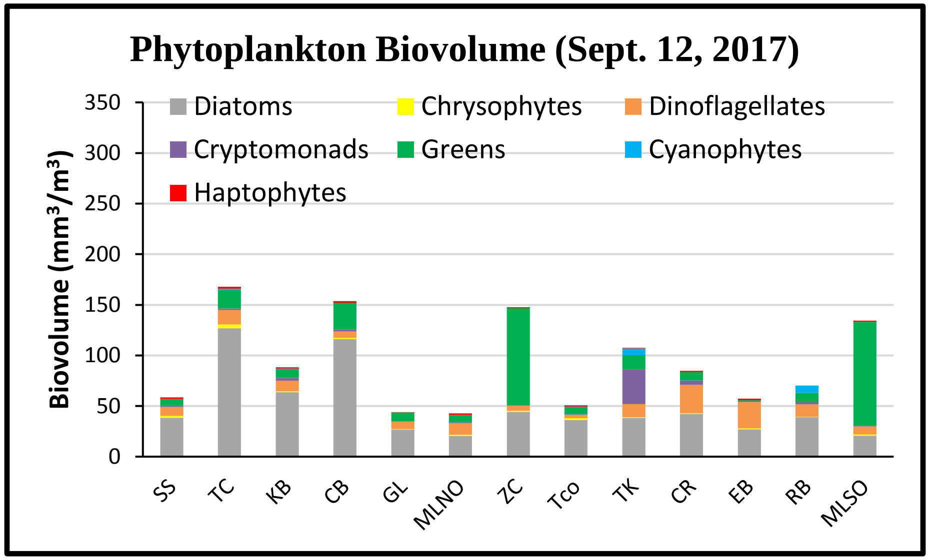


Figure 19.m. Phytoplankton biovolume at nearshore sites 9/12/17.

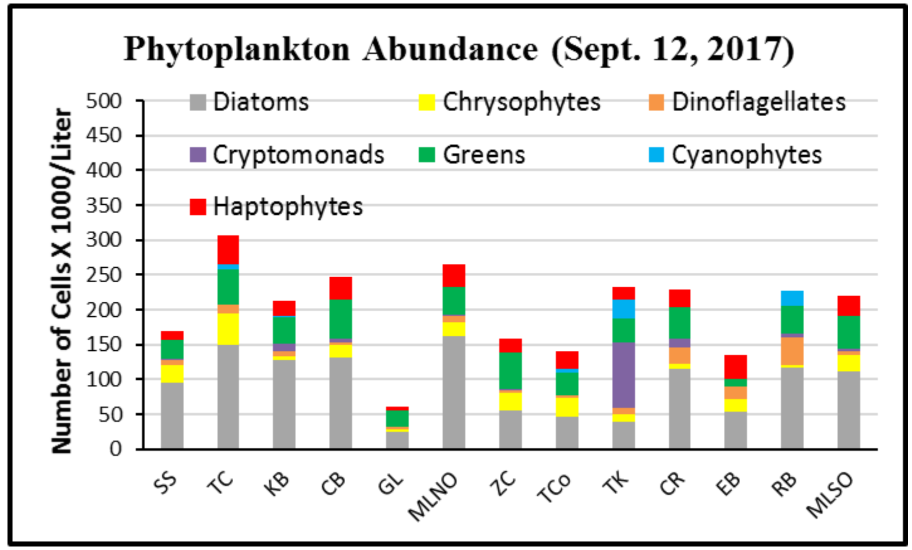


Figure 19.n. Phytoplankton abundance at nearshore sites 9/12/17.

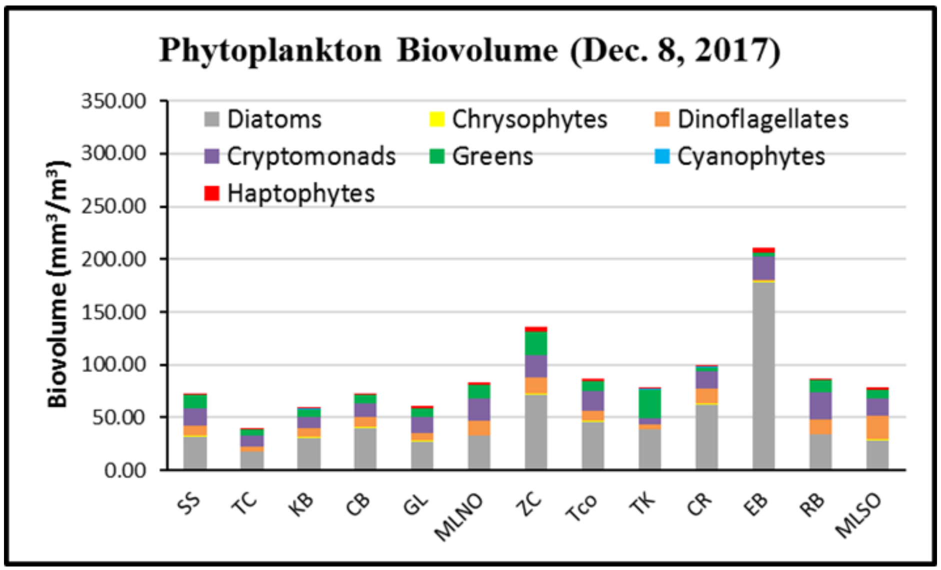


Figure 19.o. Phytoplankton biovolume at nearshore sites 12/8/17.

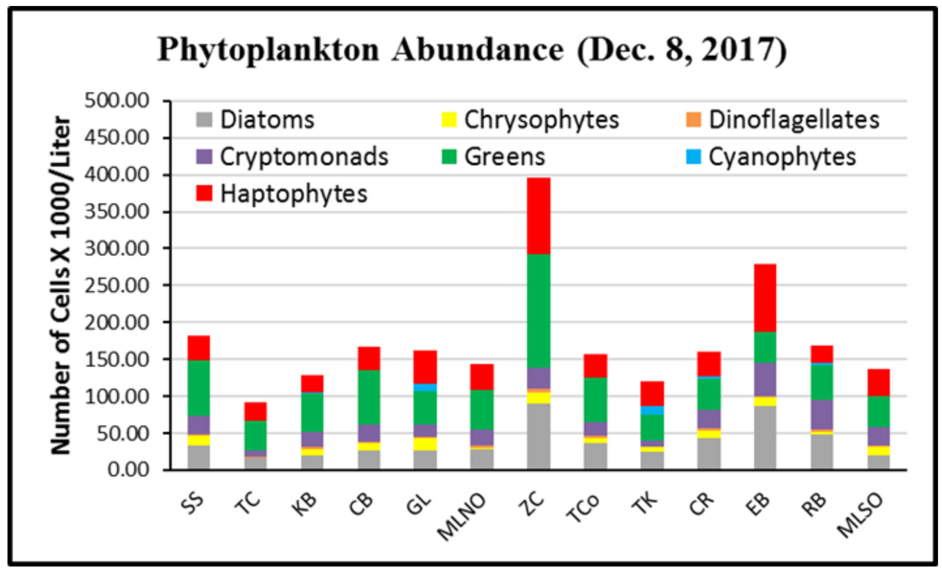


Figure 19.p. Phytoplankton abundance at nearshore sites 12/8/17.

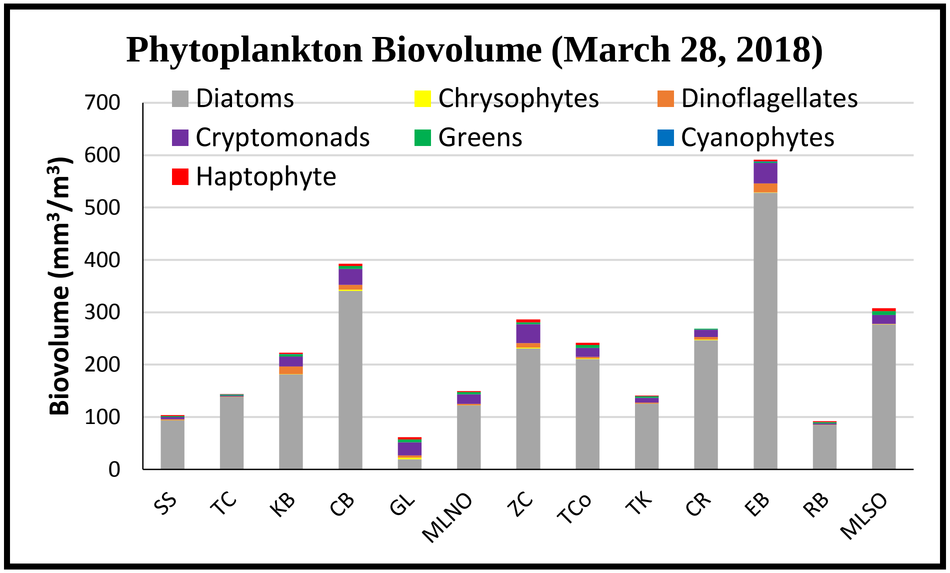


Figure 19.q. Phytoplankton biovolume at nearshore sites 3/28/18.

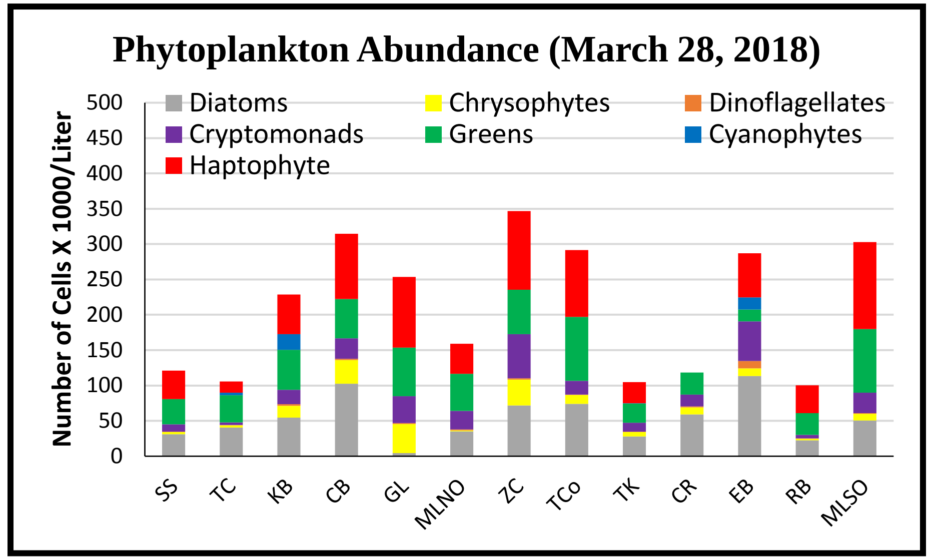


Figure 19.r. Phytoplankton abundance at nearshore sites 3/28/18...

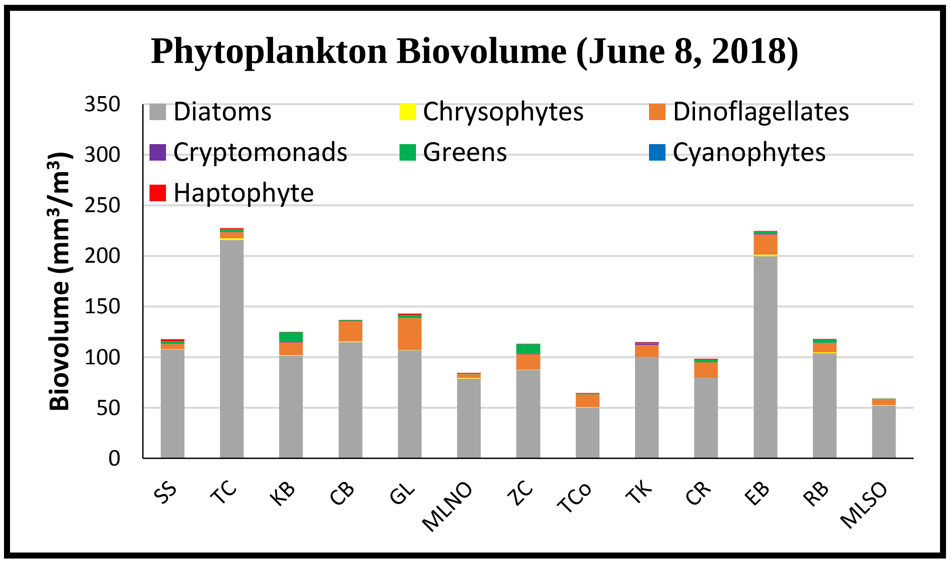


Figure 19.s. Phytoplankton biovolume at nearshore sites 6/8/18.

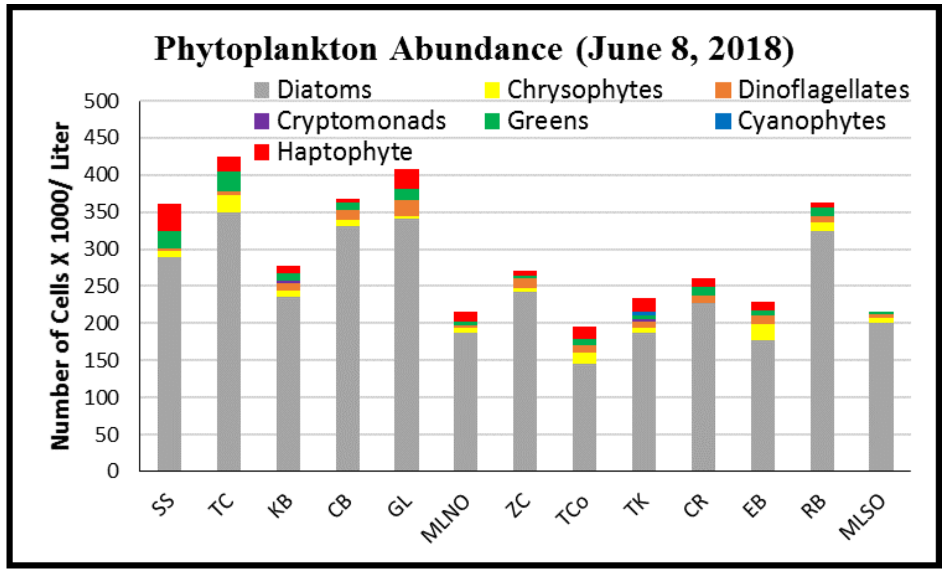


Figure 19.t. Phytoplankton abundance at nearshore sites 6/8/18.

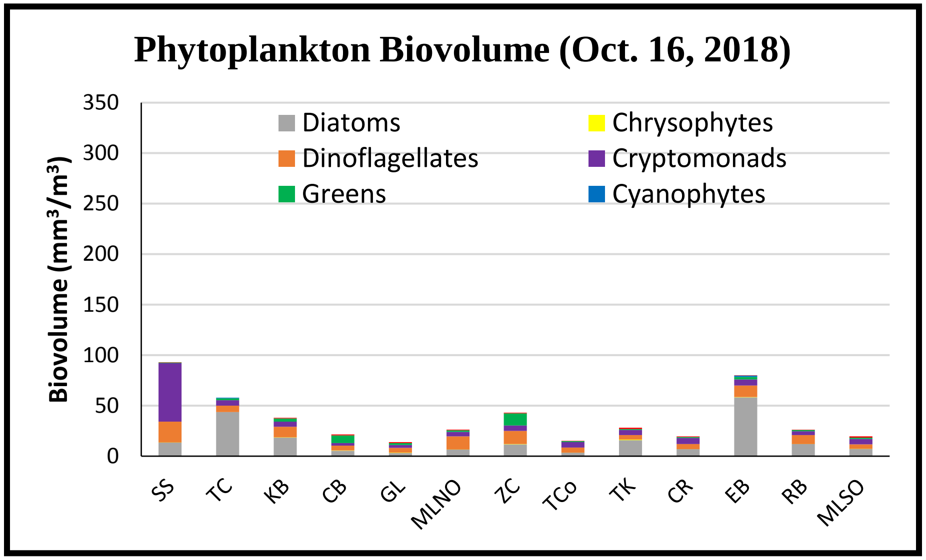


Figure 19.u. Phytoplankton biovolume at nearshore sites 10/16/18.

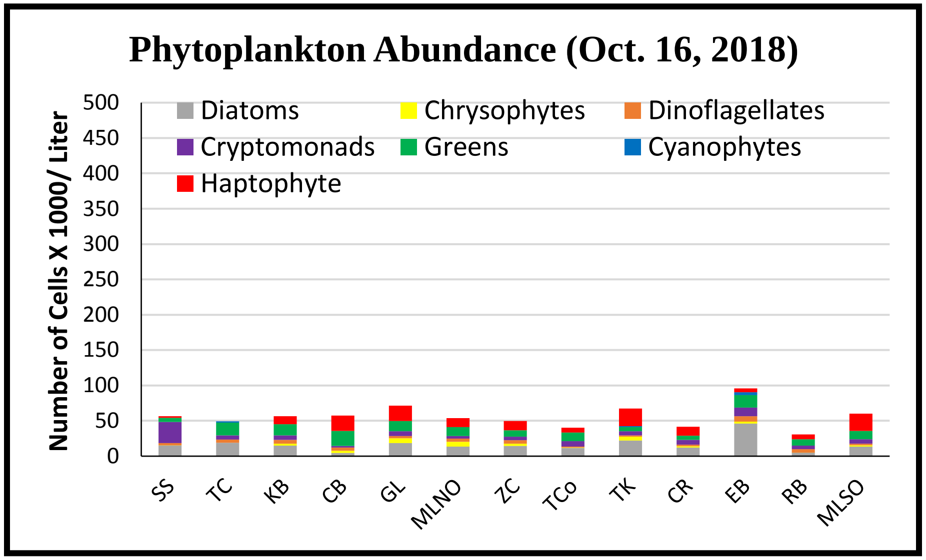


Figure 19.v. Phytoplankton abundance at nearshore sites 10/16/18.

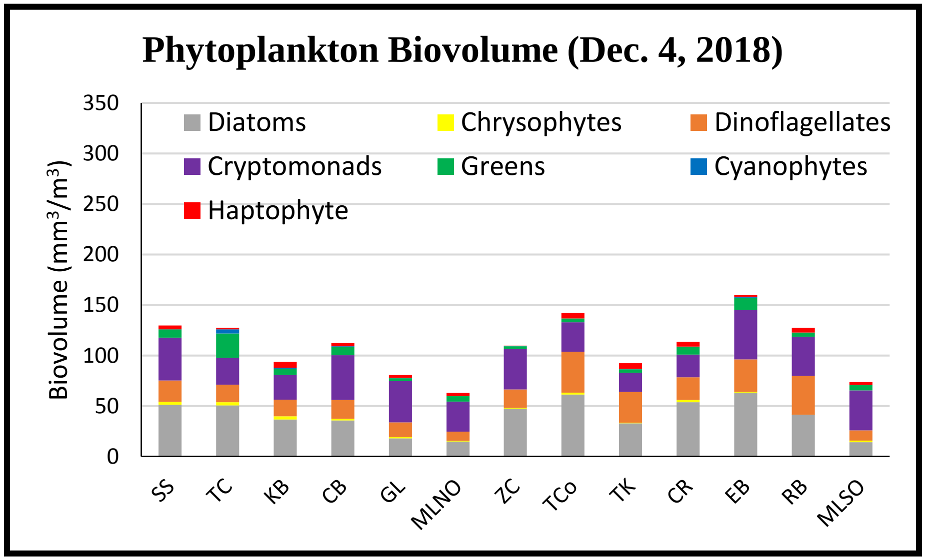


Figure 19.w. Phytoplankton biovolume at nearshore sites 12/4/18.

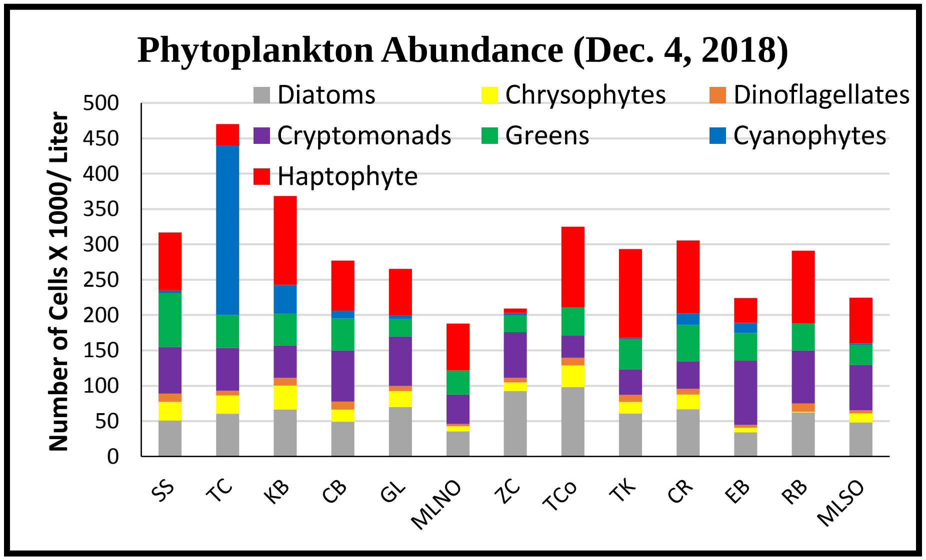


Figure 19.x. Phytoplankton abundance at nearshore sites 12/4/18.

Some patterns were apparent for biovolume and abundance through time (Figures 19.a. to 19.x.). Phytoplankton showed successional patterns in abundance and community composition throughout the year. On each sampling date, similar groups of phytoplankton were often found at many of the stations. The proportion of total biovolume or abundance contributed by each group however, could vary by site. Between dates, phytoplankton taxonomic groups changed as new successional communities were established (note the appearance and disappearance of groups throughout each year). For instance, in March 2018, biovolume was dominated by diatoms, with a lesser contribution by cryptomonads at many sites; in June 2018, the cryptomonads disappeared and were replaced by dinoflagellates, while diatoms still dominated the biovolume; in Oct. 2018, a mix of groups contributed to biovolumes and total biovolumes were low; in December 2018, diatoms, dinoflagellates and cryptomonads dominated the biovolumes.

Some sites had noticeably higher biovolumes than other sites on select dates. Emerald Bay biovolume was noticeably higher than the other sites on several dates during 2016-2018 including: March 10, 2017 (biovolume = 226.57 mm^3/m^3), June 28, 2017 (biovolume = 103.93 mm^3/m^3), Dec. 8, 2017 (biovolume = 178.24 mm^3/m^3) and Mar. 28, 2018 (biovolume = 591.14 mm^3/m^3). For other sites, Tahoe City biovolume on May 23, 2017 was very high (249.17 mm^3/m^3). The Mid-lake North site had much higher biovolume on 6/21/16 (1506.32 mm^3/m^3) than all other sites. Emerald Bay was also frequently among the sites with the highest biovolumes, while the other nearshore sites were not consistently high.

Very high biovolumes and abundances were observed at many sites on 6/21/16 (Figures 19.c, d). The high biovolumes in this June sampling, were primarily due to the unusually large presence of the diatom, *Cyclotella gordonensis* (Figure 20). The biovolume of *Cyclotella gordonensis* was highest at the Mid-lake North site with elevated biovolumes at the mid-lake south site and most other nearshore sites (excepting Emerald Bay and Camp Richardson which had relatively low biovolumes and Rubicon Bay, data not available).

The large presence of *Cyclotella gordonensis* in June 2016 may have been indicative of lower nutrient conditions at that time. Winder and Hunter (2008), and Winder et. al. (2009) indicate *Cyclotella gordonensis* is an excellent competitor during low nutrient, high light and warmer temperature conditions. It is interesting that the biovolume was greatest near the middle-north portion of the lake (Mid-lake North) on 6/21/16. Very strong south and southwest winds were noted during the week prior to sampling, and it could be the high levels of *Cyclotella gordonensis* at the Mid-lake North station, were the result of accumulation of cells associated with lake circulation patterns.

While Emerald Bay had the highest biovolumes on several dates, it also had a phytoplankton community composition quite different from the rest of the lake on several dates. For instance in March of 2017 the biovolume in Emerald Bay was much higher than other sites around the lake, and 2/3 of the biovolume was due to one species *Synedra acus*. Synedra acus was only a small

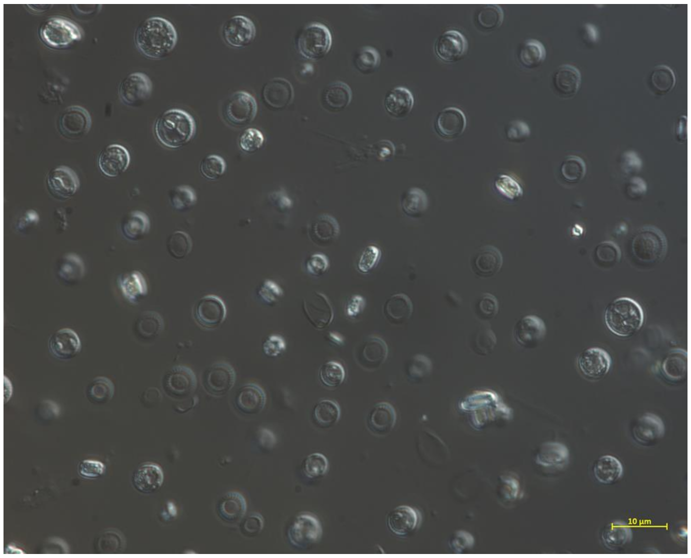


Figure 20. Light micrograph of settled small diatoms, *Cyclotella gordonensis* that was abundant at many sites on 6/21/16. Yellow bar provides scale (=10µm). Photo courtesy of Lidia Tanaka.

portion of the biovolume if present at the other sites. In May 2017, the biovolume was dominated by dinoflagellates in Emerald Bay while at the other sites, diatoms dominated the biovolume. In June of 2016 Emerald Bay *did not* have the high biovolumes of *Cyclotella gordonensis* observed at most other parts of the lake and overall biovolume was low relative to most other sites.

Phytoplankton community structure has the potential to characterize individual nearshore stations. Phytoplankton are highly responsive to changes in the type and concentration of nitrogen-based and phosphorous-based nutrients. If changes occur in lake water quality, the phytoplankton are among the first indicators of that change. The abundance or numbers of the cells will change, the biodiversity may change, and these changes may trigger changes in other parts of the food web. The appearance of new and/or undesirable phytoplankton species may also be foretelling of qualitative water quality problems such as water color change or possibly odors. In Lake Tahoe different nearshore sites offer different chemical and physical conditions; however, the differences between stations are subtle. If it is possible to define unique characteristics at some or all of the sites, then an opportunity exists to track regional differences. These results could provide information useful in making management decisions.

In an effort to identify some unique characteristics in the phytoplankton community, we looked at the incidence of elevated amounts of cyanobacteria or green algae in the phytoplankton at the sites. Some species of green algae and cyanobacteria can be associated with more nutrient-enriched waters. Data was plotted for cyanobacteria and green algae at each site and patterns for nearshore sites were compared with those for the nearby mid-lake site. Figure 21 (a-c) and Figure 22 (a-c) present data for cyanobacteria biovolume and green algae biovolume respectively for three south shore sites which showed the most interesting patterns (Mid-lake South, Timber Cove and Tahoe Keys Nearshore).

Figures 21 a-c. (Below). Biovolume data for cyanobacteria 2013 to 2018 at the Mid-lake South, Timber Cove and Tahoe Keys Nearshore sites. Black dots represent biovolume on individual dates. Predominant species contributing to the biovolume for dates with elevated biovolumes are indicated in the figures. For reference, cell counts/ ml are also shown for some species.

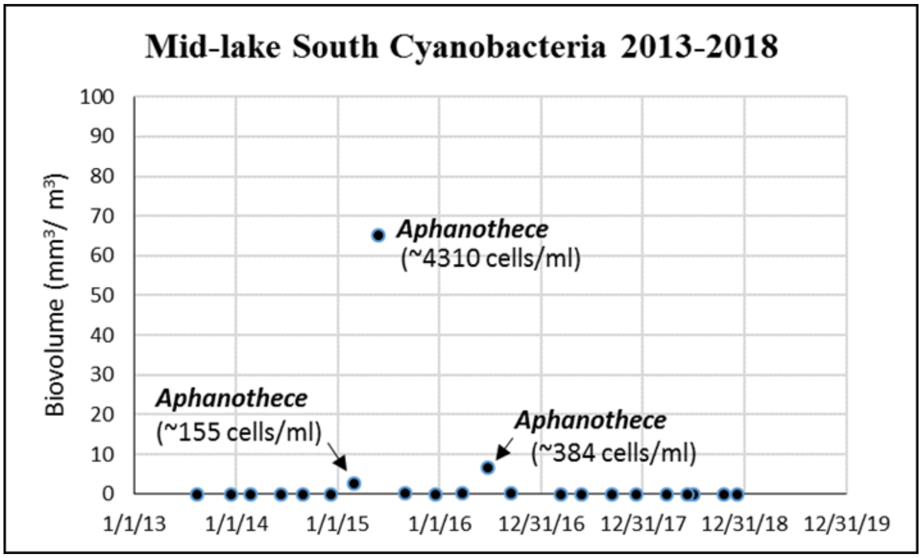


Fig. 21.a .

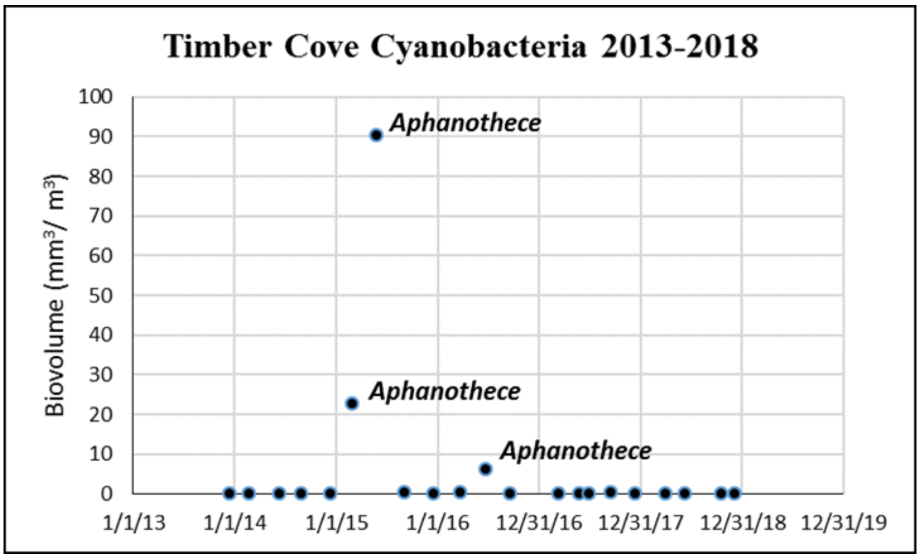


Fig. 21.b.

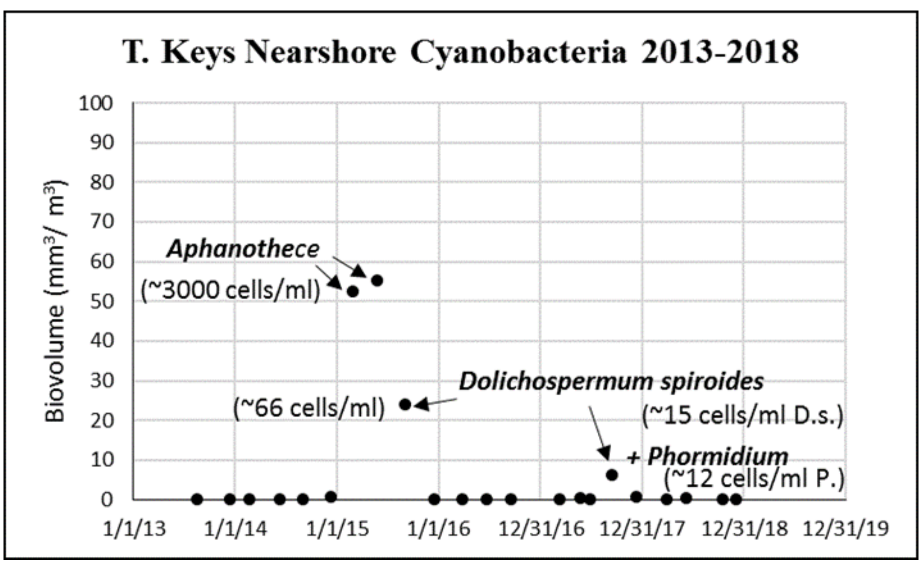


Fig. 21.c.

Figures 22.a-c. (Below). Biovolume data for green algae (Chlorophytes) 2013 to 2018 at the Mid-lake South, Timber Cove and Tahoe Keys Nearshore sites. Black dots represent biovolume on individual dates. Predominant species contributing to the biovolume for dates with elevated biovolumes are indicated in the figures.

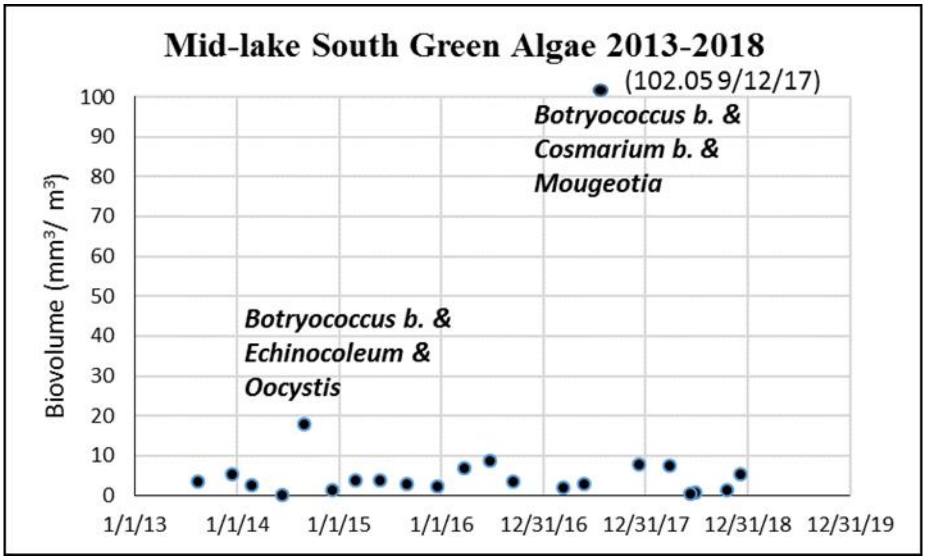


Fig. 22.a.

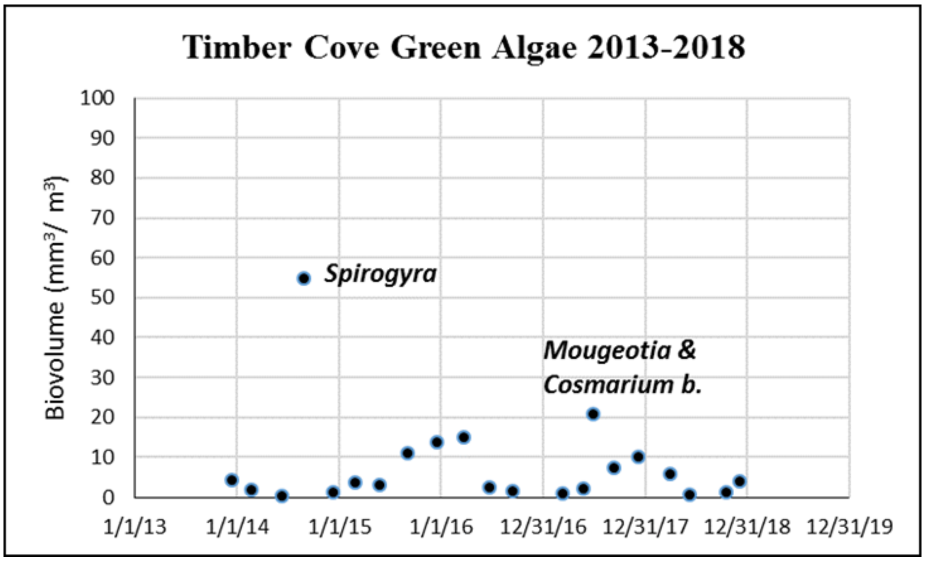


Fig. 22.b.

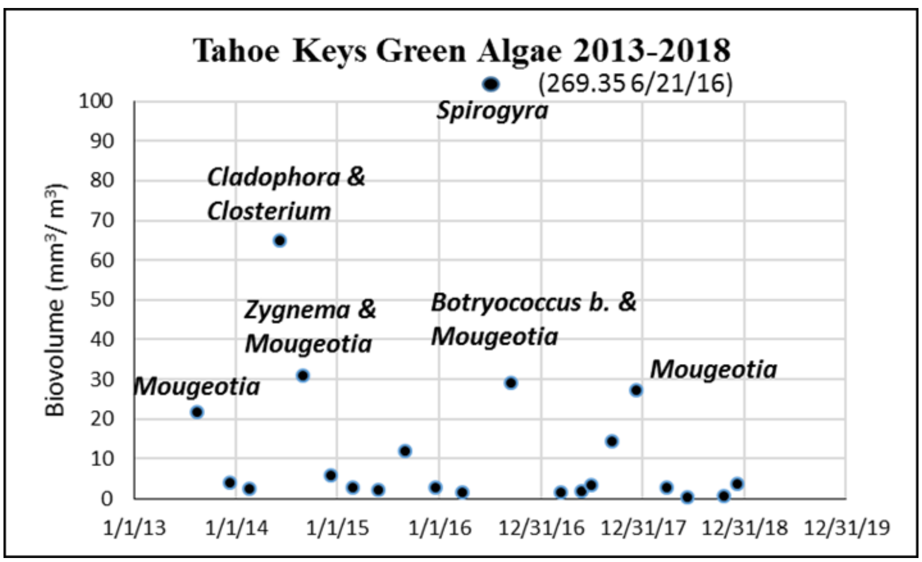


Fig. 22.c.

Generally, levels of cyanobacteria and green algae were low at the sites with occasionally elevated levels. Elevated levels of the cyanobacteria species *Aphanothece* occurred on similar dates at Mid-lake South and Timber Cove sites indicating regional distribution inshore and offshore. *Aphanothece* was also present at the Tahoe Keys Nearshore site during the 2015 samplings when it was present at many sites around the lake.

At the Tahoe Keys Nearshore site slightly elevated biovolumes associated with a cyanobacteria known as *Dolichospermum spiroides* (see images in Figure 23 a, b) was observed on Sept. 1, 2015 and Sept. 12, 2017. Interestingly, in the summer of 2017, a bloom of cyanobacteria occurred within portions of the Tahoe Keys lagoons (see: https://www.tahoedailytribune.com/news/local/low-levels-of-toxic-algae-remain-in-keys/). The bloom was a concern due to the potential for the algae involved to produce certain algal toxins. Precautions for contact by people and pets with the cyanobacteria were taken, along with increased monitoring by the Tahoe Keys and Lahontan. One of the cyanobacteria species identified in the bloom in the Tahoe Keys was *Dolichospermum (*see link: https://www.waterboards.ca.gov/lahontan/water_issues/programs/tahoe_keys_weed_control/docs/TKPOA_Cyanobacteria_Eval_2017.pdf).

It is uncertain whether the presence of *Dolichospermum spiroides* in the nearshore area off of Tahoe Keys on Sept. 12, 2017 was associated with the bloom of cyanobacteria inside the Tahoe Keys. This was because low levels of *Dolichospermum spiroides* was also observed elsewhere in the nearshore around Lake Tahoe on the same date, including at Rubicon Bay, Tahoe City and Kings Beach (see Table 7).

The results for green algae biovolumes at site 2013 to 2018 are shown in Fig 22 a-c above. Generally low levels of green algae biovolume were observed at the Mid-lake South and Timber Cove sites. At the Tahoe Keys Nearshore site there were more frequent occurrences of increased biovolume associated with green algae. The species responsible for the increased biovolume were filamentous green algae including *Mougeotia, Zygnema, Spirogyra* and *Cladophora*. The cells associated with these forms can be large and contribute substantially to the elevated biovolume. These filamentous greens may be stirred up from the shallow bottom, or may originally have been associated with periphyton or metaphyton. *Cladophora* grows in greatest abundance along the shallow margins of nutrient-enriched lakes and on rocks in fast flowing streams and rivers (Wehr et al., 2015). *Spirogyra* or *Mougeotia* contributed to elevated biovolumes at Timber Cove on a couple of dates. *Mougeotia* contributed to an elevated biovolume at the Mid-lake South site on one date, September 12, 2017. In that sample, green algae constituted a large portion (76%) of total biovolume and the primary green alga contributing to biovolume was *Botryococcus braunii*.

A more comprehensive analysis of the nearshore phytoplankton data compiled for the nearshore sampling done since 2013 is recommended to assess for distinct patterns in the phytoplankton communities at the different sites.

a. **b.**

Figure 23. a, b Light micrographs of the cyanobacteria *Dolichospermum spiroides*, observed in a sample collected from the Tahoe Keys nearshore station, 9/12/17. (a) Phase Contrast, 400x and (b) Differential Interference Contrast (DIC), 630x. Scale bar represent 20μm. Images by Lidia Tanaka, UC Davis TERC.

Table 7. Cyanobacteria was found at 5 of 11 nearshore sites during the 9/12/17 sampling and no cyanobacteria were found in the mid-lake samples. Cyanobacteria species, numbers and biovolumes are listed for the 5 sites.

Station	Species	Numbers Units/Liter	Numbers Units/ml	Biovolume mm^3/m^3	Biovolume mm^3/liter
Tahoe Keys Nearshore Sta.	*Dolichospermum spiroides*	15414	15.414	5.54	0.00554
(So. Shore)	*Phormidium sp.*	12116	12.116	0.85	0.00085
	Total	27530	27.53	6.39	0.00639
	% of Overall Sample	11.79%		5.94%	
Timber Cover Nearshore Sta.	*Phormidium sp.*	6310	6.31	0.44	0.00044
(So. Shore)	Total	6310	6.31	0.44	0.00044
	% of Overall Sample	4.47%		0.88%	
Rubicon Nearshore Site	*Dolichospermum spiroides*	20097	20.097	7.22	0.00722
(South west Shore)	*Phormidium sp.*	1827	1.827	0.13	0.00013
	Total	21924	21.924	7.35	0.00735
	% of Overall Sample	11.13%		10.46%	
Tahoe City Nearshore Site	*Dolichospermum spiroides*	3509	3.509	1.26	0.00126
	Phormidium sp.	2644	2.644	0.19	0.00019
	Total	6153	6.153	1.45	0.00145
	% of Overall Sample	2.00%		0.86%	
Kings Beach	*Dolichospermum spiroides*	959	0.959	0.34	0.00034
(North west Shore)	Total	959.02	0.959	0.3486	0.00034
	% of Overall Sample	0.45%		0.39%	

Species Richness

Species richness (number of different species) at a site provides can provide some indication of the trophic state of waters. Heyvaert et al., (2013) provide a general characterization of trophic state based on numbers of species. Levels of number of species less than 20 species, are characterized to be associated with ultra-oligotrophic conditions, levels from 20-50 are characterized as oligotrophic, levels 50-100 mesotrophic, and levels with greater than 100 species associated with eutrophic conditions. Table 8 shows the mean numbers of species for nearshore stations for all samples collected August 2013 to Dec. 2018. The mean levels for number of species Aug. 2013 – Dec. 2018 are within the oligotrophic range. Tahoe City had the greatest mean number of species ± std. dev. for samples (33±7 species), then Tahoe Keys nearshore (31±6 species), followed by Emerald Bay, Kings Beach and Camp Richardson. The lowest number of species per site were measured at the two mid-lake stations (Mid-lake No. and Mid-lake So. which both had 21 species.

Table 8. Mean number of phytoplankton species ± Std. Dev. (S.D.) for phytoplankton samples Aug. 2013 – Dec. 2018.

	2013-2018 Number of Species/ Date Mean ± S.D. (n)
Tahoe City	32.9 ± 7.0 (22)
Tahoe Keys	31.0 ± 5.8 (22)
Emerald Bay	28.3 ± 6.6 (21)
Kings Beach	27.8 ± 4.4 (22)
Camp Richardson	26.6 ± 5.0 (21)
Timber Cove	26.1 ± 5.1 (21)
Glenbrook	26.0 ± 5.3 (22)
Crystal Bay	25.1 ± 4.1 (22)
Sunnyside	25.0 ± 4.1 (22)
Zephyr Cove	23.9 ± 3.8 (22)
Rubicon Bay	23.1 ± 5.6 (21)
Mid-lake South	21.4 ± 4.5 (22)
Mid-lake North	20.6 ± 5.4 (22)

Section III. Periphyton Results

The purpose of the periphyton monitoring task is to assess the levels of nearshore attached algae (periphyton) growing around the lake. As with phytoplankton, nutrient availability plays a large role in promoting periphyton growth. The amount of periphyton biomass can reflect local nutrient loading and also be affected by long-term environmental changes. Periphyton biomass is considered an important indicator, which together with nearshore chlorophyll, phytoplankton and macrophyte metrics provide information on the trophic status of the Lake Tahoe nearshore. Trophic status in turn, along with nearshore clarity, community structure and conditions for human health are considered primary indicators of nearshore condition or health as outlined in the Lake Tahoe nearshore monitoring framework (Heyvaert et al., 2013).

Stations and Methods

Nine routine stations were monitored (Rubicon Pt., Sugar Pine Pt., Pineland, Tahoe City, Dollar Pt., Zephyr Pt., Deadman Pt., Sand Pt and Incline West). These nine sites are located around the lake (Figure 1 presents a map of locations and Table 9 provides coordinates of locations) and represent a range of backshore disturbance levels from relatively undisturbed land (Rubicon Point and Deadman Point) to a developed urban center (Tahoe City).

Table 9. Locations of Routine Periphyton Monitoring Stations

SITE NAME	LOCATION
Rubicon	N38 59.52; W120 05.60
Sugar Pine Point	N39 02.88; W120 06.62
Pineland	N39 08.14; W120 09.10
Tahoe City	N39 10.24; W120 08.42
Dollar Point	N39 11.15; W120 05.52
Zephyr Point	N39 00.10; W119 57.66
Deadman Point	N39 06.38; W11957.68
Sand Point	N39 10.59; W119 55.70
Incline West	N39 14.83; W119 59.75

A detailed description of the sample collection and analysis procedures is given in Hackley et al. (2004). Briefly, the method entails collection while snorkeling of duplicate samples of attached algae from a known area of natural rock substrate at a depth of 0.5m, using a syringe and toothbrush sampler. These samples are transported to the laboratory where the samples are processed and split, with one portion of the sample analyzed for Ash Free Dry Weight (AFDW) and the other portion frozen for later analysis of chlorophyll *a* concentration (both AFDW and chlorophyll *a* are used as measures of algal biomass). We also measure average filament length and percent algal coverage which are used to calculate the Periphyton Biomass Index PBI (which is the average filament length or height of the periphyton (cm) multiplied by the estimate of percent coverage of algae over the rock). The PBI provides a means to rapidly assess the level of periphyton biomass at a site. A subjective ranking of the level of periphyton at a site is also made, where 1 is least offensive appearing (usually natural rock surface with little or no growth) and 5 is the most offensive condition with very heavy growth. Finally, notes are made on which of three predominant algae types (stalked diatoms, filamentous green algae, or cyanobacteria (blue-green algae) are likely present based on observations underwater, samples from many sites were also examined under the microscope to determine predominant algal types present.

Results

Monitoring at Routine Sites

In this report we summarize the data collected during the three-year period October, 2016 to June, 2019. Nine routine sites were sampled at least 5 per year (three of the samplings were done during the spring when periphyton biomass tends to peak, additional samplings were done in the fall or early winter and in the late spring or summer). Table 10 presents the results for biomass (chlorophyll *a* and Ash Free Dry Weight (AFDW)) and field observations (visual score, average filament length, percent algal coverage, biomass index and basic algal types) at the nine routine periphyton sites during the period. The results for periphyton chlorophyll *a* biomass are also presented graphically in Figures 24 (a-i) together with earlier data collected since 2000. Figure 25 presents a graph of lake surface elevation and 0.5m sampling elevation Jan. 2000-June 23, 2019.

Patterns of Periphyton Biomass 2016-2019

Periphyton biomass at 0.5m was impacted substantially by changes in lake level during 2016-2017. In the fall of 2016, the lake level was very low, below the natural rim of 6223.0 ft. At many sites the heaviest biomass of the year was measured in October, 2016 in part due to the biomass contributed by cyanobacterial periphyton species. These algae tend to be a slow-growing, stable community which often contribute to the periphyton biomass slightly deeper than 0.5m when the lake level is at average or high levels. However, when the lake level is low as it was in Oct. 2016, these algae may be located at 0.5m or even shallower. Beginning in mid-October multiple very large wet storms impacted the lake (including in notable storms in mid-Oct., mid-Dec., early January and early Feb.). A substantial rise in lake level of over 4 feet occurred during the period from Dec. 2016 to March, 2017, with an additional rise of 2 feet from March to early summer associated with a prolonged spring runoff. Due to the large rises in lake level in 2017, rocks at 0.5m during winter and spring sampling were relatively recently submerged. Periphyton communities had short times to establish on the rocks at 0.5m prior to sampling and this contributed to low measured biomasses at many sites around the lake at that depth. Rising lake levels may also have had an additional impact periphyton in areas where ground water flows may impact the periphyton. In a 2015-2016 study (Naranjo et al., 2019) done at the Pineland site, an increase in lake stage (maximum rise low to high of 0.81m) was found to temporarily reduce the groundwater discharge rates in the nearshore. The lake level rise in 2016-2017 in contrast was much greater (1.98m low to high), it's possible this large rise also temporarily reduced groundwater inputs at Pineland and other sites with groundwater impact in the nearshore. Pineland and Tahoe City showed only small peaks in biomass in late in March at 0.5m, chlorophyll *a* was 31.5 mg/m^2 at Pineland and 26.2 mg/m^2 at Tahoe City. Biomass at all other sites was very low in spring 2017. At many routine sites, much heavier periphyton biomass was observed at 1 or 1.5m.

At many routine sites, much heavier biomass was observed at 1 or 1.5m during the 2017 winter and spring sampling. On May 22, 2017 we collected samples from 1.0 and 1.5m at Pineland using SCUBA, in addition to the routine 0.5m samples. These samples showed a gradient in biomass with depth. Levels of chlorophyll *a* were 3.01 mg/m^2 at 0.5m, 12.52 mg/m^2 at 1m and 104.79 mg/m^2 at 1.5m.

During January to July 2018 moderate to high spring peaks in periphyton biomass were observed at several west shore sites, while biomass at sites along the east shore remained low. By April, moderate to high spring peaks were observed at three west shore sites: Dollar Pt. (39.14 mg/m^2), Rubicon Pt. (73.41 mg/m^2) and Tahoe City (89.48 mg/m^2). The moderate to heavy periphyton observed along the west shore in 2018 was different than the light biomass observed in 2017 at 0.5m around the lake. This difference may be associated with the sustained high lake levels in 2018 (see Figure 25). Rock substrate observed at 0.5m in spring had remained continually submerged during the year, allowing development of the periphyton community. At the Pineland 0.5m site, the peak measured biomass occurred in January (33.42 mg/m^2). At the other routine periphyton monitoring sites, biomass remained relatively low through July 2018.

In spring 2019 relatively heavy growth of periphyton was observed at several of the routine monitoring sites. Highest levels of periphyton growth at 0.5m were measured in March or April at Rubicon Pt. (179.37 mg/m^2), Pineland (156.77 mg/m^2) and Tahoe City (142.85 mg/m^2). Relatively high levels were also observed at Dollar Pt. (71.28 mg/m^2), Incline West (66.36 mg/m^2) and Zephyr Pt. (39.52 mg/m^2). At Sand Pt. moderately high biomass developed later in June (33.20 mg/m^2). Deadman Pt. and Sugar Pine Pt. periphyton biomasses were slightly elevated in March (20.38 mg/m^2) and (18.37 mg/m^2) respectively. The periphyton biomass in 2019 was the highest in several years at several of the routine sites (see Figs. 24.a – 24.i).

At Pineland, particularly heavy biomass was observed at 1 and 2m in April 2019. On April 23, 2019 we collected samples from 1.0 and 2m using SCUBA in addition to sampling the 0.5m routine site. Chlorophyll *a* at 0.5m was 23.44 mg/m^2 (less than peak level of 156.77 mg/m^2 observed in March), chlorophyll *a* at 1m was 206.22 mg/m^2 and at 2m was 230.72 mg/m^2. The growth was very thick with average filament lengths of 4.0 and 4.5 cm respectively at 1 and 2m, consisting of a mix of stalked diatoms and the filamentous green algae, *Zygnema*.

Several factors may have contributed to the elevated periphyton biomasses at several sites in 2019. The lake level remained relatively high for the third year in a row. As a consequence periphyton biomass on rocks at 0.5m had a prolonged period to develop where other conditions were favorable for growth. Frequent snow storms, with some lower elevation rain events likely resulted in nutrient contributions to the lake from surface and groundwater inputs along the shoreline. Nutrients were also likely contributed to lake surface waters from lake mixing and/or upwelling in 2019 which may have contributed to the periphyton growth at several sites. Sustained high lake levels may also have impacted ground water flows which may have impacted biomasses (further evaluation of effects of sustained high lake level on groundwater inputs may provide insight as to the role groundwater inputs played in 2019).

Table 10. Summary of eulittoral periphyton chlorophyll a (Chlor.a), Ash Free Dry Weight (AFDW), visual score from above and below water, average filament length, percent algal coverage, and predominant algal types for routine periphyton monitoring sites during October, 2016- June, 2019. Note for chlorophyll *a* and AFDW, n=2 unless otherwise indicated (i.e. two replicate samples were taken and analyzed). Visual score is a subjective ranking of the aesthetic appearance of algal growth ("above" viewed above water; "below" viewed underwater) where 1 is the least offensive and 5 is the most offensive. Biomass Index is Filament Length (cm) X % Algal Cover. Also, "NA" = not available or not collected; "NES" = not enough sample for analysis; "Var." = variable amount of cover. Sampling depth and corresponding sampling elevation are also indicated. For algae types – SD=stalked diatoms; CY= Cyanobacteria; FG= filamentous greens; D= diatom mix; S= *Synedra*; "-f" indicates algae type best estimate based on field observation; "-m" indicates predominant algae types checked under microscope.

Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
Rubicon Pt.	10/20/16	0.5	6221.12	16.55	1.14	22.86	2.78	2	3	0.5	95%	0.48	CY,FG -f
Rubicon Pt.	4/4/17	0.5	6225.60	2.63	0.52	NA	NA	1	1	0.2	20%	0.04	SD,D-m
Rubicon Pt.	5/22/17	0.5	6226.50	4.21	1.59 (n=3)	3.35	0.73	2	4	1.0-4.0	20%	0.50	SD,S-m
Rubicon Pt.	5/22/17	1	6224.86	NA	NA	NA	NA	NA	5	3.0-4.0	80%	2.80	SD-f
Rubicon Pt.	6/14/17	0.5	6226.98	2.93	0.56	3.00	0.57	1.5	2.5	0.4	70%	0.28	SD-m
Rubicon Pt.	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	NA	1.0-2.0	40%	0.60	SD-f
Rubicon Pt.	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	NA	0.5	30%	0.15	SD-f
Rubicon Pt.	7/20/17	0.5	6227.28	2.01	0.60	NA	NA	2	2	0.2	60%	0.12	D,FG,CY-m
Rubicon Pt.	7/20/17	1.0	6225.64	NA	NA	NA	NA	NA	NA	1.0	40%	0.40	FG-f
Rubicon Pt.	1/2/18	0.5	6226.10	3.62	0.55	NA	NA	2	2	<0.1	30%	<0.03	D,SD,CY-m
Rubicon Pt.	2/6/18	0.5	6226.32	3.78	0.13	NA	NA	2	1	<0.1	NA	NA	D,CY-m
Rubicon Pt.	3/29/18	0.5	6226.94	17.63	6.49	9.30	4.43	3	3	1.6	98%	1.57	SD,CY-m
Rubicon Pt.	4/25/18	0.5	6227.02	73.41	7.89 (n=3)	27.65	2.72 (n=3)	4	4	2.8	100%	2.80	SD-m
Rubicon Pt.	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	1.5	80%	1.20	FG,CY-f
Rubicon Pt.	7/25/18	0.5	6227.01	7.69	2.44	4.42	1.78	1.5	2	0.3	60%	0.18	D,CY,FG-m
Rubicon Pt.	1/11/19	0.5	6225.09	7.94	1.06	5.21	0.81	2	2	0.1	90%	0.09	CY,FG-m
Rubicon Pt.	3/19/19	0.5	6226.28	63.99	30.77 (n=3)	22.85	10.84 (n=3)	4	4	2.2	100%	2.2	SD,CY,FG-m
Rubicon Pt.	4/26/19	0.5	6226.36	179.37	24.74 (n=2)	107.97	10.33 (n=2)	4	4.5	4.0	100%	4.0	SD,CY,FG-m
Rubicon Pt.	6/18/19	0.5	6227.31	4.38	2.74	4.58	1.68	2	3	0.2	60%	0.12	SD,D,FG,CYm
Sugar Pine Pt.	10/20/16	0.5	6221.12	23.44	5.93	20.65	4.47	NA	2	0.2	70%	0.14	CY-f
Sugar Pine Pt.	4/4/17	0.5	6225.60	6.44	(n=1)	3.89	(n=1)	NA	3	0.7	70%	0.49	SD -m
Sugar Pine Pt.	5/22/17	0.5	6226.50	1.93	0.38	NA	NA	NA	2	0.5	30%	0.15	SD$_2$-m
Sugar Pine Pt.	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	NA	1.5	60%	0.90	SD-f
Sugar Pine Pt.	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	NA	3.0	80%	2.40	SD -m
Sugar Pine Pt.	6/14/17	0.5	6226.98	2.97	0.37	2.70	0.76	NA	2	0.1	80%	0.08	SD -m

Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
Sugar Pine Pt.	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	3	0.8	80%	0.64	SD-f
Sugar Pine Pt.	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	4	2.5	80%	2.00	SD-f
Sugar Pine Pt.	7/20/17	0.5	6227.28	NES	NES	1.11	(n=1)	NA	2	<0.1	60%	<0.06	SD -m
Sugar Pine Pt.	7/20/17	1.0	6225.64	NA	NA	NA	NA	NA	1	0	0%	0.00	
Sugar Pine Pt.	1/2/18	0.5	6226.10	NES	NES	NES	NES	NA	1	0	0%	0.00	
Sugar Pine Pt.	2/6/18	0.5	6226.32	NES	NES	NES	NES	1	1	0	0%	0.00	
Sugar Pine Pt.	3/29/18	0.5	6226.94	5.15	0.33	2.54	0.24	NA	2.5	0.3	90%	0.27	SD-m
Sugar Pine Pt.	4/25/18	0.5	6227.02	10.15	0.46	5.38	0.28	2	2	1.0	90%	0.90	SD-m
Sugar Pine Pt.	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	1.0	80%	0.80	FG,SD-f
Sugar Pine Pt.	7/25/18	0.5	6227.01	NES	NES	NES	NES	1	1	<0.01	10%	0.01	SD,D-m
Sugar Pine Pt.	1/11/19	0.5	6225.09	NES	NES	2.82	1.70	NA	2	0.1	20%	0.02	CY-m
Sugar Pine Pt.	3/19/19	0.5	6226.28	18.37	0.94	7.26	0.87	3.5	3	0.4	70%	0.28	SD,CY,S-m
Sugar Pine Pt.	4/26/19	0.5	6226.36	9.71	0.30	7.02	0.49	3.5	3.5	0.7	80%	0.56	FG,CY,SD-m
Sugar Pine Pt.	6/18/19	0.5	6227.31	2.99	0.64	2.58	0.76	2	2	0.2	50%	0.10	SD,CY,FG-m
Pineland	10/20/16	0.5	6221.12	15.05	0.32	18.97	2.73	2	2	0.6	60%	0.36	SD,CY-f
Pineland	2/13/17	0.5e	6224.55e	NA	NA	NA	NA	NA	NA	NA	NA	NA	SD-f
Pineland	2/13/17	1.1e	6222.68e	NA	NA	NA	NA	NA	NA	NA	NA	NA	SD-f
Pineland- Rock A	2/13/17	0.2e	6225.53e	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Pineland	3/29/17	0.5	6225.52	NA	NA	NA	NA	3	3	0.5	50%	0.25	SD- f
Pineland- Rock A	3/29/17	0.5	6225.52	31.46	1.45 (n=3)	16.52	2.38 (n=3)	3.5	3.5	0.8	90%	0.72	SD,S-m
Pineland	3/29/17	1.03	6223.78	NA	NA	NA	NA	5	5	3.0-4.0	100%	3.5	SD-f
Pineland	4/4/17	0.5	6225.60	NA	NA	NA	NA	NA	2	0.1	60%	0.06	SD,S-m
Pineland- Rock A	4/4/17	0.55	6225.44	8.54	0.32 (n=3)	6.67	0.66 (n=3)	NA	3	0.4	80%	0.32	SD,S-m
Pineland	5/22/17	0.5	6226.50	3.01	1.12	4.27	1.29	1.5	1.5	0.1	40%	0.04	SD,S-m
Pineland- Rock A	5/22/17	0.8	6225.52	20.21	0.25	22.39	1.98	NA	NA	1.2	90%	1.08	SD,S-m
Pineland	5/22/17	1.0	6224.86	12.52	4.42 (n=3)	14.85	6.49 (n=3)	2	4	1.5	60%	0.90	SD,-m
Pineland	5/22/17	1.5	6223.22	104.79	9.02 (n=3)	98.47	30.87 (n=3)	5	5	4.5	100%	4.50	SD,S-m
Pineland	6/14/17	0.5	6226.98	1.01	0.01	NES	NES	2	2	0.1	70%	0.07	SD-m
Pineland- Rock A	6/14/17	0.96	6225.47	NA	NA	NA	NA	NA	3.5	1.5	80%	1.20	
Pineland	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	2.5	0.6	22%	0.13	SD-f
Pineland	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	5	4.5	95%	4.28	SD-f
Pineland	7/20/17	0.5	6227.28	2.26	0.85	NES	NES	2	1.5	<0.1	15%	<0.02	CY,FG,d-m
Pineland	7/20/17	1.0	6225.64	NA	NA	NA	NA	NA	NA	<0.1	10%	<0.01	SD-f

Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m²)	Std Dev (mg/m²)	AFDW (g/m²)	Std Dev (mg/m²)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
Pineland	7/20/17	1.5	6224.00	NA	NA	NA	NA	NA	NA	<0.1	10%	<0.01	SD-f
Pineland	1/2/18	0.5	6226.10	33.42	2.02	13.76	0.94	2	3	0.4	60%	0.24	D,SD,CY,FGm
Pineland	2/6/18	0.5	6226.32	5.39	1.13	1.75	0.72	3	2.5	0.1	70%	0.07	SD,FG,CY-m
Pineland	3/29/18	0.5	6226.94	24.10	5.32 (n=3)	13.64	3.96 (n=3)	3	3	0.7	61%	0.43	SD-m
Pineland	4/26/18	0.5	6227.03	20.55	5.45 (n=3)	20.40	5.67 (n=3)	3.5	3.5	1.0	69%	0.69	SD,CY,FG-m
Pineland- Rock A	4/26/18	0.8	6226.05	NA	NA	NA	NA	NA	NA	2.5	100%	2.50	
Pineland	4/26/18	1.0	6225.39	NA	NA	NA	NA	NA	NA	3.5	100%	3.50	SD,FG-f
Pineland	4/26/18	1.5	6223.75	NA	NA	NA	NA	NA	NA	2.5	65%	1.63	SD,FG-f
Pineland	7/25/18	0.5	6227.01	11.07	0.16	11.69	4.33	2	2.5	0.1	50%	0.05	D,FG-m
Pineland	1/11/19	0.5	6225.09	62.31	19.34	23.04	1.65	2	2	0.2	70%	0.14	CY,D-m
Pineland	3/19/19	0.5	6226.28	156.77	96.23 (n=3)	65.04	26.24 (n=3)	3	3	1.0	59%	0.59	S,FG,D-m
Pineland	3/19/19	1.0	6224.64	NA	NA	NA	NA	NA	NA	2.5	100%	2.5	SD,FG-f
Pineland	4/23/19	0.5	6226.30	23.44	7.87 (n=3)	20.73	8.77 (n=3)	3	3	0.7	54%	0.38	S,SD,D,FG-m
Pineland	4/23/19	1.0	6224.66	206.22	47.71 (n=3)	138.13	39.20 (n=3)	NA	NA	4.0	90%	3.60	SD,FG-m
Pineland	4/23/19	2.0	6221.38	230.72	41.73 (n=4)	169.20	28.72 (n=4)	NA	NA	4.5	90%	4.05	FG,SD,S-m
Pineland	4/23/19	8.0	6201.69	74.11	45.27 (n=3)	63.97	32.49 (n=3)	NA	NA	0.2	100%	0.20	CY,D,FG-m
Pineland	6/17/19	0.5	6227.30	2.15	0.64 (n=3)	3.57	0.84 (n=3)	2	1.5	<0.1	60%	<0.06	FG,D-m
Tahoe City	10/20/16	0.5	6221.12	3.52	1.82	4.69	1.16	2	2	0.1	50%	0.05	SD,CY-f
Tahoe City	3/29/17	0.5	6225.52	26.24	2.02 (n=3)	30.20	3.65 (n=3)	3	3	1.0	80%	0.80	SD,S-m
Tahoe City	5/22/17	0.5	6226.50	13.60	2.93 (n=3)	26.34	0.39 (n=3)	NA	2	0.6	70%	0.42	SD-m
Tahoe City	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	NA	1.0-1.5	50%	0.63	SD-f
Tahoe City	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	NA	1.0-1.5	20%	0.25	SD-f
Tahoe City	6/14/17	0.5	6226.98	7.96	4.05	11.47	7.02	3	2.5	0.30	80%	0.24	SD,D-m
Tahoe City	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	2	0.60	40%	0.24	SD-f
Tahoe City	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	NA	1.0	20%	0.20	SD-f
Tahoe City	7/20/17	0.5	6227.28	3.27	0.12	NA	NA	2	2	0.1	50%	0.05	FG,D-m
Tahoe City	7/20/17	1.0	6225.64	NA	NA	NA	NA	NA	NA	0.1	40%	0.04	SD-f
Tahoe City	1/2/18	0.5	6226.10	23.64	4.33	20.98	0.82	2	3	0.4	80%	0.32	SD-m

Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m²)	Std Dev (mg/m²)	AFDW (g/m²)	Std Dev (mg/m²)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
Tahoe City	2/6/18	0.5	6226.32	57.92	1.47 (n=3)	43.09	5.06 (n=3)	3	3	0.8	80%	0.64	SD,D-m
Tahoe City	3/29/18	0.5	6226.94	62.54	8.94 (n=3)	45.71	6.57 (n=3)	3	3.5	1.2	90%	1.08	SD,D-m
Tahoe City	4/26/18	0.5	6227.03	89.48	38.90 (n=3)	61.63	22.12 (n=3)	4	4	3.0	95%	2.85	SD-m
Tahoe City	4/26/18	1.5	6223.75	NA	NA	NA	NA	NA	NA	2.0	40%	0.80	SD-f
Tahoe City	7/25/18	0.5	6227.01	16.92	4.00	9.97	6.02	2	2	0.1	95%	0.10	D,FG-m
Tahoe City	1/14/19	0.5	6225.09	17.39	5.44	8.09	0.23	NA	2.5	0.10	70%	0.07	D,SD,FG,CYm
Tahoe City	3/19/19	0.5	6226.28	83.91	16.38 (n=3)	48.75	2.06 (n=3)	4	4	1.7	95%	1.62	SD,S,FG-m
Tahoe City	4/22/19	0.5	6226.30	142.85	54.69 (n=3)	103.61	13.06 (n=3)	4	4	3.5	95%	3.33	SD-m
Tahoe City	6/18/19	0.5	6227.31	3.89	(n=1)	2.66	0.30	2	2	0.2	70%	0.14	SD-m
Dollar Pt.	10/20/16	0.5	6221.12	15.94	5.13	12.11	4.27	3	2	0.1	60%	0.06	SD,CY-f
Dollar Pt.	4/4/17	0.5	6225.60	10.74	1.58 (n=3)	13.42	1.39 (n=3)	3	3.5	0.8	80%	0.64	SD -m
Dollar Pt.	5/22/17	0.5	6226.50	7.74	0.23	22.03	0.32	2	3	0.8	85%	0.68	SD,S,D-m
Dollar Pt.	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	NA	1.0	70%	0.70	SD-f
Dollar Pt.	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	NA	1.0	30%	0.30	SD -m
Dollar Pt.	6/14/17	0.5	6226.98	3.77	0.82	4.29	0.15	NA	2	0.3	90%	0.27	SD,D-m
Dollar Pt.	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	2	0.3	80%	0.24	SD-f
Dollar Pt.	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	2	0.5	20%	0.10	SD-f
Dollar Pt.	7/20/17	0.5	6227.28	4.28	0.37	NES	NES	NA	2	0.1	80%	0.08	FG,SD-m
Dollar Pt.	7/20/17	1.0	6225.64	NA	NA	NA	NA	NA	1.5	0.4	3%	0.01	SD-f
Dollar Pt.	1/2/18	0.5	6226.10	20.44	3.21	7.29	0.44	2	2	0.3	40%	0.12	CY,D-m
Dollar Pt.	2/6/18	0.5	6226.32	16.93	0.84	7.87	0.99	2	2.5	0.6	33%	0.20	CY,D-m
Dollar Pt.	3/29/18	0.5	6226.94	17.23	1.91	9.01	0.23	2.5	2.5	0.2	90%	0.18	SD,CY,D-m
Dollar Pt.	4/26/18	0.5	6227.03	39.14	9.40 (n=3)	24.45	5.04 (n=3)	2	3	1.5	80%	1.20	SD,D-m
Dollar Pt.	7/25/18	0.5	6227.01	3.94	0.58	NES	NES	1.5	2	<0.1	80%	0.08	CY-m
	1/11/19	0.5	6225.09	26.73	15.15	13.79	(n=1)	2	2	<0.1	80%	<0.08	D,CY-m
Dollar Pt.	3/19/19	0.5	6226.28	36.06	11.62 (n=3)	24.90	2.49 (n=3)	3.5	3.5	0.6	95%	0.57	SD,S,CY-m
Dollar Pt.	4/18/19	0.5	6226.28	71.28	17.97 (n=3)	58.64	13.40 (n=3)	3.5	4.0	1.8	98%	1.76	SD-m
Dollar Pt.	4/18/19	1.5	6223.00	NA	NA	NA	NA	NA	NA	1.5	50%	0.75	SD-m
Dollar Pt.	6/17/19	0.5	6227.30	2.46	1.39 (n=3)	3.69	0.24	2	2	<0.1	80%	<0.08	

Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
Incline West	10/20/16	0.5	6221.12	31.61	9.00	49.99	14.08	3	3	0.3	80%	0.24	CY-f
Incline West	4/4/17	0.5	6225.60	16.82	4.07 (n=3)	10.72	2.69 (n=3)	4	4	1.2	100%	1.20	SD-m
Incline West	5/22/17	0.5	6226.50	4.18	0.71	7.88	1.09	3	3	0.6	70%	0.42	SD,S,FG-m
Incline West	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	4	1.5	70%	1.05	SD-f
Incline West	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	NA	3.0	70%	2.10	SD,FG-f
Incline West	6/13/17	0.5	6226.97	2.53	0.45	4.08	1.16	1.5	2	0.2	70%	0.14	SD-m
Incline West	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	3	0.7	50%	0.35	
Incline West	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	NA	3.0/1.0	25%/75%	1.50	SD-f
Incline West	7/20/17	0.5	6227.28	4.74	1.60	NES	NES	1	2	0.3	30%	0.09	D,FG-m
Incline West	7/20/17	1.0	6225.64	NA	NA	NA	NA	NA	NA	0.3	30%	0.09	
Incline West	1/2/18	0.5	6226.10	3.96	0.90	2.26	0.90	2	2	<0.1	40%	<0.04	CY,D,SD-m
Incline West	2/6/18	0.5	6226.32	1.62	0.03	NES	NES	1	2	0.2	60%	0.12	CY,D-m
Incline West	3/29/18	0.5	6226.94	12.37	1.99	6.94	1.09	2	3	0.4	90%	0.36	CY,SD,D-m
Incline West	5/10/18	0.5	6227.10	15.69	2.41	12.50	1.38	2	3	1.0	80%	0.80	SD,CY-m
Incline West	7/25/18	0.5	6227.01	13.32	3.58	7.48	1.13	2	2	0.2	50%	0.10	D,FG,CY-m
Incline West	1/11/19	0.5	6225.09	18.12	4.57	11.14	3.00	2	2	0.1	60%	0.06	CY,D-m
Incline West	3/19/19	0.5	6226.28	44.38	2.36	26.96	2.13	3	3	0.5	90%	0.45	SD,CY-m
Incline West	4/29/19	0.5	6226.43	66.36	8.78 (n=3)	41.94	9.89 (n=3)	4	4	2.5	100%	2.50	SD,S-m
Incline West	6/18/19	0.5	6227.31	10.79	1.60 (n=3)	10.88	1.97 (n=3)	3	3	1.2	75%	0.90	SD,FG,D,CYm
Sand Pt.	10/20/16	0.5	6221.12	23.65	5.03	49.99	14.08	3	3	0.3	80%	0.24	CY-f
Sand Pt.	4/4/17	0.5	6225.60	5.01	1.46	3.34	0.99	3.5	3.5	0.9	95%	0.86	SD-m
Sand Pt.	5/22/17	0.5	6226.50	7.15	3.52	8.98	5.14	3	3.5	1.0	95%	0.95	SD-m
Sand Pt.	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	4	3.0-4.0	30%	1.05	SD-f
Sand Pt.	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	3	NA	NA	NA	SD-f
Sand Pt.	6/13/17	0.5	6226.97	2.56	0.43	NES	NES	NA	1.5	<0.1	50%	<0.05	SD-m
Sand Pt.	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	NA	2.0	30%	0.60	
Sand Pt.	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	NA	2.0	0-70%	0.70	
Sand Pt.	7/20/17	0.5	6227.28	2.58	0.02	3.40	0.05	1	2	0.3	40%	0.12	SD,FG-m
Sand Pt.	7/20/17	1.0	6225.64	NA	NA	NA	NA	NA	NA	3.0	80%	2.40	SD-f
Sand Pt.	1/2/18	0.5	6226.10	3.32	0.47	4.13	0.75	1.5	1.5	<0.1	60%	<0.06	CY,D,SD,FGm
Sand Pt.	2/6/18	0.5	6226.32	1.81	0.11	NES	NES	1	2	0.1	60%	0.06	CY,D,SD,FGm
Sand Pt.	3/29/18	0.5	6226.94	4.16	0.93	3.79	0.15	2	2	0.3	50%	0.15	CY,D-m
Sand Pt.	5/10/18	0.5	6227.10	3.36	0.93	5.45	4.34	2	2.5	0.3	80%	0.24	SD,CY-m
Sand Pt.	5/10/18	1.5	6223.82	NA	NA	NA	NA	NA	NA	1.0	50%	0.50	FG,SD-f

Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
Sand Pt.	7/25/18	Near Surf	6228.65	17.70	2.11	19.96	1.25	4	NA	2.5	NA	NA	SD-m
Sand Pt.	7/25/18	0.5	6227.01	6.35	0.08	4.61	0.87	NA	2	0.3	40%	0.12	D,CY-m
Sand Pt.	1/11/19	0.5	6225.09	4.96	0.43	7.42	0.71	2	2.5	0.10	50%	0.05	CY-m
Sand Pt.	3/19/19	0.5	6226.28	20.72	2.15	9.11	0.89	2.5	3	0.2	90%	0.18	SD,D,CY-m
Sand Pt.	4/29/19	0.5	6226.43	6.48	0.41	6.16	0.31	3	3	0.4	70%	0.28	CY,D,SD,FGm
Sand Pt.	6/18/19	0.5	6227.31	33.20	11.14 (n=3)	19.15	5.35 (n=3)	3	3	1.4	75%	1.05	SD,CY,FG-m
Deadman Pt.	10/20/16	0.5	6221.12	49.52	18.38	80.58	32.23	3	3	0.3	95%	0.29	CY-f
Deadman Pt.	4/4/17	0.5	6225.60	1.72	0.18	NES	NES	2	3	0.3	95%	0.29	SD-m
Deadman Pt.	5/22/17	0.5	6226.50	4.62	0.33	6.37	4.30	2	2.5	0.3	70%	0.21	SD,CY-m
Deadman Pt.	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	2	NA	NA	NA	
Deadman Pt.	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	2	NA	NA	NA	
Deadman Pt.	6/13/17	0.5	6226.97	0	0	0	0	NA	0	0	0	0	
Deadman Pt.	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	NA	0.3	50%	0.15	SD-f
Deadman Pt.	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	NA	1.0	30%	0.30	
Deadman Pt.	7/20/17	0.5	6227.28	2.20	0.27	NES	NES	2	3	0.4	30%	0.12	SD,CY-m
Deadman Pt.	7/20/17	1.0	6225.64	NA	NA	NA	NA	NA	NA	1.5	80%	1.20	FG-f
Deadman Pt.	1/2/18	0.5	6226.10	3.81	2.36	NES	NES	1.5	1.5	<0.1	80%	<0.08	SD,CY,FG-m
Deadman Pt.	2/6/18	0.5	6226.32	4.33	1.80	8.12	(n=1)	1	1	<0.1	50%	<0.05	CY,D-m
Deadman Pt.	3/29/18	0.5	6226.94	6.63	1.10	8.43	1.69	2	2	0.1	80%	0.08	CY,D-m
Deadman Pt.	5/10/18	0.5	6227.10	2.98	0.76	NES	NES	1.5	2	0.1	50%	0.05	SD,CY-m
Deadman Pt.	7/25/18	0.5	6227.01	10.21	1.35	11.89	1.17	NA	NA	1.0	40%	0.40	SD,FG,CY-m
Deadman Pt.	1/11/19	0.5	6225.09	8.53	0.20	9.31	0.58	3	2	0.10	70%	0.07	CY,D-m
Deadman Pt.	3/19/19	0.5	6226.28	20.38	9.86	12.69	3.40	2	2	0.2	80%	0.16	SD,FG,CY-m
Deadman Pt.	5/8/19	0.5	6226.56	18.25	3.84	18.57	4.43	3.5	3.5	0.6	70%	0.42	FG,CY, -m
Deadman Pt.	5/8/19	1.0	6224.92	NA	NA	NA	NA	NA	NA	0.6/0.1	30%/40%	0.22	FG,CY-f
Deadman Pt.	6/18/19	0.5	6227.13	NES	NES	2.94	(n=1)	3	2	0.0	0%	0.00	CY,SD-m
Zephyr Pt.	10/20/16	0.5	6221.12	10.95	0.62	11.82	2.08	2	2	0.2	95%	0.19	SD,CY-f
Zephyr Pt.	4/4/17	0.5	6225.60	2.99	0.86	2.82	(n=1)	2	2	0.5	40%	0.20	SD -m
Zephyr Pt.	5/22/17	0.5	6226.50	2.49	0.32	3.27	0.23	2	2	0.1	100%	0.10	SD,D-m
Zephyr Pt.	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	3	0.75	30%	0.23	SD-f
Zephyr Pt.	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	NA	3.5	1%	0.04	SD-f
Zephyr Pt.	6/14/17	0.5	6226.98	NES	NES	0.90	0.21	NA	1.5	<0.1	70%	<0.07	SD,S-m
Zephyr Pt.	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	NA	<0.1	50%	<0.05	
Zephyr Pt.	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	NA	<0.1	50%	<0.05	
Zephyr Pt.	7/20/17	0.5	6227.28	8.78	3.99	5.83	0.85	2	3	0.40	30%	0.12	FG-m

Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
Zephyr Pt.	1/2/18	0.5	6226.10	6.42	0.83	3.95	0.81	NA	NA	<0.1	80%	<0.08	D,CY-m
Zephyr Pt.	2/6/18	0.5	6226.32	9.06	2.06	3.96	0.13	2	2	0.2	40%	0.08	FG,D,CY-m
Zephyr Pt.	3/29/18	0.5	6226.94	9.55	2.28	5.04	1.65	3	2	0.2	100%	0.20	SD,D,CY-m
Zephyr Pt.	5/15/18	0.5	6227.17	8.24	0.50	8.24	0.73	2	2	0.3	90%	0.27	CY,SD,FG-m
Zephyr Pt.	7/25/18	0.5	6227.01	7.63	4.59	4.98	3.24	1	2	0.3	60%	0.18	D,CY
Zephyr Pt.	1/11/19	0.5	6225.09	15.73	2.88	9.47	1.84	2	2	0.1	90%	0.09	CY-m
Zephyr Pt.	3/19/19	0.5	6226.28	39.52	20.17 (n=3)	22.85	11.01 (n=3)	2	2	0.2	80%	0.16	SD,CY,FG-m
Zephyr Pt.	4/26/19	0.5	6226.36	13.51	1.60 (n=3)	10.14	1.94 (n=3)	1	2	0.3	70%	0.21	CY,SD-m
Zephyr Pt.	6/18/19	0.5	6227.31	11.10	3.36	8.95	4.15	2.5	2.5	0.2	70%	0.14	CY,SD,D-m

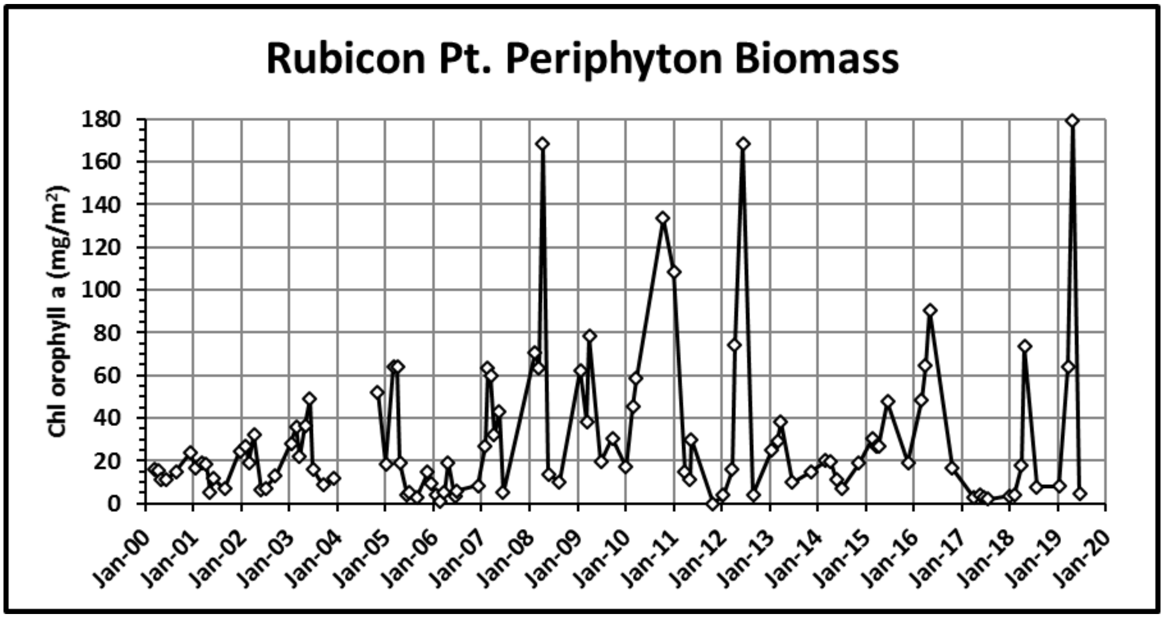


Figure 24.a. Rubicon Pt. periphyton biomass (chlorophyll *a*) 2000-2019.

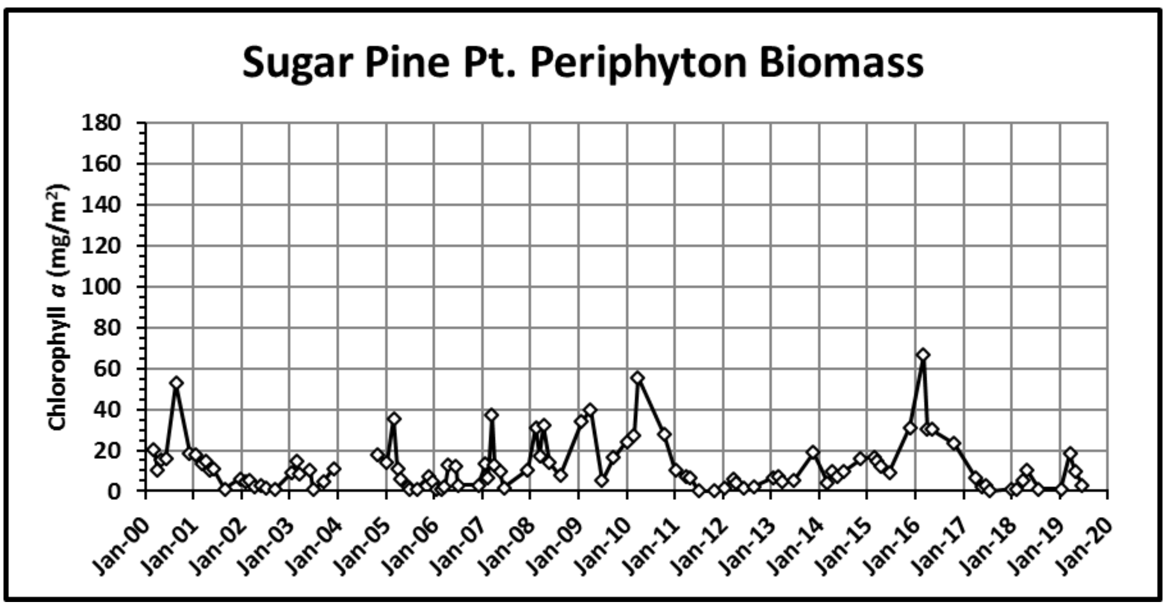


Figure 24.b. Sugar Pine Pt. periphyton biomass (chlorophyll *a*) 2000-2019.

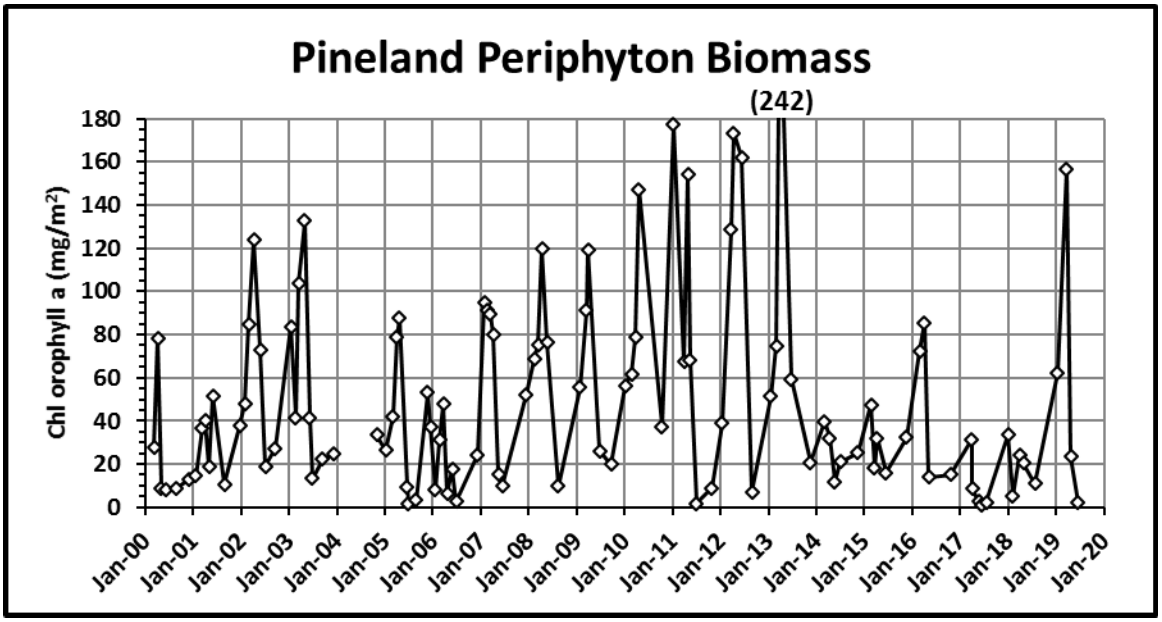


Figure 24.c. Pineland periphyton biomass (chlorophyll *a*) 2000-2019.

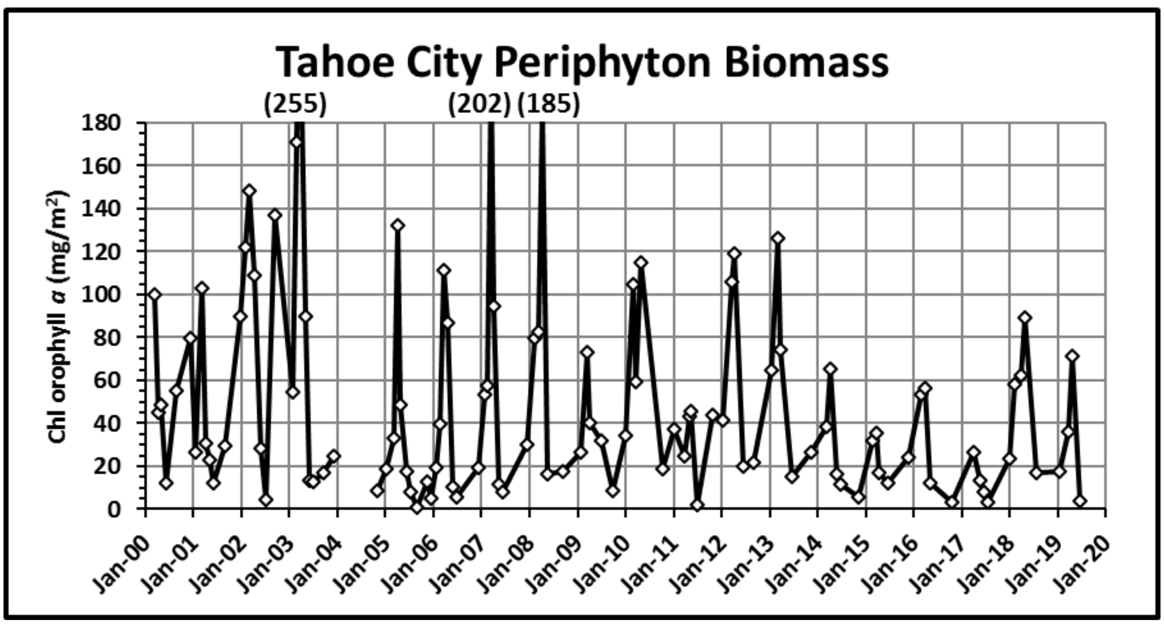


Figure 24.d. Tahoe City periphyton biomass (chlorophyll *a*) 2000-2019.

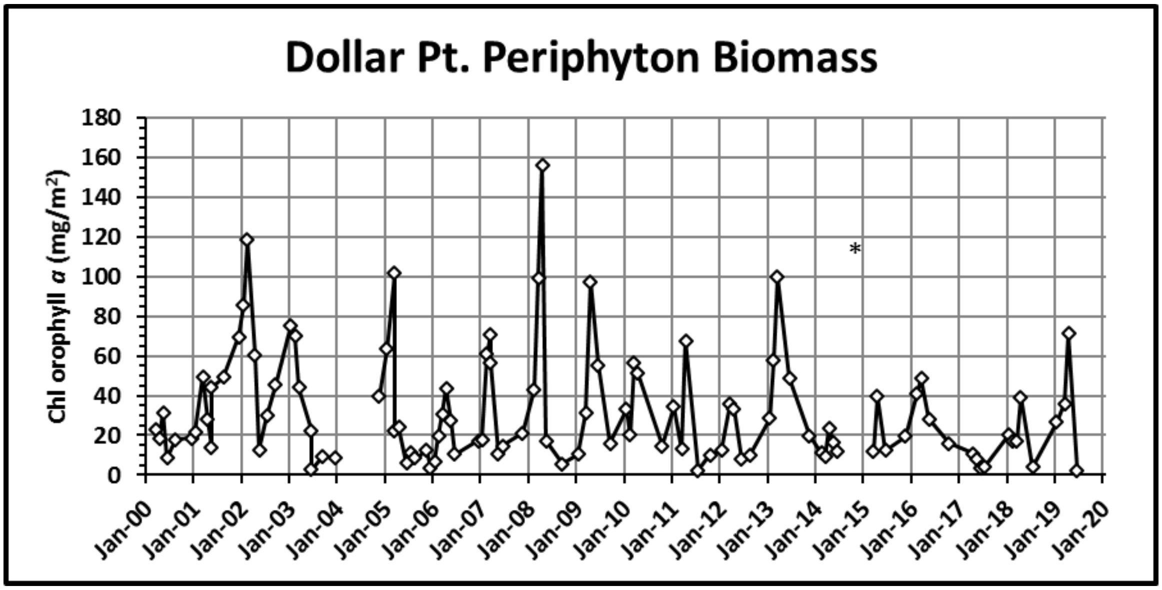


Figure 24.e. Dollar Pt. periphyton biomass (chlorophyll *a*) 2000-2019. *Note- the chlorophyll data for 11/11/14 was considered anomalous and not included in the long-term data.

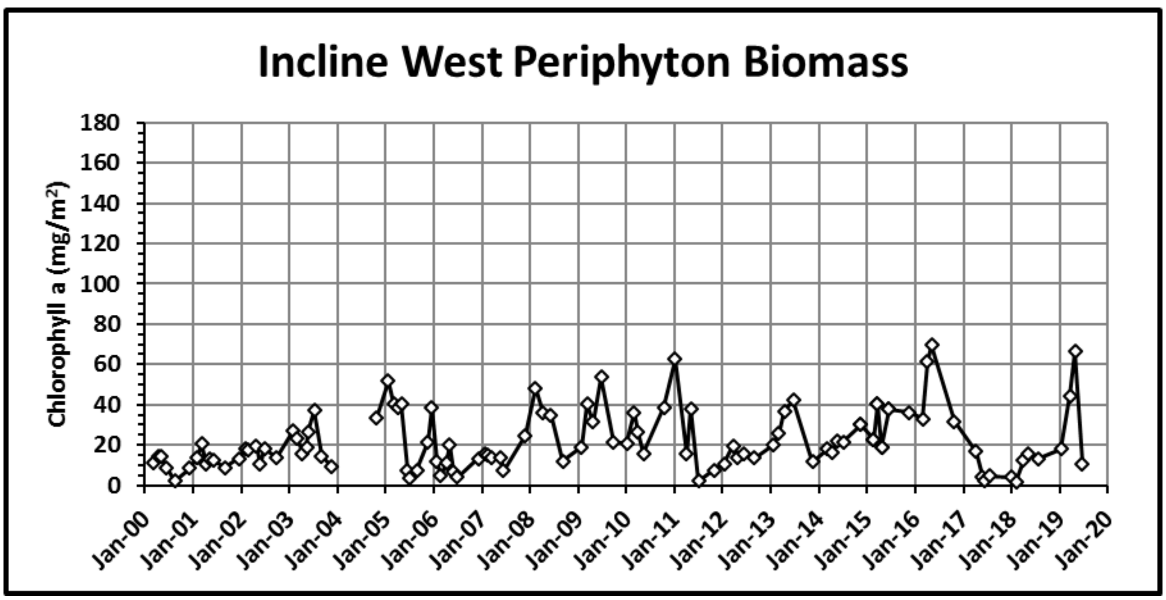


Figure 24.f. Incline West periphyton biomass (chlorophyll *a*) 2000-2019.

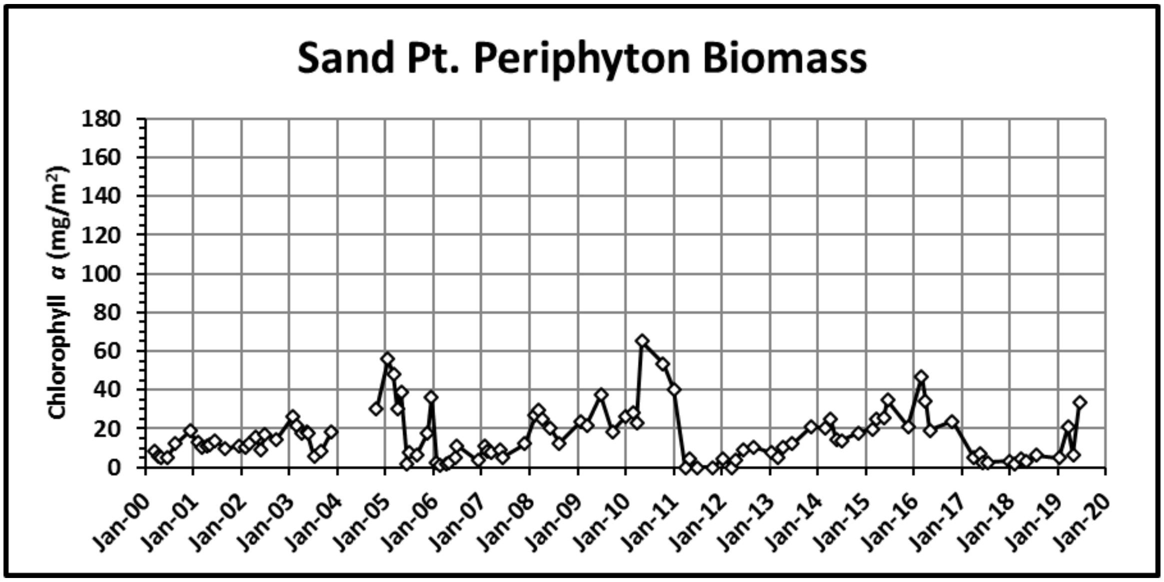


Figure 24.g. Sand Pt. periphyton biomass (chlorophyll *a*) 2000-2019.

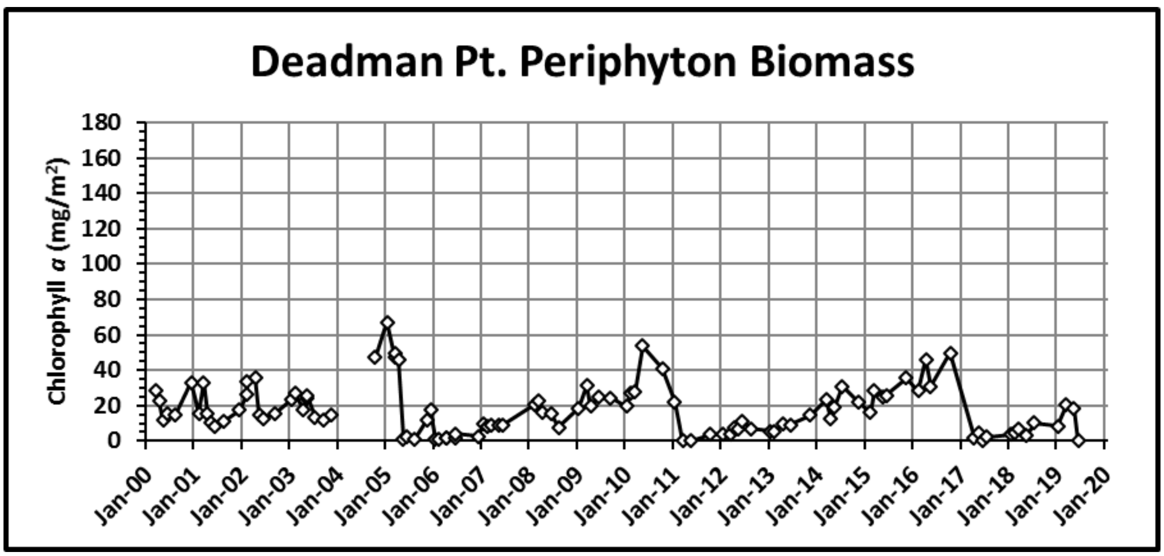


Figure 24.h. Deadman Pt. periphyton biomass (chlorophyll *a*) 2000-2019.

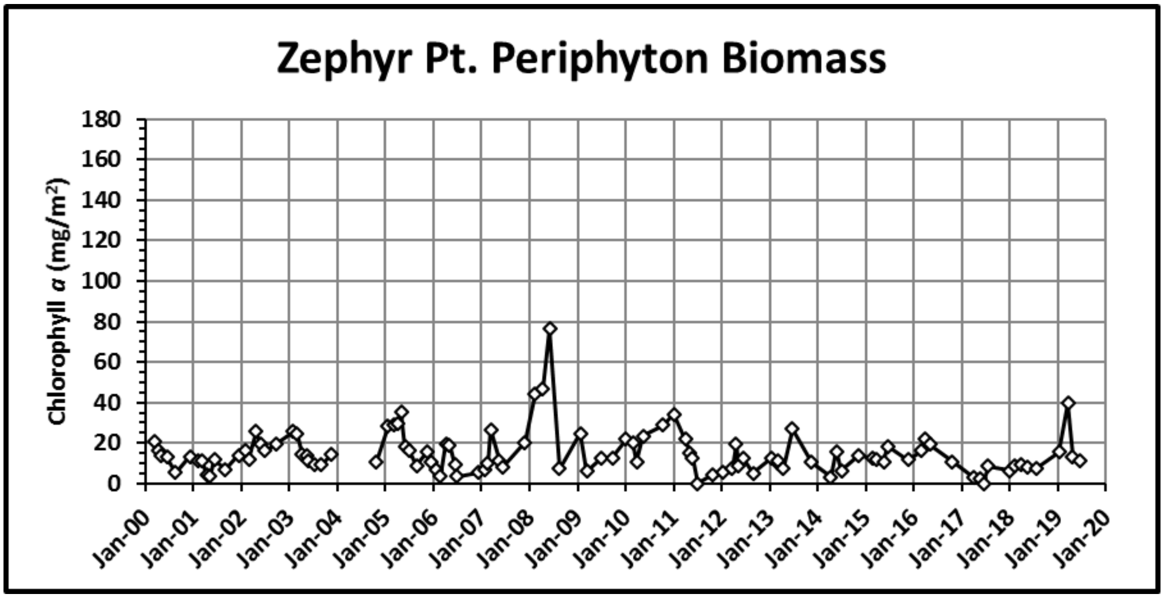


Figure 24.i. Zephyr Pt. periphyton biomass (chlorophyll *a*) 2000-2019.

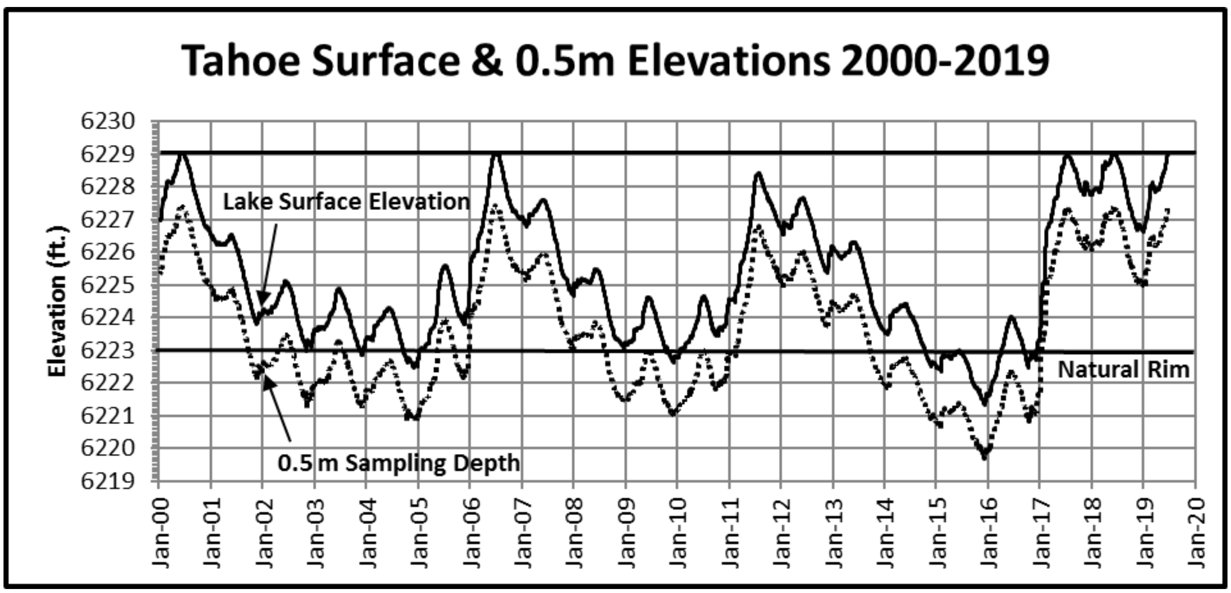


Figure 25. Fluctuation in Lake Tahoe surface elevation 1/1/00-6/23/19. Periphyton samples were typically collected during the period from natural rock substrata at a depth of 0.5m below the water surface. The 0.5m sampling depth (shown as a dotted line) fluctuates with the lake surface elevation. The elevation of the natural rim of Lake Tahoe is 6223 ft. The top 6.1 ft. of the lake above the natural rim (to 6229.1 ft.) is operated as a reservoir. Lake level data is from USGS web site (http://nwis.waterdata.usgs.gov).

Annual Maximum Biomass

Figure 26 presents the winter/spring maximum periphyton chlorophyll *a* biomasses for 2017, 2018 and 2019. All sites had higher winter-spring peak chlorophyll *a* biomasses in 2019 compared to 2017 and 2018 at 0.5m. Peak chlorophyll *a* levels were particularly high compared to the previous two years at Rubicon Pt., Pineland and Tahoe City. In 2017, periphyton biomass at 0.5m was light at most sites associated with the large rise in lake level that year. Heavier biomass was observed deeper, (at 1.5m) at many sites in 2017. 2019 was a stormy year, but it did not have the multiple large stream flow events associated with heavy rains that were observed in 2017. Nutrient contributions to surface waters (likely including contributions from surface and subsurface flows and from lake mixing and/or upwelling) may have helped thick growth of periphyton to develop at several sites in spring 2019.

It is evident that large rises in lake level such as occurred in 2017 can impact maximum biomass levels measured at 0.5m. Large rises in lake level associated with very wet years have occurred 3 times since 2000: in 2006, 2011, and 2017. In 2011, we believe we were able to sample the peak spring biomass before substrate with much lighter biomass was located at 0.5m. However, in 2006, the rapid rise in lake level may have resulted in a low measured peak biomass at 0.5m notably at Pineland. For future periphyton monitoring we will be including sampling of the 0.5m depth along with sampling of deeper substrate by SCUBA, including substrate above and below the depth at which the periphyton community shifts from primarily stalked diatoms to cyanobacteria (with stalked diatoms at some sites). It is hoped this sampling will better represent periphyton biomass in years in which lake level rises rapidly.

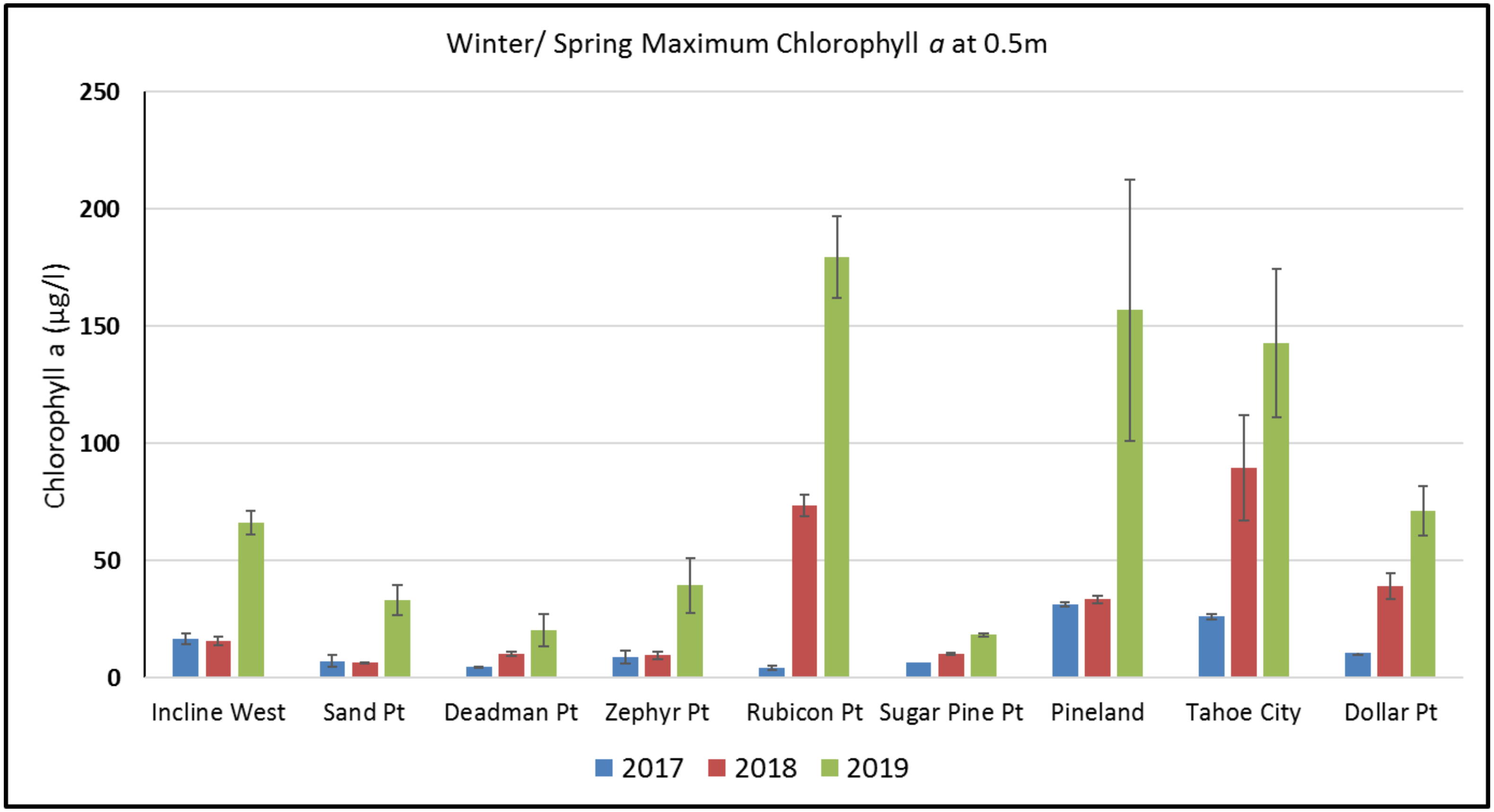


Figure 26. Maximum winter – spring (Jan.- July) periphyton chlorophyll *a* during 2017-2019 at the nine routine periphyton monitoring sites at 0.5m.

Additional Observations from Monitoring of Routine Sites 2016-2019

Multiple Large Storms 2016-2017 - Multiple large storms contributed much rain at lower elevations (particularly in mid- and late October, mid-December 2016, early January and early February 2017 (some photos from storms are shown in Fig. 27 a-c). The precipitation and runoff from these storms resulted in stepwise or incremental increases in lake level amounting to nearly 4.5 feet by early April. Substantial nutrients and sediments were contributed to the lake from basin streams. Very strong winds accompanied some of the storms. There were also strong northeast winds in late March which resulted in sloughing of algae along portions of the west shore. A substantial rise in lake level occurred during this period of over four feet from Dec. 2016 to March, 2017, with an additional rise of 2 feet from March to early summer associated with a prolonged spring runoff. The large increases in lake level during the winter resulted in areas of little or no periphyton growth on the newly submerged substrate right along shore at 0.5m.

a.

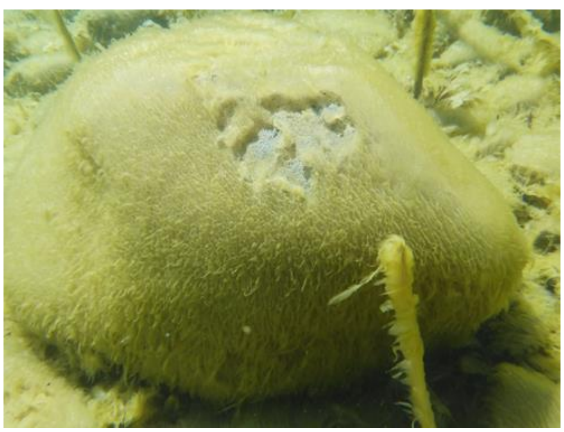
b.

c.

Figure 27. Several large storms occurred in the fall and winter of 2016-2017: (a) flooded section of Highway 89 near Tahoe City during the large January 2017 storm; (b) high flow on Ward Cr. during the same storm; (c) snapped tree along west shore from high winds during one storm.

Wind-associated Periphyton Sloughing 2017 -At the end of March, a strong north-northeast wind event occurred March 30-31, which impacted algae levels in some areas. Figure 27.a. shows the waves along shore near the Pineland station during this event. The strong wave activity along the shoreline from these winds caused the algae to partially slough from the rocks (Fig. 27b) shows a rock at Pineland before and (Fig. 27.c.) shows it after the wind and wave event) the chlorophyll *a* levels at Pineland dropped from 31.46 on March 29 to 8.54 mg/m^2 on April 4. This wind event also appeared to impact other sites along the central west shore including several spring synoptic sites. Biomass at the other routine sites on April 4 were also low ranging from 1.72 mg/m^2 at Deadman Pt. to 16.82 mg/m^2 at Incline West.

a.



b. c.

Figure 27. On March 30-31 a strong North – Northeast wind event impacted portions of the west shore with substantial wave activity. Figure 27.a. shows waves along the shoreline near the Pineland periphyton monitoring site on March 31, 2017. Figure 27.b. shows a rock (Pineland Rock A) at 0.5m with moderate periphyton growth on March 29 before the wind event. Figure 27.c. shows the same rock on April 4 after the wind event. Much of the algae had sloughed from the rock and the surrounding lakebed.

Summer Periphyton Levels at Routine Sites –The routine sites were also sampled during the mid-summer in 2017 and 2018. Summer monitoring has also been done during several years in past TERC and TRG monitoring studies. Levels of chlorophyll *a* were very low at 0.5m at all sites on this date, ranging from non-detectable at Sugar Pine Pt. to 8.78 mg/m^2 at Zephyr Pt. for the sampling done July 20, 2017. Highest levels of chlorophyll *a* at the routine sites at 0.5m in summer 2018 (July 25, 2018) were slightly higher than in 2017, but still low (ranging from non-detectable at Sugar Pine Pt. to 16.92 mg/m^2 at Tahoe City. At Sand Pt. on the east shore there was a layer of thicker periphyton right near the surface on the rocks with chlorophyll *a* of 17.70 mg/m^2 while at 0.5m lighter growth was present (chlorophyll *a* at 0.5m= 6.35 mg/m^2).

Aerial Observations of Periphyton at Pineland 6/25/17 and 5/14/19 -On 6/25/17 and 5/14/19, we had the opportunity to survey the shoreline around Lake Tahoe from helicopter (courtesy of pilot Mike Bruno). One highly visible feature of the shoreline observed on the 6/25/17 flight was the heavy periphyton growth in the region of the Ward Cr. mouth and along the shoreline near the Pineland periphyton monitoring site (Figures 28 and 29). The periphyton was very apparent as a white coverage over the bottom rocks, extending from slightly south of the Ward Cr. mouth to Sunnyside Marina. This shoreline area represents much of the lakeshore boundary of the lower portion of the Ward Valley watershed. On 5/14/19 we again flew the same section of shoreline. Periphyton was not very apparent from the air on that date (Figure 30). The site had last been sampled on 4/23/19 and heavy periphyton was observed then, particularly at 1 and 2m. It was interesting that periphyton were less discernable from the air on 5/14/19. This may have been due to either generally lighter growth, different coloration of the algae (there was green algae mixed in on 4/23/19), and possibly poor water clarity at the site on 5/14/19.

Figure 28. West Lake Tahoe shoreline north of Ward Cr. observed on 6/25/17 with white bands of heavy periphyton growth quite apparent. The black arrow indicates the section of shoreline where the Pineland routine periphyton monitoring site is located.

Figure 29. Pineland routine monitoring site 6/25/17 with white bands of heavy periphyton growth quite apparent.

Figure 30. Pineland routine monitoring site 5/14/19, presence of algae is less apparent.

Spring Synoptic Periphyton Monitoring

An additional 40-45 sites (Table 11) are monitored once each spring to provide information on the distribution of biomass between the nine routine sites around the lake. Monitoring of these additional sites is timed as much as possible to occur with the peak spring biomass, the routine sites are also monitored during this period. This "spring synoptic" sampling provides essentially a "snapshot picture" of the distribution of periphyton biomass around the lake. Since peak periphyton growth does not necessarily occur at the same time at all sites around the lake, this synoptic monitoring may catch some sites prior to or following their peak biomass.

The results of the spring synoptic sampling are presented in the following sections. We first present the relationships between PBI and chlorophyll *a* for each year. Then brief summaries of the monitoring results, tables of data and maps showing PBI levels around the lake are presented for spring 2017, 2018 and 2019.

Table 11. Periphyton Spring Synoptic Monitoring Sites

SITE DESIGNATION	WEST SHORE	LOCATION
A	Cascade Creek	N38 57.130; W120 04.615
B	S. of Eagle Point	N38 57.607; W120 04.660
C	E.Bay/Rubicon	N38 58.821; W120 05.606
D	Gold Coast	N39 00.789; W120 06.796
E	S. Meeks Point	N39 01.980; W120 06.882
F	N. Meeks Bay	N39 02.475; W120 07.194
G	Tahoma	N39 04.199; W120 07.771
H	S. Fleur Du Lac	N39 05.957; W120 09.774
I	Blackwood Creek	N39 06.411; W120 09.424
	Kaspian Pt.	(Point near Elizabeth Dr.)
J	Ward Creek	N39 07.719; W120 09.304
K	N. Sunnyside	N39 08.385; W120 09.135
L	Tavern Point	N39 08.806; W120 08.628
TCT	Tahoe City Tributary	(adjacent to T.C. Marina)
M	TCPUD Boat Ramp	N39 10.819; W120 07.177
	Lake Forest	
N	S. Dollar Point	N39 11.016; W120 05.888
O	S. Dollar Creek	N39 11.794; W120 05.699
P	Cedar Flat	N39 12.567; W120 05.285
Q	Garwood’s	N39 13.486; W120 04.974
R	Flick Point	N39 13.650; W120 04.155
S	Stag Avenue	N39 14.212; W120 03.710
T	Agatam Boat Launch	N39 14.250; W120 02.932
	EAST SHORE	
E1	South side of Elk Point	N38 58.965; W119 57.399
E2	North Side of Elk Point	N38 59.284; W119 57.341
E3	South Side of Zephyr Point	N38 59.956; W119 57.566
E4	North Zephyr Cove	N39 00.920; W119 57.193
E5	Logan Shoals	N39 01.525; W119 56.997
E6	Cave Rock Ramp	N39 02.696; W119 56.935
E7	South Glenbrook Bay	N39 04.896;W119 56.955
E8	South Deadman Point	N39 05.998; W119 57.087
E9	Skunk Harbor	N39 07.856; W119 56.597
E10	Chimney Beach	N39 09.896; W119 56.063
E11	Observation Point	N39 12.580; W119 55.861
	NORTH SHORE	
E12	Hidden Beach Offshore	N39 13.263; W119 55.832
	Hidden Beach Nearshore	
E13	Burnt Cedar Beach	N39 14.680; W119 58.132
	Incline Condo	N39 14.90; W119 59.63
	Old Incline West	(100 yds No. Incline West)
E14	Stillwater Cove	N39 13.789; W120 00.020
E15	North Stateline Point	N39 13.237; W120 00.193
E16	Brockway Springs	N39 13.560; W120 00.829
E17	Kings Beach Ramp Area	N39 14.009; W120 01.401
	SOUTH SHORE	
S1	Tahoe Keys Entrance	N38 56.398; W120 00.390
S2	Kiva Point	N38 56.555; W120 03.203
	Timber Cove Rocks	Rocks west T. Cove Pier

Chlorophyll *a* to Periphyton Biomass Index Relationship

At all spring synoptic sites, a "Periphyton Biomass Index (PBI)" value was determined from measurements of algal filament length (or algal mat thickness) and algal percent cover (PBI = Filament Length (cm) X % Algal Cover). PBI is useful for rapidly assessing the aesthetic condition of the nearshore with respect to periphyton growth. Periphyton chlorophyll *a* was also determined on samples collected from about a third of the spring synoptic sites. Comparison of PBI with chlorophyll *a* has typically shown there is an association between the two, but it is not always strong. Figures 31-33 present the associations between PBI and chlorophyll *a* for spring synoptics 2017-2019.

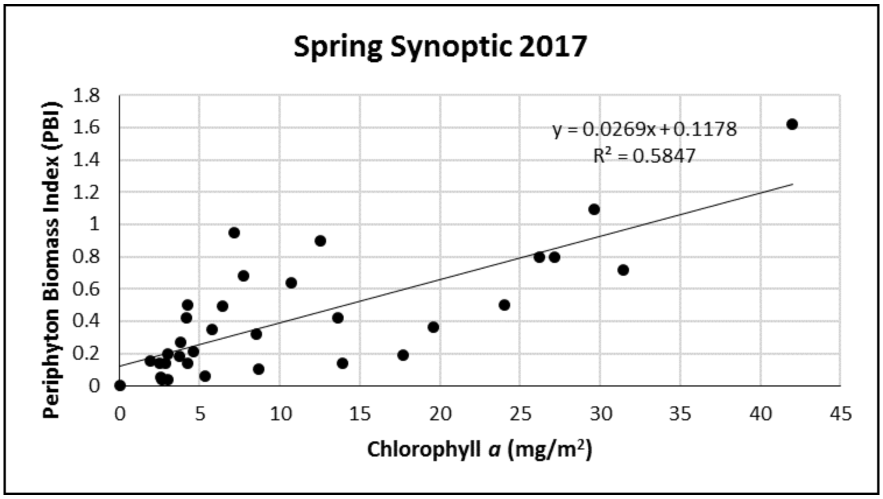


Figure 31. Relation between periphyton chlorophyll *a* and Periphyton Biomass Index (PBI) for sites where both were measured during the 2017 spring synoptic.

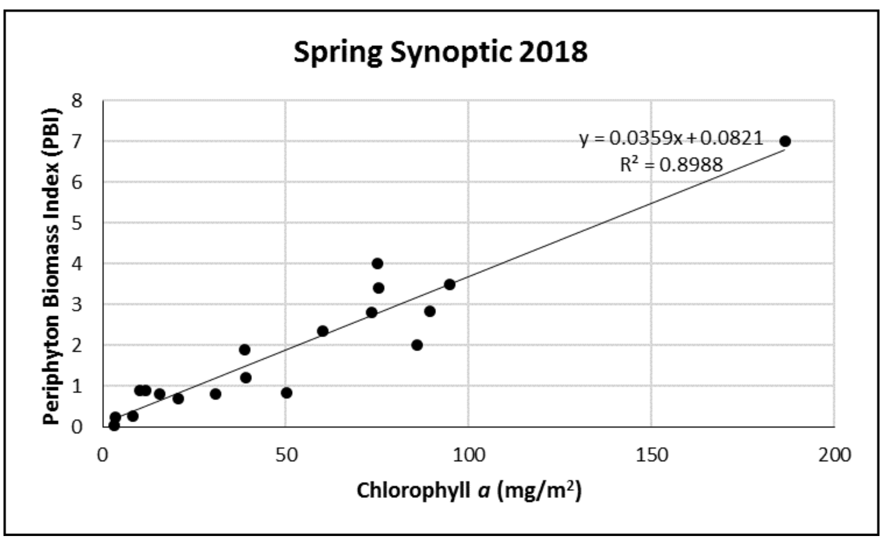


Figure 32. Relation between periphyton chlorophyll *a* and Periphyton Biomass Index (PBI) for sites where both were measured during the 2018 spring synoptic.

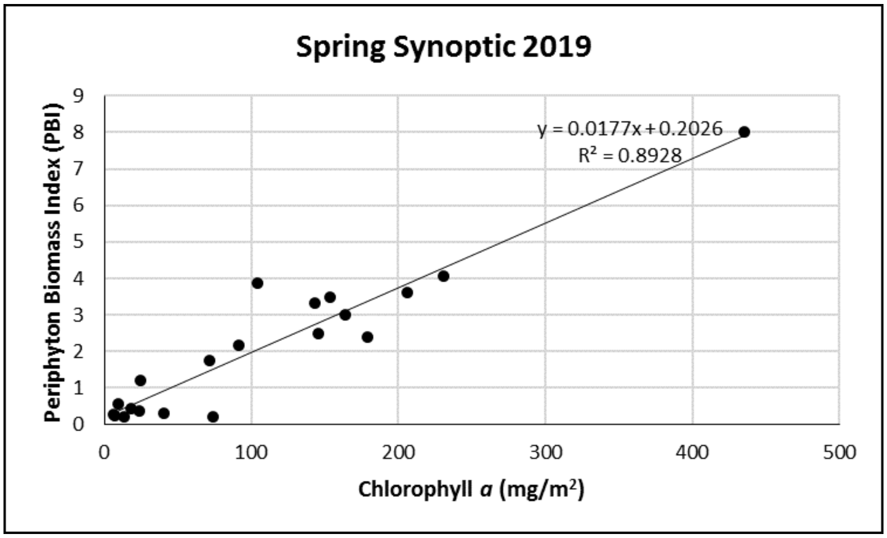


Figure 33. Relation between periphyton chlorophyll *a* and Periphyton Biomass Index (PBI) for sites where both were measured during the 2019 spring synoptic (samples analyzed as of preparation of this report).

As observed in previous synoptics, there were associations between chlorophyll *a* and PBI in the synoptics done 2017-2019. The associations were relatively strong in 2018 ($R^2 = 0.899$) and 2019 ($R^2 = 0.893$), while in 2017 the association was weaker ($R^2 = 0.585$). During the spring synoptics of 2018 and 2019 there was a much greater range of PBI and chlorophyll *a* values (in 2018 chlorophyll ranged to 186.44 mg/m^2 and PBI ranged to 7.0; in 2019 chlorophyll *a* ranged to 434.98 mg/m^2 and PBI ranged to 8.0). While in 2017 chlorophyll *a* only ranged to 42 mg/m^2 and PBI ranged to 1.62.

While PBI and chlorophyll *a* showed a strong association in 2018 and 2019 synoptics, the equations describing the associations PBI and chlorophyll *a* were different in the two years. The slope of the equation was about twice as high in 2018 (m=0.0359) compared with 2019 (m=0.0177). For a given PBI value, the chlorophyll *a* was about twice as high in 2019 compared with 2018. As indicated in previous reports, PBI and chlorophyll *a* are not interchangeable, they measure different aspects of the periphyton biomass. PBI is a visual assessment technique to rapidly assess levels of periphyton present while snorkeling and is based on measurements of overall periphyton thickness and coverage. Chlorophyll *a* is a measurement of extracted pigment that is related to live biomass and other characteristics of the periphyton.

2017 Periphyton Spring Synoptic Monitoring

Sampling for the spring 2017 synoptic monitoring was done April 4, 2017-June 14, 2017. Table 12 presents a summary of data for the 2017 spring synoptic sampling. At all spring synoptic sites, a "Periphyton Biomass Index (PBI)" value was determined. Periphyton chlorophyll *a* and Ash Free Dry Weight (AFDW) was also determined on samples collected from about a third of the synoptic sites.

The PBI values were used to prepare maps of synoptic distribution of periphyton for spring 2017 at three different depths 0.5m (Fig 34), 1m (Fig. 35) and approximately 1.5m (Fig. 36) (the depth measurements near 1.5m were approximated relative to a measuring ruler which was 1.2m long). For the map at 1m there were a few areas where 1m PBI was not measured. The levels of PBI in those areas were assumed to be similar to the levels at adjacent sites extending from either side. At 1.5m there were larger areas where PBI data was not collected, these areas were left as white areas in the maps. Spring synoptic sampling was carried out from 3/29/17 to 6/14/17.

Generally light PBI (indicated by the two shades of green, in the map) was observed at 0.5m around much of the lake (Figure 34) while heavier biomass was observed at 1 and 1.5m at many sites. At 0.5m Tavern Point had the heaviest PBI (1.62). Three other sites had moderately heavy PBI, Brockway (PBI of 1.20), Lake Forest (PBI of 1.09) and Tahoe City Boat ramp (PBI of 1.47).

At 1.0 meters (Figure 35), heavier PBI than observed at 0.5m was observed in the northwest and southwest portions of the lake and at individual sites along the east shore. PBI ranged between 1.35 and 3.6 in the northwest portion of the lake (Tahoe City Tributary to Brockway), similarly PBI ranged between 1.35 to a high of 3.5 along the southwest coast (No. Meeks Bay to Emerald Bay Rubicon). Biomass along the west portion of the shoreline from Tahoe City to Sugar Pine Pt. at 1.0 m was variable with several low values. Levels of PBI at many of the sites was noted to be wind-impacted. Along the north and east shore at 1m, PBI levels were low to moderate, with a couple sites with high levels (i.e. Cave Rock (1.75) and South Elks Pt. (4.5)).

PBI measurements were also determined for the lake at approximately 1.5m (Figure 36) for a portion of the lake. These areas were primarily the north and northwest portion of the lake and the southeast portions of the lake. Along the north and northwest portion of the lake, levels of PBI were quite high ranging from 1.0-5.0. The levels at this depth tended to be similar or higher than levels at 1.0 m. The highest PBI levels were observed at South Dollar Cr. (PBI=5.0), Tahoe City Tributary (5.0), South Dollar Pt. (4.5) and Pineland (4.5). The generally high levels of biomass at 1.5m likely resulted in part from these sites being submerged most of the winter and spring, allowing for long periods for colonization and growth. Sites may have been impacted by nutrient inputs associated with some of the large storms. Levels of PBI along the southeast portion of the lake at 1.5m tended to be relatively low (i.e. less than 0.5) at many sites. There were a few exceptions notably South Elk Pt. (5.5) and South Deadman (2.1). Cave Rock on 5/2/17 at 1.5m was also noted to have very heavy biomass at 1.5m (with some algal lengths over 7 cm) an estimate of percent cover though was not collected there.

The predominant algal types in the periphyton observed around the lake during the spring synoptic were primarily stalked diatoms and a pennate diatom tentatively identified as *Synedra ulna*. At some sites there was a low-growing film of a particularly small stalked diatom possibly either *Gomphonema* or *Gomphoneis*. This algae appeared to do well in some areas with significant wave activity.

Table 12. Summary of periphyton chlorophyll *a*, Ash Free Dry Weight (AFDW), visual score, avg. filament length, percent algal coverage and Periphyton Biomass Index for routine sites (shaded) and Spring Synoptic survey sites during April 4, 2017-June 14, 2017. Note for chlorophyll *a* and AFDW, n=2 unless otherwise indicated. Visual score is a subjective ranking of the aesthetic appearance of algal growth (viewed underwater) where 1 is the least offensive and 5 is the most offensive. Biomass Index is filament length (cm) times percent algal cover. "NA" = not available or not collected; "NES" = not enough sample for analysis. Sampling depth and corresponding sampling elevation is also indicated. For algae types – SD=stalked diatoms; CY= Cyanobacteria; FG= filamentous greens; D= diatom mix; S= *Synedra*; "-f" indicates algae type best estimate based on field observation; "-m" indicates predominant algae types checked under microscope.

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
A	Cascade Creek	5/22/17	0.5	6226.50	NA	NA	NA	NA	1	2	1.0	40%	0.40	SD -f
A	Cascade Creek	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	2	1.0	40%	0.40	SD -f
A	Cascade Creek	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	2	1.0	60%	0.60	SD -f
B	S. of Eagle Point	4/10/17	0.5	6225.84	5.32	0.22	3.11	0.24	1	2	0.2	30%	0.06	SD,S-m
B	S. of Eagle Point	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	2	NA	NA	NA	SD-f
C	E.Bay/Rubicon	4/10/17	0.5	6225.84	NA	NA	NA	NA	3	3	0.8	90%	0.72	SD -f
C	E.Bay/Rubicon	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	5	2.5	100%	2.50	
	Rubicon Pt.	4/4/17	0.5	6225.60	2.63	0.52	NA	NA	1	1	0.2	20%	0.04	SD,D-m
	Rubicon Pt.	5/22/17	0.5	6226.50	4.21	1.59 (n=3)	3.35	0.73	2	4	1.0-4.0	20%	0.50	SD,S-m
	Rubicon Pt.	5/22/17	1	6224.86	NA	NA	NA	NA	NA	5	3.0-4.0	80%	2.80	SD- f
D	Gold Coast	4/10/17	0.5	6225.84	NA	NA	NA	NA	2	3	0.5	80%	0.40	SD -f
D	Gold Coast	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	5	3.5	100%	3.50	SD -f
E	S. Meeks Point	4/10/17	0.5	6225.84	5.77	0.55	1.59	0.31	2	3	0.5	70%	0.35	SD -m
E	S. Meeks Point	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	4	1.5	90%	1.35	SD -f
F	N. Meeks Bay	4/10/17	0.5	6225.84	NA	NA	NA	NA	2	4	1.5	60%	0.90	SD -f
F	N. Meeks Bay	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	5	3.0	100%	3.0	SD -f
F	N. Meeks Bay	4/10/17	1.5	6222.56	NA	NA	NA	NA	NA	5	3.0	100%	3.0	SD -f
	Sugar Pine Pt.	4/4/17	0.5	6225.60	6.44	(n=1)	3.89	(n=1)	NA	3	0.7	70%	0.49	SD -m
	Sugar Pine Pt.	5/22/17	0.5	6226.50	1.93	0.38	NA	NA	NA	2	0.5	30%	0.15	SD-m
	Sugar Pine Pt.	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	NA	1.5	60%	0.90	SD-f
	Sugar Pine Pt.	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	NA	3.0	80%	2.40	
G	Tahoma	4/10/17	0.5	6225.84	NA	NA	NA	NA	NA	2	0.2	30%	0.06	SD -f
G	Tahoma	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	2	0.2	20%	0.04	SD -f
G	Tahoma	4/10/17	1.5	6222.56	NA	NA	NA	NA	NA	3.5				SD -f
H	S. Fleur Du Lac	4/10/17	0.5	6225.84	3.76	1.41	3.13	(n=1)	NA	2	0.3	60%	0.18	SD,S,FG -m
H	S. Fleur Du Lac	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	2	0.5	53%	0.27	FG-f
I	Blackwood Creek	4/10/17	0.5	6225.84	NA	NA	NA	NA	NA	1.5	0.1	5%	0.005	
I	Blackwood Creek	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	1	<0.1	1%	<0.001	

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
	Kaspian Pt.	4/10/17	0.5	6225.84	NA	NA	NA	NA	2	2	0.4	70%	0.28	SD -f
	Kaspian Pt.	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	4	1.75			SD -f
J	Ward Creek	4/10/17	0.5	6225.84	13.90	0.67	12.51	0.03	2	2.5	0.6	24%	0.14	SD,S-m
J	Ward Creek	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	4	2.25	63%	1.42	SD -f
J	Ward Creek	4/10/17	1.5	6222.56	NA	NA	NA	NA	NA	5	NA	NA	>1m	SD -f
	Pineland- Rock A	3/29/17	0.5	6225.52	31.46	1.45 (n=3)	16.52	2.38 (n=3)	3.5	3.5	0.8	90%	0.72	SD,S-m
	Pineland- Rock A	4/4/17	0.55	6225.44	8.54	0.32 (n=3)	6.67	0.66 (n=3)	NA	3	0.4	80%	0.32	SD,S-m
	Pineland	3/29/17	0.5	6225.52					3	3	0.5	50%	0.25	SD -f
	Pineland	3/29/17	1.1						5	5	3.5	100%	3.50	SD -f
	Pineland	5/22/17	0.5	6226.50	3.01	1.12	4.27	1.29	1.5	1.5	0.1	40%	0.04	SD,S-m
	Pineland	5/22/17	1.0	6224.86	12.52	4.42 (n=3)	14.85	6.49 (n=3)	2	4	1.5	60%	0.90	SD -m
	Pineland	5/22/17	1.5	6223.22	104.79	9.02 (n=3)	98.47	30.87 (n=3)	5	5	4.5	100%	4.50	SD,S-m
K	N. Sunnyside	4/10/17	0.5	6225.84	NA	NA	NA	NA	NA	1	0	0	0	
K	N. Sunnyside	4/10/17	1.0	6224.20	NA	NA	NA	NA	NA	2	1.2	20%	0.24	SD -f
L	Tavern Pt.	4/10/17	0.5	6225.84	42.00	5.81	29.61	3.34	4	4	1.7	95%	1.62	SD,S-m
L	Tavern Pt.	4/10/17	1.0	6224.20							2.0	90%	1.80	SD -f
	Tahoe City	3/29/17	0.5	6225.52	26.24	2.02 (n=3)	30.20	3.65 (n=3)	3	3	1.0	80%	0.80	SD,S-m
	Tahoe City	5/22/17	0.5	6226.50	13.60	2.93 (n=3)	26.34	0.39 (n=3)	NA	2	0.6	70%	0.42	SD -m
	Tahoe City	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	NA	1.0-1.5	50%	0.63	SD-f
	Tahoe City	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	NA	1.0-1.5	20%	0.25	SD-f
TCT	Tahoe City Trib.	5/2/17	0.5	6226.02	27.13	8.26 (n=3)	35.02	21.96 (n=3)	3.5	3.5	1.0	80%	0.80	S,SD -m
TCT	Tahoe City Trib.	5/2/17	1.0	6224.38	NA	NA	NA	NA	NA	5	4.0	90%	3.6	SD -f
TCT	Tahoe City Trib.	5/2/17	1.5	6222.74	NA	NA	NA	NA	NA	5	5.0	100%	5.0	SD -f
M	TCPUD Boat Ramp	4/25/17	0.5	6226.05	NA	NA	NA	NA	4	4	1.5	98%	1.47	
M	TCPUD Boat Ramp	4/25/17	1.0	6224.41	NA	NA	NA	NA	NA	5	3.5	100%	3.50	SD- f
M	TCPUD Boat Ramp	4/25/17	1.5	6222.77	NA	NA	NA	NA	NA	5	3.5	100%	3.50	
	Lake Forest	5/9/17	0.5	6226.33	29.65	3.78 (n=3)	72.00	16.63 (n=3)	3	4	1.2	91%	1.09	SD- f
	Lake Forest	5/9/17	1.0	6224.69	NA	NA	NA	NA	NA	4	1.5	90%	1.35	
	Lake Forest	5/9/17	1.5	6223.05	NA	NA	NA	NA	NA	5	3	90%	2.70	

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m²)	Std Dev (mg/m²)	AFDW (g/m²)	Std Dev (mg/m²)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
N	S. Dollar Pt.	4/25/17	0.5	6226.05	NA	NA	NA	NA	2	2	0.4	53%	0.21	SD,S-m
N	S. Dollar Pt.	4/25/17	1.0	6224.41	NA	NA	NA	NA	NA	4	2	90%	1.80	SD- f
N	S. Dollar Pt.	4/25/17	1.5	6222.77	NA	NA	NA	NA	NA	5	4.5	90%	4.05	SD- f
	Dollar Pt.	4/4/17	0.5	6225.60	10.74	1.58 (n=3)	13.42	1.39 (n=3)	3	3.5	0.8	80%	0.64	SD -m
	Dollar Pt.	5/22/17	0.5	6226.50	7.74	0.23	22.03	0.32	2	3	0.8	85%	0.68	SD,S,D-m
	Dollar Pt.	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	NA	1.0	70%	0.70	SD-f
	Dollar Pt.	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	NA	1.0	30%	0.30	
O	S. Dollar Creek	4/25/17	0.5	6226.05	17.69	3.38	16.57	0.29	3	3	0.4	47%	0.19	SD,S-m
O	S. Dollar Creek	4/25/17	1.0	6224.41	NA	NA	NA	NA	NA	4	2.5	80%	2.00	SD- f
O	S. Dollar Creek	4/25/17	1.5	6222.77	NA	NA	NA	NA	NA	5	5	100%	5.00	SD- f
P	Cedar Flat	4/25/17	0.5	6226.05	NA	NA	NA	NA	NA	3	0.4	80%	0.32	SD- f
P	Cedar Flat	4/25/17	1.0	6224.41	NA	NA	NA	NA	NA	4	2.5	80%	2.00	SD- f
P	Cedar Flat	4/25/17	1.5	6222.77	NA	NA	NA	NA	NA	4	2.5	90%	2.25	SD- f
Q	Garwood's	4/25/17	0.5	6226.05	NA	NA	NA	NA	2.5	2.5	0.2	50%	0.10	SD- f
Q	Garwood's	4/25/17	1.0	6224.41	NA	NA	NA	NA	NA	4	2.5	70%	1.75	SD- f
Q	Garwood's	4/25/17	1.5	6222.77	NA	NA	NA	NA	NA	4	3.25	80%	2.60	SD- f
R	Flick Point	4/25/17	0.5	6226.05	8.66	0.85	2.13	0.71	2.5	2.5	0.3	34%	0.10	SD,S-m
R	Flick Point	4/25/17	1.0	6224.41	NA	NA	NA	NA	NA	4	2.5	70%	1.75	SD-f
R	Flick Point	4/25/17	1.5	6222.77	NA	NA	NA	NA	NA	4	2.5	70%	1.75	
S	Stag Avenue	4/25/17	0.5	6226.05	NA	NA	NA	NA	3	3	0.5	100%	0.50	SD- f
S	Stag Avenue	4/25/17	1.0	6224.41	NA	NA	NA	NA	NA	5	3	100%	3.00	SD- f
S	Stag Avenue	4/25/17	1.5	6222.77	NA	NA	NA	NA	NA	5	3	100%	3.00	SD- f
T	Agatam Boat R.	4/25/17	0.5	6226.05	NA	NA	NA	NA	3	3	0.4	90%	0.36	SD- f
T	Agatam Boat R.	4/25/17	1.0	6224.41	NA	NA	NA	NA	NA	4	2	80%	1.60	
T	Agatam Boat R.	4/25/17	1.5	6222.77	NA	NA	NA	NA	NA	4	2	80%	1.60	
E17	Kings Beach	4/25/17	0.5	6226.05	NA	NA	NA	NA	3	4	1	100%	1.00	SD,S-m
E17	Kings Beach	4/25/17	1.5-1.5	6222.77	NA	NA	NA	NA	NA	5	3.5	100%	3.50	SD- f
E16	Brockway Springs	4/25/17	0.5	6226.05	NA	NA	NA	NA	NA	4	1.2	100%	1.20	SD- f
E16	Brockway Springs	4/25/17	1-1.5	6224.41	NA	NA	NA	NA	NA	5	3	100%	3.00	SD- f
E15	No. Stateline Point	6/13/17	0.5	6226.97	NA	NA	NA	NA	NA	2.5	0.2	60%	0.12	SD- f
E15	No. Stateline Point	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	3	1	60%	0.60	SD- f
E15	No. Stateline Point	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	5	5	60%	3.00	SD- f

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
E14	Stillwater Cove	6/13/17	0.5	6226.97	NA	NA	NA	NA	2	2.5	1.2	50%	0.60	SD- f
E14	Stillwater Cove	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	2.5	0.8	50%	0.40	SD- f
E14	Stillwater Cove	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	3	2	50%	1.00	SD- f
	Old Incline West	6/13/17	0.5	6226.97	NA	NA	NA	NA	2	2	0.2	30%	0.06	SD- f
	Old Incline West	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	3	1	50%	0.5	SD- f
	Old Incline West	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	4	4	80%	3.2	SD- f
	Incline West	5/22/17	0.5	6226.50	4.18	0.71	7.88	1.09	3	3	0.6	70%	0.42	SD,S,FG-m
	Incline West	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	4	1.5	70%	1.05	SD-f
	Incline West	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	NA	3.0	70%	2.10	SD,FG-f
	Incline West	6/13/17	0.5	6226.97	2.53	0.45	4.08	1.16	1.5	2	0.2	70%	0.14	SD-m
	Incline West	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	3	0.7	50%	0.35	
	Incline West	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	NA	3.0/1.0	25%/75%	1.50	SD-f
	Incline Condo	6/13/17	0.5	6226.97	NA	NA	NA	NA	3.5	3	0.4	100%	0.40	SD-f
	Incline Condo	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	3	0.7	100%	0.70	
	Incline Condo	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	4	2	90%	1.80	SD-f
E13	Burnt Cedar	6/13/17	0.5	6226.97	3.80	0.25	5.02	0.39	3	3	0.3	90%	0.27	SD- f
E13	Burnt Cedar	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	NA	0.5	90%	0.45	SD- f
E13	Burnt Cedar	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	NA	2.5	80%	2.00	SD- f
	Hidden Beach Insh.	6/13/17	0.5	6226.97	NA	NA	NA	NA	1.5	2	0.2	50%	0.10	
	Hidden Beach Insh.	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	2	0.6	60%	0.36	
	Hidden Beach Insh.	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	3.5	2	50%	1.00	
	Hidden Beach Offsh	6/13/17	0.5	6226.97	NA	NA	NA	NA	NA	2	0.4	20%	0.08	SD- f
	Hidden Beach Offsh	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	3	0.3	50%	0.15	
	Observation Pt.	6/13/17	0.5	6226.97	NA	NA	NA	NA	NA	1.5	0.2	1%	0.002	SD- f
	Sand Pt.	5/22/17	0.5	6226.50	7.15	3.52	8.98	5.14	3	3.5	1.0	95%	0.95	SD-m
	Sand Pt.	5/22/17	1.0	6224.86	NA	NA	NA	NA	NA	4	3.0-4.0	30%	1.05	SD-f
	Sand Pt.	5/22/17	1.5	6223.22	NA	NA	NA	NA	NA	3	NA	NA	NA	SD-f
	Sand Pt.	6/13/17	0.5	6226.97	2.56	0.43	NES	NES	NA	1.5	<0.1	50%	<0.05	SD-m
	Sand Pt.	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	NA	2.0	30%	0.60	
	Sand Pt.	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	NA	2.0	0-70%	0.70	
E10	Chimney Beach	6/13/17	0.5	6226.97	NA	NA	NA	NA	1.5	1.5	<0.1	50%	<0.05	SD-f
E10	Chimney Beach	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	3	1	80%	0.80	SD-f
E10	Chimney Beach	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	NA	1.25	80%	1.00	
E9	Skunk Harbor	6/13/17	0.5	6226.97	NA	NA	NA	NA	NA	1	<0.1	5%	<0.005	
E9	Skunk Harbor	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	NA	0.1	5%	0.005	SD-f

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
	Deadman Pt.	5/22/17	0.5	6226.50	4.62	0.33	6.37	4.30	2	2.5	0.3	70%	0.21	SD,CY-m
	Deadman Pt.	6/13/17	0.5	6226.97	0	0	0	0	NA	0	0	0	0	
	Deadman Pt.	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	NA	0.3	50%	0.15	SD-f
	Deadman Pt.	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	NA	1.0	30%	0.30	
E8	So. Deadman Point	6/13/17	0.5	6226.97	2.88	0.91	2.08	(n=1)	2	2.5	0.2	70%	0.14	SD-m
E8	So. Deadman Point	6/13/17	1.0	6225.33	NA	NA	NA	NA	NA	3	0.5	50%	0.25	SD-f
E8	So. Deadman Point	6/13/17	1.5	6223.69	NA	NA	NA	NA	NA	4	3	70%	2.10	SD-f
E7	So. Glenbrook Bay	6/14/17	0.5	6226.98	NA	NA	NA	NA	NA	2	0.1	70%	0.07	SD-f
E7	So. Glenbrook Bay	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	NA	0.4	40%	0.16	SD-f
E7	So. Glenbrook Bay	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	NA	0.5	25%	0.13	SD-f
E6	Cave Rock Ramp	5/2/17	0.5	6226.02	24.00	7.13 (n=3)	25.89	11.15 (n=3)	3	3	1.5	33%	0.50	SD,S -m
E6	Cave Rock Ramp	5/2/17	1.0	6224.38	NA	NA	NA	NA	NA	4	3.5	50%	1.75	SD-f
E6	Cave Rock Ramp	5/2/17	1.5	6222.74	NA	NA	NA	NA	NA	NA	To 7.6	NA	NA	SD-f
E6	Cave Rock Ramp	6/14/17	0.5	6226.98	4.25	0.84	4.02	0.21	2	2.5	0.2	70%	0.14	SD,S-m
E6	Cave Rock Ramp	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	4	3	40%	1.2	SD-f
E6	Cave Rock Ramp	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	2.5	1.25	30%	0.38	
E5	Lincoln Park	6/14/17	0.5	6226.98	NA	NA	NA	NA	1.5	2	<0.1	50%	<0.05	SD-f
E5	Lincoln Park	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	2	<0.1	40%	<0.04	SD-f
E5	Lincoln Park	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	2	0.1	30%	0.03	
E4	No. Zephyr Cove	6/14/17	0.5	6226.98	NA	NA	NA	NA	NA	2.5	0.3	40%	0.12	SD-f
E4	No. Zephyr Cove	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	3	1	70%	0.7	SD-f
E4	No. Zephyr Cove	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	2.5	0.5	30%	0.15	
	Zephyr Pt.	4/4/17	0.5	6225.60	2.99	0.86	2.82	n=1	2	2	0.5	40%	0.20	SD,D-m
	Zephyr Pt.	6/14/17	0.5	6226.98	NES	NES	0.90	0.21	NA	1.5	<0.1	70%	<0.07	SD,S-m
	Zephyr Pt.	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	NA	<0.1	50%	<0.05	
	Zephyr Pt.	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	NA	<0.1	50%	<0.05	
	So. Zephyr Pt.	6/14/17	0.5	6226.98	NA	NA	NA	NA	2	2.5	0.3	70%	0.21	SD-f
	So. Zephyr Pt.	6/14/17	1.0	6225.34	NA	NA	NA	NA	NA	2.5	0.4	60%	0.24	
	So. Zephyr Pt.	6/14/17	1.5	6223.70	NA	NA	NA	NA	NA	NA	0.4	40%	0.16	SD-f
E2	No. Elk Pt.	5/19/17	0.5	6226.45	NA	NA	NA	NA	2	2	0.4	40%	0.16	SD-f
E2	No. Elk Pt.	5/19/17	1.0	6224.81	NA	NA	NA	NA	NA	NA	0.4	50%	0.20	SD-f
E2	No. Elk Pt.	5/19/17	1.5	6223.17	NA	NA	NA	NA	NA	NA	NA	50-70%		SD-f
E1	So. Elk Point	5/19/17	0.5	6226.45	19.60	2.12 (n=3)	31.73	3.66 (n=3)	3	4	1.8	20%	0.36	SD-m
E1	So. Elk Point	5/19/17	1.0	6224.81	NA	NA	NA	NA	NA	5	4.5	100%	4.50	SD-f
E1	So. Elk Point	5/19/17	1.5	6223.17	NA	NA	NA	NA	NA	5	5.5	100%	5.50	SD-f

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m²)	Std Dev (mg/m²)	AFDW (g/m²)	Std Dev (mg/m²)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
	Timber Cove Rock	4/5/17	0.9	6224.29	NA	NA	NA	NA	NA	3	1.4	65%	0.91	SD-f
S1	T. Keys Entrance	4/5/17	0.5	6225.60	NA	NA	5.15	1.70	NA	3	0.4	70%	0.28	SD-f
	Kiva Pt.	5/2/17	0.5	6226.02	NA	NA	NA	NA	NA	3.5	1.2	10%	0.12	SD-f
	Kiva Pt.	5/2/17	1.0	6224.38	NA	NA	NA	NA	NA	3.5	1.2	14%	0.17	
	Kiva Pt.	5/2/17	1.5	6222.74	NA	NA	NA	NA	NA	3	NA	NA	NA	

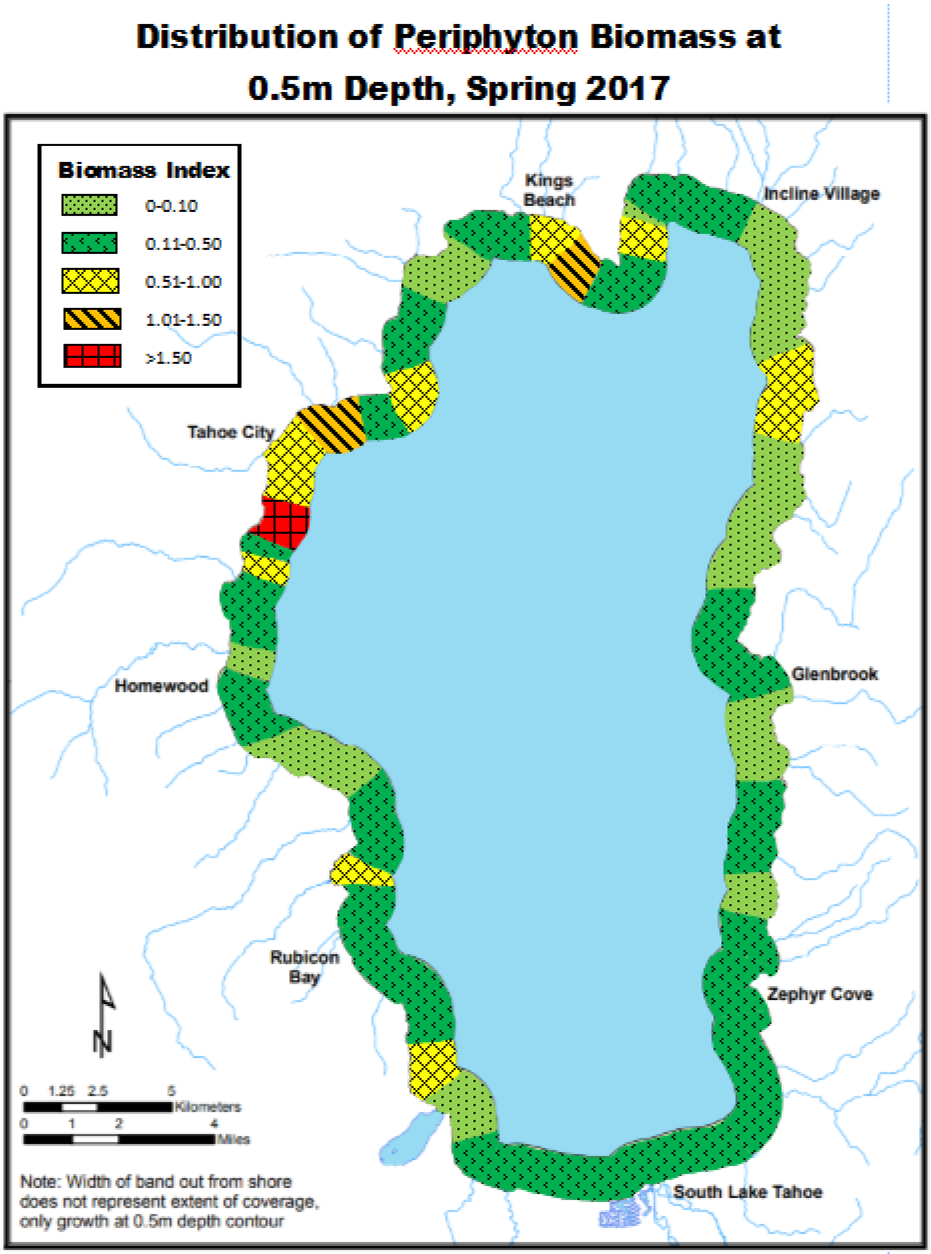


Figure 34. Distribution of peak periphyton biomass measured during the spring synoptic 2017 (3/29/17-6/14/17) at 0.5m. Shading indicates levels of biomass measured using a rapid assessment method: Periphyton Biomass Index (PBI). (PBI= Avg. Filament Length X (multiplied by) Percent Area Covered with Algae).

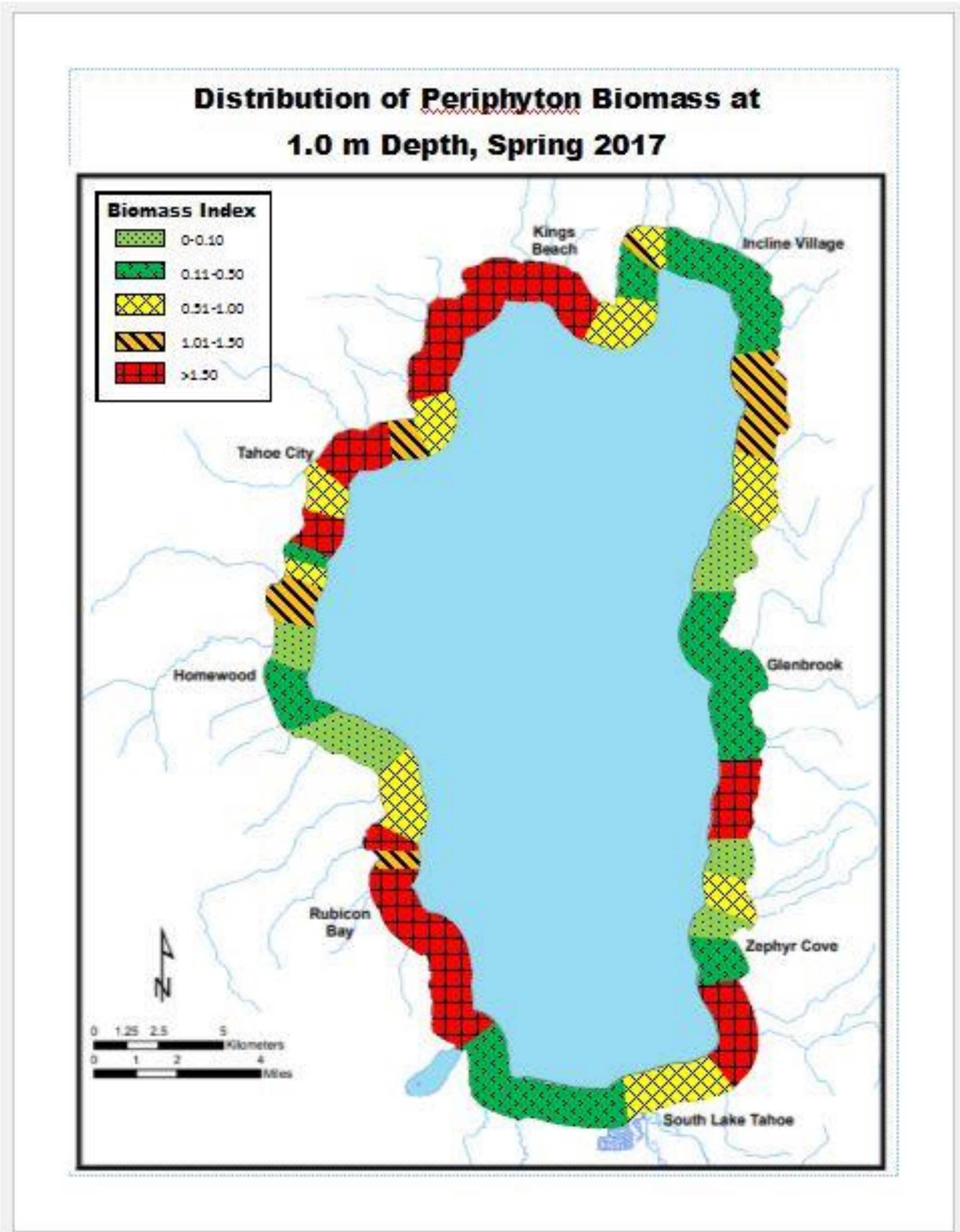


Figure 35. Distribution of peak periphyton biomass measured during the spring synoptic 2017 (4/10/17-6/14/17) at 1.0 m. Shading indicates levels of biomass measured using a rapid assessment method: Periphyton Biomass Index (PBI). (PBI= Avg. Filament Length X (multiplied by) Percent Area Covered with Algae). For the map at 1m there were a few areas where 1m PBI was not measured. The levels of PBI in those areas were assumed to be similar to the levels at adjacent sites extending to the sampling point with no data.

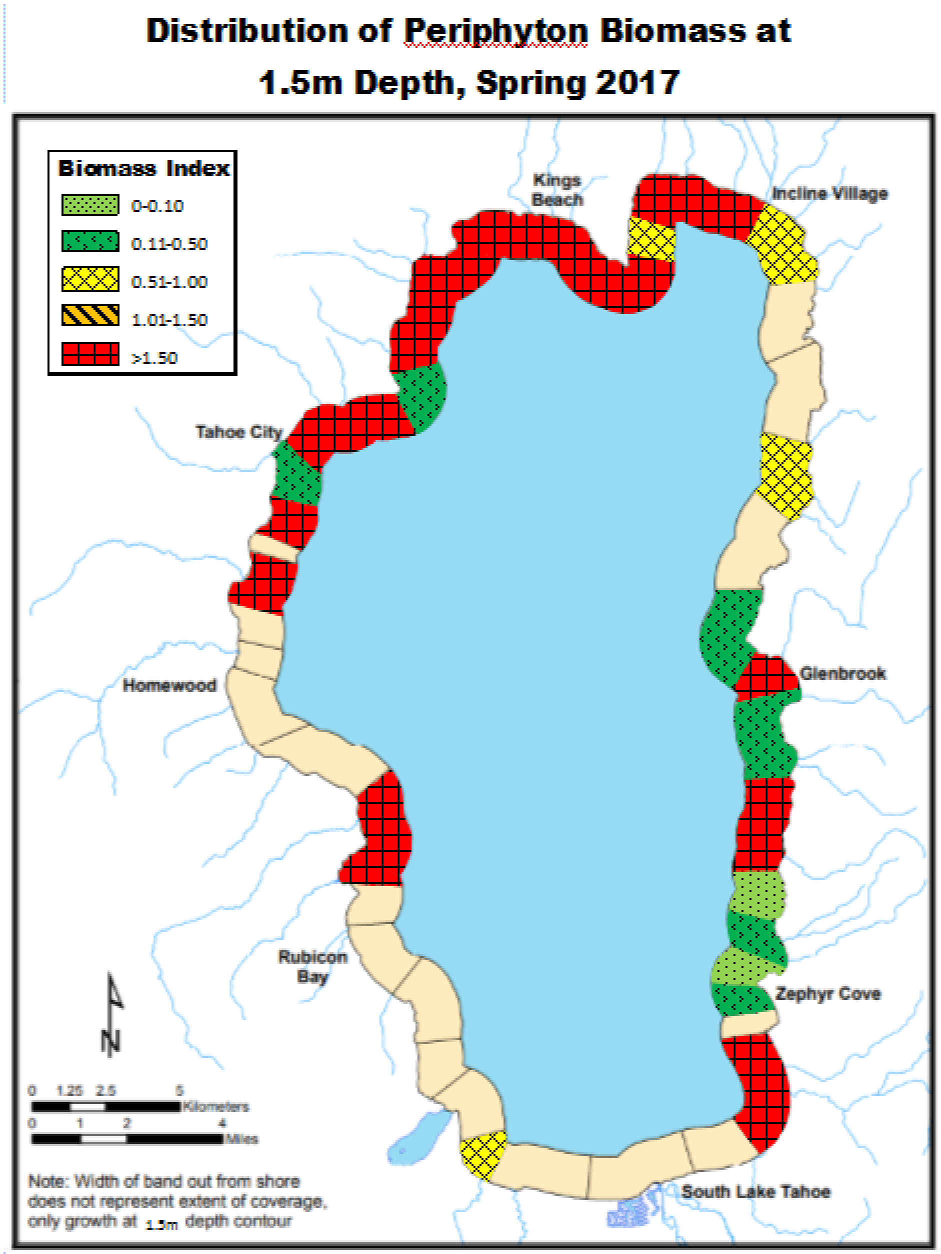


Figure 36. Distribution of peak periphyton biomass measured during the spring synoptic 2017 (4/10/17-6/14/17) at approximately 1.5 m. Shading indicates levels of biomass measured using a rapid assessment method: Periphyton Biomass Index (PBI). (PBI= Avg. Filament Length X (multiplied by) Percent Area Covered with Algae). There were large areas where PBI data was not collected, these areas were left a white areas in the maps.

2018 Periphyton Spring Synoptic Monitoring

46 sites in addition to the 9 routine sites were monitored in spring 2018 to provide lake-wide information on the distribution of periphyton biomass. This monitoring was done during 4/25/18 to 5/15/18. We included measurements of PBI at 1 or 1.5 meters in addition to 0.5m at many of the sites to allow comparison with 2017 in which the rapidly rising lake level resulted relatively light biomass at 0.5m at many sites with heavier biomass deeper at 1 or 1.5m. The data collected in the spring synoptic monitoring are summarized in Table 13. The map of synoptic PBI distribution of periphyton for spring 2018 at 0.5m is presented in Fig 37.

Generally light PBI (indicated by the two shades of green, in Figure 37) was observed at 0.5m along much of the east shore and at a couple of sites along the southwest shore. Heavy PBI (indicated by red) or moderate-heavy PBI (indicated by orange) was measured along much of the west shore and at several locations along the south east shore. The areas with the highest PBI included: South Fleur du lac (PBI = 7.0), Tahoe City Tributary (PBI = 4.0), So. Dollar Cr. (PBI =4.0), Ward Cr. (PBI = 3.5), Garwoods (PBI = 3.4) and Emerald Bay/ Rubicon (PBI = 3.0). Moderate PBI (indicated by yellow was observed in areas along the north and south shores and along portions of the west and east shore.

The amount of periphyton as represented by PBI was much heavier in 2018 at 0.5m compared to 2017 (Figure 38 a, b). In 2017 light biomass was observed around much of the lake in shallow water (0.5m) associated with a large increase in lake level (see discussion in “Patterns of Periphyton Biomass 2016-2019” page 56). The generally higher PBI in 2018 may be partly due to the sustained high lake levels in 2018. Rock substrate sampled at 0.5m in the spring synoptic, had remained continually submerged during the year, allowing development of the periphyton community over a prolonged period. Inputs of nutrients with surface and subsurface flows may have contributed to elevated growth of periphyton at 0.5m at some sites. 2018 precipitation was near or slightly below normal (DWR, 2018) and included strong storms in mid-November and early April, which may have contributed to the increased growth of periphyton.

The pattern noted above of heavier PBI along the west shore compared to the east shore in 2018 may be the result of several contributing factors. The west shore typically receives more precipitation and contributes more surface and subsurface inputs of water with associated nutrients, to fuel periphyton growth than the east shore. Impacts of local sources of nutrients from developed areas, storm water runoff, lake mixing, upwelling, currents and degree of exposure to wave activity and potential sloughing of algae are some of the other factors which may contribute to higher PBI along the west shore.

Observations of PBI were also made at 1.5m at many of the sites around the lake in 2018. PBI at 0.5m in 2018 was near to or higher than PBI at 1.5m at many sites. At 20 of 31 sites the 0.5m PBI was either higher than or similar to the PBI level at 1.5 m. This was different that the general pattern in 2017, when PBI was generally lighter at 0.5m than at 1 or 1.5m at many sites.

Table 13. Summary of periphyton chlorophyll *a*, Ash Free Dry Weight (AFDW), visual score, avg. filament length, percent algal coverage and Periphyton Biomass Index for routine sites (shaded) and Spring Synoptic survey sites during April 25, 2018-May 15, 2018. Note for chlorophyll *a* and AFDW, n=2 unless otherwise indicated. Visual score is a subjective ranking of the aesthetic appearance of algal growth (viewed underwater) where 1 is the least offensive and 5 is the most offensive. Biomass Index is filament length (cm) times percent algal cover. “NA” = not available or not collected; “NES” = not enough sample for analysis. Sampling depth and corresponding sampling elevation are also indicated. For algae types – SD=stalked diatoms; CY= Cyanobacteria; FG= filamentous greens; D= diatom mix “-f” indicates algae type best estimate based on field observation; “-m” indicates predominant algae types checked under microscope.

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
A	Cascade Creek	4/27/18	0.5	6227.02	50.11	1.96	29.93	4.52	3	3	1.2	70%	0.84	SD,FG -m
A	Cascade Creek	4/27/18	1.5	6223.74	NA	NA	NA	NA	2.5	2.5	1.0	50%	0.50	SD-f
B	S. of Eagle Point	4/25/18	0.5	6227.02	NA	NA	NA	NA	2.5	3	0.4	90%	0.36	FG,SD-f
B	S. of Eagle Point	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	0.4	80%	0.32	FG,SD-f
C	E.Bay/Rubicon	4/25/18	0.5	6227.02	NA	NA	NA	NA	4	4	3.0	100%	3.00	SD-f
C	E.Bay/Rubicon	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	1.0	80%	0.80	FG-f
	Rubicon Pt.	4/25/18	0.5	6227.02	73.41	7.89 (n=3)	27.65	2.72 (n=3)	4	4	2.8	100%	2.80	SD-m
	Rubicon Pt.	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	1.5	80%	1.20	FG,CY-f
D	Gold Coast	4/25/18	0.5	6227.02	85.77	45.24 (n=3)	35.14	15.84 (n=3)	4	4	2.0	100%	2.00	SD-m
D	Gold Coast	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	2.0	80%	1.60	SD,FG-f
E	S. Meeks Point	4/25/18	0.5	6227.02	NA	NA	NA	NA	3	3	2.5	100%	2.50	SD,FG-f
E	S. Meeks Point	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	1.0	80%	0.80	SD-f
F	N. Meeks Bay	4/25/18	0.5	6227.02	NA	NA	NA	NA	3	3	1.5	80%	1.20	SD,FG-f
F	N. Meeks Bay	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	1.5	80%	1.20	FG-f
	Sugar Pine Pt.	4/25/18	0.5	6227.02	10.15	0.46	5.38	0.28	2	2	1.0	90%	0.90	SD-m
	Sugar Pine Pt.	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	1.0	80%	0.80	FG,SD-f
G	Tahoma	4/25/18	0.5	6227.02	NA	NA	NA	NA	NA	2	1.5	90%	1.35	SD,FG-f
G	Tahoma	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	1.5	50%	0.75	SD,FG-f
H	S. Fleur Du Lac	4/25/18	0.5	6227.02	186.44	96.48 (n=3)	75.54	26.80 (n=3)	4	5	7.0	100%	7.00	SD-m
H	S. Fleur Du Lac	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	3.0	100%	3.00	SD,FG-f
I	Blackwood Creek	4/25/18	0.5	6227.02	NA	NA	NA	NA	NA	3	2.0	100%	2.00	SD-f
I	Blackwood Creek	4/25/18	0.75		NA	NA	NA	NA	NA	NA	3.5	100%	3.50	
	Kaspian Pt.	4/26/18	0.5	6227.03	NA	NA	NA	NA	4	4	2.5	100%	2.50	SD-f
	Kaspian Pt.	4/26/18	1.5	6223.75	NA	NA	NA	NA	NA	NA	2.0	90%	1.80	FG,SD-f
J	Ward Creek	4/26/18	0.5	6227.03	94.69	29.31 (n=3)	55.22	26.45 (n=3)	5	5	3.5	100%	3.5	SD-m
J	Ward Creek	4/26/18	1.5	6223.75	NA	NA	NA	NA	NA	NA	1.0-6.0	50%	0.50+	SD-f

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
	Pineland	4/26/18	0.5	6227.03	20.55	5.45 (n=3)	20.40	5.67 (n=3)	3.5	3.5	1.0	69%	0.69	SD,CY,FG-m
	Pineland- Rock A	4/26/18	0.8	6226.04	NA	NA	NA	NA	NA	NA	2.5	100%	2.50	
	Pineland	4/26/18	1.0	6225.38	NA	NA	NA	NA	NA	NA	3.5	100%	3.50	SD,FG-f
	Pineland	4/26/18	1.5	6223.75	NA	NA	NA	NA	NA	NA	2.5	65%	1.63	SD,FG-f
K	N. Sunnyside	4/26/18	0.5	6227.03	NA	NA	NA	NA	NA	3	0.5	33%	0.17	SD-f
L	Tavern Pt.	4/26/18	0.5	6227.03	NA	NA	NA	NA	2.5	2.5	1.0	NA	NA	SD-f
L	Tavern Pt.	4/26/18	1.5	6223.75	NA	NA	NA	NA	NA	NA	2.0	70%	1.40	SD,FG-f
	Tahoe City	4/26/18	0.5	6227.03	89.48	38.90 (n=3)	61.63	22.12 (n=3)	4	4	3.0	95%	2.85	SD-m
	Tahoe City	4/26/18	1.5	6223.75	NA	NA	NA	NA	NA	NA	2.0	40%	0.80	SD-f
TCT	Tahoe City Trib.	4/27/18	0.5	6227.02	75.12	37.71 (n=3)	73.13	28.75 (n=3)	5	5	4.0	100%	4.00	SD-m
TCT	Tahoe City Trib.	4/27/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	5.08	100%	5.08	SD-f
M	TCPUD Boat Ramp	5/11/18	0.5	6227.11	NA	NA	NA	NA	4	4	2.5	90%	2.25	SD-f
	Lake Forest	5/11/18	0.5	6227.11	60.13	43.37 (n=3)	46.91	15.32 (n=3)	NA	4	2.5	94%	2.35	SD,D,FG,CYm
N	S. Dollar Pt.	4/26/18	0.5	6227.03	NA	NA	NA	NA	NA	2	1.0	80%	0.80	SD-f
N	S. Dollar Pt.	4/26/18	0.75-1.5	6226.21-6223.75	NA	NA	NA	NA	NA	NA	2.0	100%	2.0	SD-f
	Dollar Pt.	4/26/18	0.5	6227.03	39.14	9.40 (n=3)	24.45	5.04 (n=3)	2	3	1.5	80%	1.20	SD,D-m
O	S. Dollar Creek	4/26/18	0.5	6227.03	NA	NA	NA	NA	NA	4	4.0	100%	4.0	SD-f
O	S. Dollar Creek	4/26/18	0.75	6226.21	NA	NA	NA	NA	NA	NA	7.0	100%	7.0	SD-f
O	S. Dollar Creek	4/26/18	1.5	6223.75	NA	NA	NA	NA	NA	NA	7.0	100%	7.0	SD-f
P	Cedar Flat	4/26/18	0.5	6227.03	NA	NA	NA	NA	3	3	2	90%	1.8	SD-f
P	Cedar Flat	4/26/18	1.5	6223.75	NA	NA	NA	NA	NA	NA	1.5	80%	1.2	SD-f
Q	Garwood's	5/9/18	0.5	6227.09	75.29	10.83 (n=3)	88.28	14.80 (n=3)	4.5	4.5	4.0	85%	3.4	SD,D-m
Q	Garwood's	5/9/18	1.5	6223.81	NA	NA	NA	NA	NA	NA	6.4	50%	3.2	SD-f
R	Flick Point	5/9/18	0.5	6227.09	NA	NA	NA	NA	3	3.5	1.5	60%	0.90	SD-f
S	Stag Avenue	5/9/18	0.5	6227.09	NA	NA	NA	NA	3	3	1.0	80%	0.80	SD-f
S	Stag Avenue	5/9/18	1.5	6223.81	NA	NA	NA	NA	NA	NA	1.5	50%	0.75	SD,FG-f
T	Agatam Boat R.	5/9/18	0.5	6227.09	30.84	7.32	21.19	1.83	3	3	0.9	90%	0.81	SD,CY-m
T	Agatam Boat R.	5/9/18	1.5	6223.81	NA	NA	NA	NA	NA	NA	2.0	25%	0.50	SD-f
E17	Kings Beach	5/9/18	0.5	6227.09	NA	NA	NA	NA	2	3	1.5	40%	0.60	SD-f
E17	Kings Beach	5/9/18	1.5	6223.81	NA	NA	NA	NA	NA	NA	2.0	20%	0.40	SD-f

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
E16	Brockway Springs	5/9/18	0.5	6227.09	NA	NA	NA	NA	NA	NA	0.1/1.0	80%/50%	0.53	SD,CY-m
E16	Brockway Springs	5/9/18	1.5	6223.81	NA	NA	NA	NA	NA	NA	1.5	25%	0.38	SD-f
E15	No. Stateline Point	5/10/18	0.5	6227.10	NA	NA	NA	NA	3	3	0.5	90%	0.45	SD-f
E15	No. Stateline Point	5/10/18	1.5	6223.82	NA	NA	NA	NA	NA	NA	2.0	50%	1.00	SD-f
E14	Stillwater Cove	5/10/18	0.5	6227.10	NA	NA	NA	NA	2	2	1.0	60%	0.60	SD-f
	Old Incline West	5/10/18	0.5	6227.10	NA	NA	NA	NA	2	3	1.5	50%	0.75	SD-f
	Incline West	5/10/18	0.5	6227.11	15.69	2.41	12.50	1.38	2	3	1.0	80%	0.80	SD,CY-m
	Incline Condo	5/10/18	0.5	6227.10	NA	NA	NA	NA	3	3	1.1	90%	0.99	SD-f
E13	Burnt Cedar	5/10/18	0.5	6227.10	11.75	0.30	9.51	1.10	3	3	1.0	90%	0.90	SD,CY-m
	Hidden Beach Insh.	5/10/18	0.5	6227.10	NA	NA	NA	NA	1	2	0.5	50%	0.25	SD-f
	Hidden Beach Offsh	5/10/18	0.5	6227.10	NA	NA	NA	NA	NA	2	0.3	70%	0.21	SD-f
	Observation Pt.	5/10/18	0.5	6227.10	NA	NA	NA	NA	2	2	0.5	50%	0.25	SD-f
	Observation Pt.	5/10/18	1.5	6223.82	NA	NA	NA	NA	NA	NA	1.0	80%	0.80	FG,SD-f
	Sand Pt.	5/10/18	0.5	6227.10	3.36	0.93	5.45	4.34	2	2.5	0.3	80%	0.24	SD,CY-m
	Sand Pt.	5/10/18	1.5	6223.82	NA	NA	NA	NA	NA	NA	1.0	50%	0.50	FG,SD-f
E10	Chimney Beach	5/10/18	0.5	6227.10	NA	NA	NA	NA	2	2.5	0.5	90%	0.45	SD-f
E10	Chimney Beach	5/10/18	1.5	6223.82	NA	NA	NA	NA	NA	NA	2.0	70%	1.40	FG,SD-f
E9	Skunk Harbor	5/10/18	0.5	6227.10	NA	NA	NA	NA	2	2	0.3	50%	0.15	SD,CY-f
E9	Skunk Harbor	5/10/18	1.5	6223.82	NA	NA	NA	NA	NA	NA	≤1.0	50%	≤0.50	SD,FG-f
	Deadman Pt.	5/10/18	0.5	6227.10	2.98	0.76	NES	NES	1.5	2	0.1	50%	0.05	SD,CY-m
E8	So. Deadman Point	5/10/18	0.5	6227.10	NA	NA	NA	NA	NA	3	0.5	90%	0.45	SD-f
E8	So. Deadman Point	5/10/18	1.5	6223.82	NA	NA	NA	NA	NA	NA	2.0	60%	1.2	SD,FG-f
E7	So. Glenbrook Bay	5/10/18	0.5	6227.10	NA	NA	NA	NA	3	3	0.4	90%	0.36	SD-f
E6	Cave Rock Ramp	5/10/18	0.5	6227.10	38.84	8.78 (n=3)	28.62	7.44 (n=3)	4	4	2.0	95%	1.9	SD,CY-m
E5	Lincoln Park	5/15/18	0.5	6227.17	NA	NA	NA	NA	2	3	0.2	50%	0.1	SD-f
E4	No. Zephyr Cove	5/15/18	0.5	6227.17	NA	NA	NA	NA	2	3	0.8	70%	0.56	SD,FG-f
	Zephyr Pt.	5/15/18	0.5	6227.17	8.24	0.50	8.24	0.73	2	2	0.3	90%	0.27	CY,SD,FG-m
	So. Zephyr Pt.	5/15/18	0.5	6227.17	NA	NA	NA	NA	2	4	2.5	90%	2.25	SD-f
E2	No. Elk Pt.	5/15/18	0.5	6227.17	NA	NA	NA	NA	2	3	0.5	70%	0.35	SD-f
E1	So. Elk Point	5/15/18	0.5	6227.17	NA	NA	NA	NA	2	5	3.0	90%	2.70	SD-f
	Timber Cove Rock	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	3.5	1.0	70%	0.70	SD-f
S1	T. Keys Entrance	4/25/18	0.5	6227.02	NA	NA	NA	NA	3	4	3.0/1.0	20%/40%	1.0	FG,SD-f
	Kiva Pt.	4/25/18	0.5	6227.02	NA	NA	NA	NA	2	2	0.3	10%	0.5	SD-f
	Kiva Pt.	4/25/18	1.5	6223.74	NA	NA	NA	NA	NA	NA	1.5	30%	0.45	SD-f

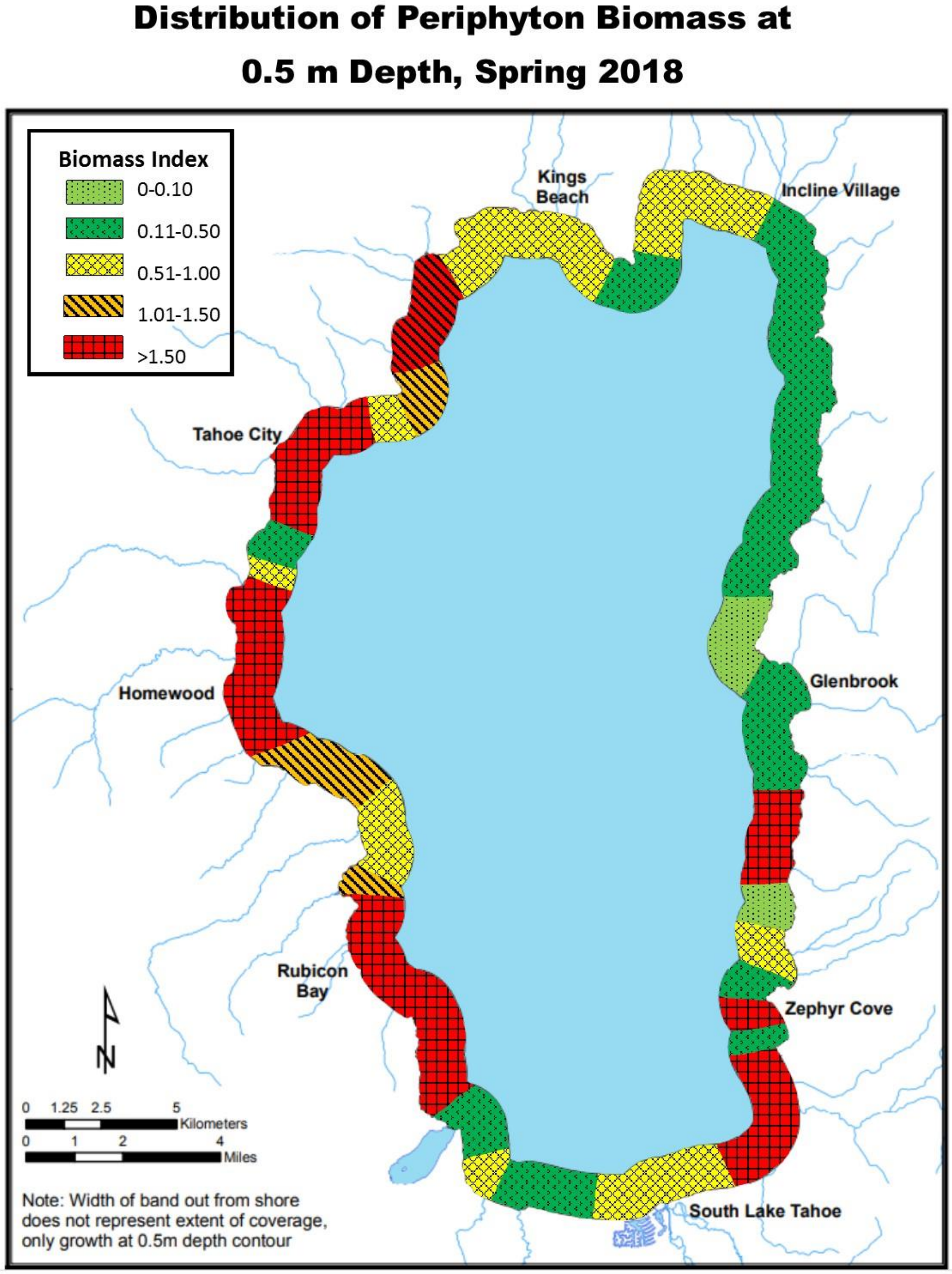


Figure 37. Distribution of peak periphyton biomass measured during the spring synoptic 2018 (4/25/18-5/15/18) at 0.5m. Shading indicates levels of biomass measured using a rapid assessment method: Periphyton Biomass Index (PBI). (PBI= Avg. Filament Length x (multiplied by) Percent Area Covered with Algae).

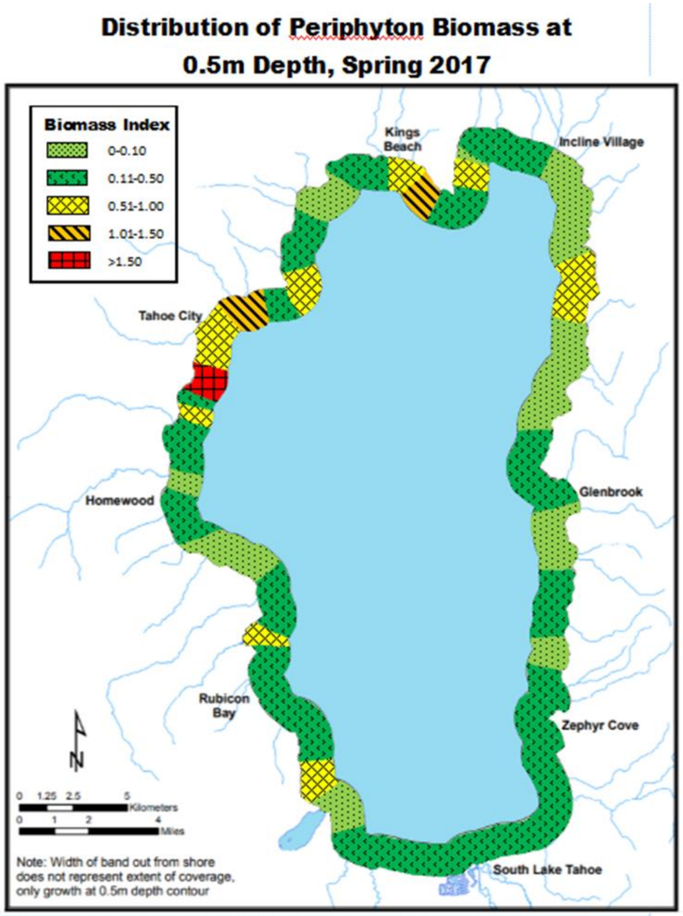


Fig. 38.a. Spring 2017 PBI

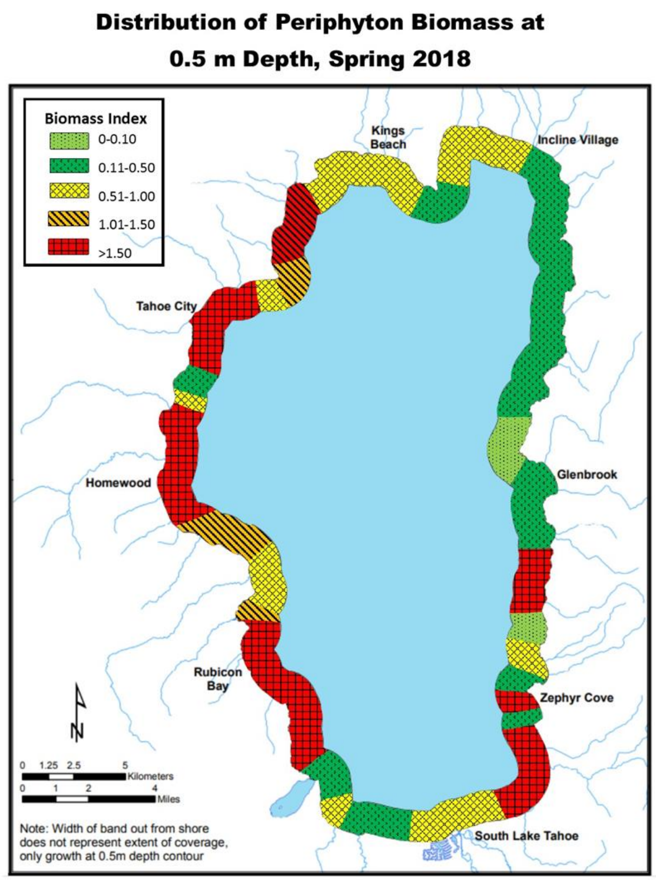


Fig. 38.b. Spring 2018 PBI.

Figures 38 a, b. Comparison of periphyton biomass index (PBI) levels at 0.5m during spring synoptics in 2017 and 2018. PBI levels were much higher at 0.5m in 2018. A sustained high lake level, and longer period for the periphyton community to develop on rock substrate at 0.5m likely contributed to the higher PBI levels in 2018.

Heavy Periphyton Growth at South Fleur du Lac in Spring 2018

One interesting observation from the spring 2018 sampling relates to the level of growth at the South Fleur du lac site. That site had unusually heavy growth. The algae there had a unique growth pattern, producing long stringy filaments in addition to the furry coating over the rocks, some of the strands were over 5 inches long (Figure 39). Two different stalked diatoms were observed make up some of the stalks (Figure 40) A long-time resident from the area indicated the level of growth there was the heaviest he's seen it going back to 1990. The cause of the heavy growth this year there is not known. There is a large stormwater outfall pipe adjacent to the site and it is also south of Blackwood Cr. However, it is unknown if water inputs from these sources had substantial impacts on the levels of growth seen there in 2018.

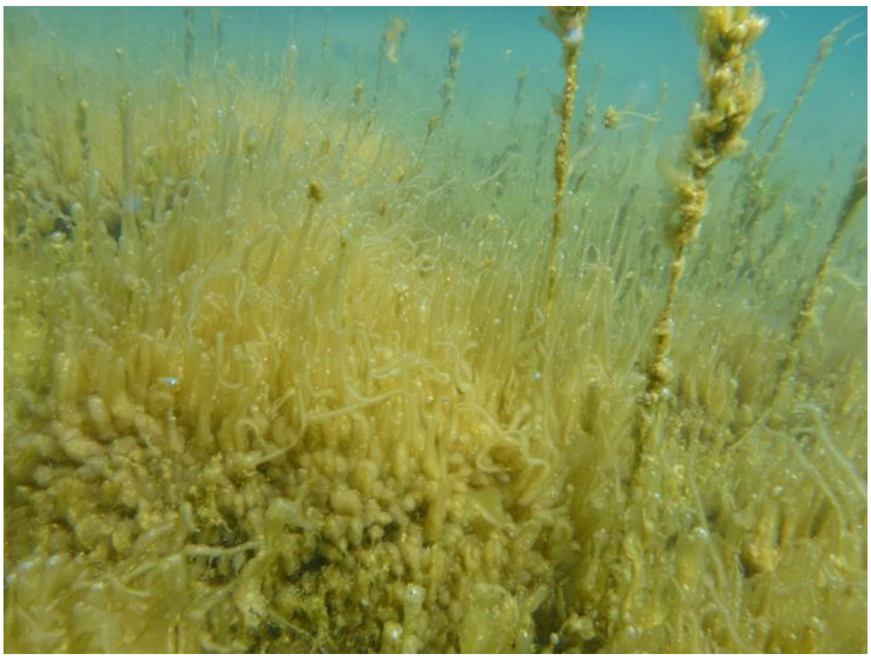


Figure 39. Heavy growth of periphyton at South Fleur du lac site 4/25/18. Photo by Katie Senft.

Figure 40. Large and small stalked diatoms, at edge of periphyton strand, South Fleur du lac.

Predominant Algal Types during 2018 Spring Synoptic

The predominant algal types in the periphyton observed around the lake at 0.5m during the spring synoptic 2018 were primarily large and/or and small stalked diatoms. Cyanobacteria and/or filamentous green algae was also present at multiple sites.

2019 Periphyton Spring Synoptic Monitoring

46 sites in addition to the 9 routine sites were monitored in spring 2019 to provide lake-wide information on the distribution of periphyton biomass. This monitoring was done during 4/18/19 to 5/8/19. The data collected in the spring synoptic monitoring are summarized in Table 14. Figure 41 presents the map of PBI levels at 0.5m around the lake.

Generally light PBI (indicated by the two shades of green, in Figure 41) was observed at 0.5m along much of the northeast shore with one heavy PBI site interspersed at Chimney Beach (PBI=1.96) and at a couple of sites along the southwest shore. Heavy PBI (indicated by red) or moderate-heavy PBI (indicated by orange) was measured along much of the west shore and at a one location along the southeast shore. The areas with the highest PBI included: Ward Cr. (PBI=8.0), Gold Coast (PBI=4.5), So. Dollar Cr. (PBI=3.88), Garwoods (3.5), Tahoe City (PBI=3.33), So. Fleur du lac (PBI=3.00), Kaspian (PBI=3.00). Nutrient contributions to lake surface waters (likely including contributions from surface and subsurface flows and from lake mixing and/or upwelling) may have helped thick growth of periphyton to develop at many sites in spring 2019.

The pattern of PBI in spring 2019 was fairly similar to that observed in 2018. PBI in both years was relatively heavy along the west shore with areas of light PBI along the northeast shore and along the southwest shore. However in 2019 there were several patches along the central west portion of the lake with light PBI indicated by green. It's possible these were due to sloughing of heavier growth earlier in the spring or other causes. Tahoe City Tributary which typically has had heavy spring periphyton growth had was one of the sites with light PBI in April 2019 (PBI=0.32). Areas of high PBI were on either side of it (Tahoe City, PBI=3.33; and Tahoe City Boat Ramp and Lake Forest to the north (PBI= 2.70 and 2.88 respectively), it seems likely heavy growth may have sloughed there. Another patch of lighter PBI was at Pineland at 0.5m (PBI=0.38). Interestingly at that site PBI was also low in March (PBI=0.59) yet chlorophyll *a* was relatively high 156.77 mg/m^2. That site was also unusual in that there was very little stalked diatom presence in the community in March with some present in April. It's possible that sloughing occurred early at this site and periphyton were slowly returning going through community succession.

Table 14. Summary of periphyton chlorophyll *a*, Ash Free Dry Weight (AFDW), visual score, avg. filament length, percent algal coverage and Periphyton Biomass Index for routine sites (shaded) and Spring Synoptic survey sites during April 18, 2019-May 8, 2019. Note for chlorophyll *a* and AFDW, n=2 unless otherwise indicated. Visual score is a subjective ranking of the aesthetic appearance of algal growth where 1 is the least offensive and 5 is the most offensive. Biomass Index is filament length (cm) times percent algal cover. "NA" = not available or not collected; "NES" = not enough sample for analysis; "TBA" to be analyzed. Sampling depth and corresponding sampling elevation are shown. For algae types – SD=stalked diatoms; CY= Cyanobacteria; FG= filamentous greens; S= Synedra; D= diatom mix "-f" indicates algae type best estimate based on field observation; "-m" indicates predominant algae types checked under microscope.

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
A	Cascade Creek	4/26/19	0.5	6226.36	TBA	TBA	17.36	4.42 (n=3)	3	3	0.5	100%	0.50	SD,CY,D,FGm
B	S. of Eagle Point	4/26/19	0.5	6226.36	NA	NA	NA	NA	3	4	2.0	90%	1.80	SD,FG-f
C	E.Bay/Rubicon	4/26/19	0.5	6226.36	NA	NA	NA	NA	NA	4	2.0	70%	1.40	SD-f
	Rubicon Pt.	4/26/19	0.5	6226.36	179.37	24.74 (n=2)	107.97	10.33 (n=2)	4	4.5	4.0	60%	2.40	SD,CY,FG-m
D	Gold Coast	4/26/19	0.5	6226.36	NA	NA	NA	NA	4	5	4.5	100%	4.50	SD-f
E	S. Meeks Point	4/26/19	0.5	6226.36	145.98	85.53 (n=3)	106.35	93.69 (n=3)	4	5	2.5	100%	2.50	SD,CY,FG-f
F	N. Meeks Bay	4/26/19	0.5	6226.36	NA	NA	NA	NA	5	5	3.5/0.5	33%/67%	1.50	SD-f
	Sugar Pine Pt.	4/26/19	0.5	6226.36	9.71	0.30 (n=2)	7.02	0.49 (n=2)	3.5	3.5	0.7	80%	0.56	FG,CY,SD-m
G	Tahoma	4/18/19	0.5	6226.28	NA	NA	NA	NA	2	3	1.2	90%	1.08	SD,FG-f
H	S. Fleur Du Lac	4/18/19	0.5	6226.28	164.31	74.96 (n=3)	66.36	12.59 (n=3)	4	4	3.0	100%	3.00	SD,FG-m
I	Blackwood Creek	4/18/19	0.5	6226.28	NA	NA	NA	NA	3	3	0.8	50%	0.40	SD-f
I	Blackwood Creek	4/18/19	1.0	6224.64	NA	NA	NA	NA	NA	NA	1.25	80%	1.00	
	Kaspian Pt.	4/18/19	0.5	6226.28	NA	NA	NA	NA	4	4	3.0	100%	3.00	SD,FG-f
J	Ward Creek	4/18/19	0.5	6226.28	434.98	16.83 (n=2)	177.70	30.38 (n=2)	5	5	8.0	100%	8.00	SD-m
J	Ward Creek	4/18/19	1.0	6224.64	NA	NA	NA	NA	NA	NA	6.0	100%	6.00	SD-f
	Pineland	4/23/19	0.5	6226.30	23.44	7.87 (n=3)	20.73	8.77 (n=3)	3	3	0.7	54%	0.38	S,SD,D,FGm
	Pineland	4/23/19	1.0	6224.66	206.22	47.71 (n=3)	138.13	39.20 (n=3)	NA	NA	4.0	90%	3.60	SD,FG-m
	Pineland	4/23/19	2.0	6221.38	230.72	41.73 (n=4)	169.20	28.72 (n=4)	NA	NA	4.5	90%	4.05	FG,SD,S,CYm
	Pineland	4/23/19	8.0	6201.69	74.11	45.27 (n=3)	63.97	32.49 (n=3)	NA	NA	0.2	100%	0.20	CY,D,FG-m
K	N. Sunnyside	4/18/19	0.5	6226.28	NA	NA	NA	NA	3	3.5	1.4	60%	0.84	SD-f
K	N. Sunnyside	4/18/19	1.0	6224.64	NA	NA	NA	NA	NA	NA	5.0	100%	5.00	SD-f
L	Tavern Pt.	4/18/19	0.5	6226.28	91.87	26.64 (n=3)	66.16	16.63 (n=3)	4	4	2.2	98%	2.16	S,SD-m

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
	Tahoe City	4/22/19	0.5	6226.30	142.85	54.69 (n=3)	103.61	13.06 (n=3)	4	4	3.5	95%	3.33	SD-m
TCT	Tahoe City Trib.	4/22/19	0.5	6226.30	40.51	7.93 (n=3)	29.95	6.11 (n=3)	3.5	3.5	0.7	46%	0.32	SD,S-m
M	TCPUD Boat Ramp	4/18/19	0.5	6226.28	NA	NA	NA	NA	4	4	3.0	90%	2.70	SD-f
	Lake Forest	4/18/19	0.5	6226.28	NA	NA	NA	NA	4	4	3.0	96%	2.88	SD,CY-f
	Lake Forest	4/18/19	1.0	6224.64	NA	NA	NA	NA	NA	NA	4.0	100%	4.00	SD-f
N	S. Dollar Pt.	4/18/19	0.5	6226.28	NA	NA	NA	NA	3	3	0.6	45%	0.27	SD-f
N	S. Dollar Pt.	4/18/19	1.5	6223.00	NA	NA	NA	NA	NA	NA	1.5	50%	0.75	
	Dollar Pt.	4/18/19	0.5	6226.28	71.28	17.97 (n=3)	58.64	13.40 (n=3)	3.5	4	1.8	98%	1.76	SD-f
O	S. Dollar Creek	4/18/19	0.5	6226.28	104.02	29.76 (n=3)	78.55	8.59 (n=3)	4	5	4.0	97%	3.88	SD,S-m
O	S. Dollar Creek	4/18/19	1.5	6223.00	NA	NA	NA	NA	NA	NA	4.0	60%	2.40	SD-f
P	Cedar Flat	4/29/19	0.5	6226.43	NA	NA	NA	NA	2	3	1.5	50%	0.75	SD,FG-f
P	Cedar Flat	4/29/19	1.0	6224.79	NA	NA	NA	NA	NA	NA	3.0	80%	2.40	SD-f
Q	Garwood’s	4/29/19	0.5	6226.43	153.35	107.52 (n=3)	122.03	110.52 (n=3)	4	5	3.5	100%	3.5	SD,CY,S-m
Q	Garwood’s	4/29/19	1.0	6224.79	NA	NA	NA	NA	NA	NA	6.0	100%	6.0	SD-f
Q	Garwood’s	4/29/19	1.5	6223.15	NA	NA	NA	NA	NA	NA	3.0	100%	3.0	
R	Flick Point	4/29/19	0.5	6226.43	NA	NA	NA	NA	2	3	1.2	70%	0.84	SD-f
R	Flick Point	4/29/19	1.0	6224.79	NA	NA	NA	NA	NA	NA	1.2	70%	0.84	SD-f
S	Stag Avenue	4/29/19	0.5	6226.43	NA	NA	NA	NA	3	4	1.5	100%	1.5	SD-f
S	Stag Avenue	4/29/19	1.0	6224.79	NA	NA	NA	NA	NA	NA	2.0	70%	1.4	
T	Agatam Boat R.	4/29/19	0.5	6226.43	NA	NA	NA	NA	2	3	1.2	70%	0.84	SD-f
T	Agatam Boat R.	4/29/19	0.75	6225.61	NA	NA	NA	NA	NA	NA	3.0	90%	2.70	SD-f
E17	Kings Beach	4/29/19	0.5	6226.43	TBA	TBA	193.71	28.59 (n=3)	4	4	2.5	80%	2.00	SD,S-m
E17	Kings Beach	4/29/19	1.0	6224.79	NA	NA	NA	NA	NA	NA	3.0	90%	2.70	SD-f
E16	Brockway Springs	4/29/19	0.5	6226.43	NA	NA	NA	NA	2	3	1.0	60%	0.60	SD-f
E16	Brockway Springs	4/29/19	1.0	6223.15	NA	NA	NA	NA	NA	NA	1.0	60%	0.60	SD-f
E15	No. Stateline Point	4/29/19	0.5	6226.43	NA	NA	NA	NA	2	3	1.5	30%	0.45	SD-f
E14	Stillwater Cove	4/29/19	0.5	6226.43	TBA	TBA	60.39	18.12 (n=3)	3	4	3.0/0.5	30%/56%	1.18	SD,S-m
	Old Incline West	4/29/19	0.5	6226.43	NA	NA	NA	NA	3	3	1.2	90%	1.08	SD-f
	Incline West	4/29/19	0.5	6226.43	NA	NA	41.94	9.89 (n=3)	4	4	2.5	100%	2.50	SD,S-m
	Incline Condo	4/29/19	0.5	6226.43	NA	NA	NA	NA	3	3	1.3	90%	1.17	SD-f

Site	Site Name	Date	Samp. Depth (m)	Samp. Elev. (ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
E13	Burnt Cedar	4/29/19	0.5	6226.43	NA	NA	NA	NA	4	3	0.7	80%	0.56	SD-f
E13	Burnt Cedar	4/29/19	1.0	6224.79	NA	NA	NA	NA	NA	NA	0.7	70%	0.49	SD-f
	Hidden Beach Insh.	4/29/19	0.5	6226.43	TBA	TBA	8.76	1.01	3	3	0.6	80%	0.48	SD,CY-m
	Hidden Beach Offsh	4/29/19	0.5	6226.43	NA	NA	NA	NA	2	2	0.1/0.3	35%/35%	0.14	CY,SD-f
	Observation Pt.	4/29/19	0.5	6226.43	NA	NA	NA	NA	2	3	0.2	60%	0.12	CY,SD,FG-f
	Sand Pt.	4/29/19	0.5	6226.43	6.48	0.41	6.16	0.31	3	3	0.4	70%	0.28	CY,D,SD,FGm
E10	Chimney Beach	5/8/19	0.5	6226.56	NA	NA	NA	NA	3	3.5	2.0	98%	1.96	SD-f
E10	Chimney Beach	5/8/19	1.0	6224.92	NA	NA	NA	NA	NA	NA	2.0	30%	0.6	SD-f
E9	Skunk Harbor	5/8/19	0.5	6226.56	NA	NA	NA	NA	3	3	0.6	70%	0.42	SD,FG-f
E9	Skunk Harbor	5/8/19	1.0	6224.92	NA	NA	NA	NA	NA	NA	0.6	70%	0.42	SD,FG-f
	Deadman Pt.	5/8/19	0.5	6226.56	18.25	3.84	18.57	4.43	3.5	3.5	0.6	70%	0.42	FG,CY-m
	Deadman Pt.	5/8/19	1.0	6224.92	NA	NA	NA	NA	NA	NA	0.6/0.1	30%/40%	0.22	FG,CY-f
E8	So. Deadman Point	5/8/19	0.5	6226.56	NA	NA	NA	NA	2	3	1.0	80%	0.80	SD-f
E8	So. Deadman Point	5/8/19	1.0	6224.92	NA	NA	NA	NA	NA	NA	1.5	50%	0.75	SD-f
E7	So. Glenbrook Bay	5/8/19	0.5	6226.56	NA	NA	NA	NA	2	2	<0.1	70%	<0.07	CY-f
E6	Cave Rock Ramp	5/8/19	0.5	6226.56	24.56	4.77 (n=3)	19.62	4.54 (n=3)	2	3	1.5	80%	1.20	SD,CY-m
E5	Lincoln Park	5/8/19	0.5	6226.56	NA	NA	NA	NA	2	2	0.1	50%	0.05	CY,SD-f
E4	No. Zephyr Cove	5/8/19	0.5	6226.56	NA	NA	NA	NA	3	3	0.4	70%	0.28	CY,FG,SD-f
	Zephyr Pt.	4/26/19	0.5	6226.36	13.51	1.60 (n=3)	10.14	1.94 (n=3)	1	2	0.3	70%	0.21	CY,SD-m
	So. Zephyr Pt.	4/26/19	0.5	6226.36	NA	NA	NA	NA	NA	4	2.5	40%	1.00	SD-f
E2	No. Elk Pt.	4/26/19	0.5	6226.36	NA	NA	NA	NA	1	2	0.2	5%	0.01	SD-f
E1	So. Elk Point	4/26/19	0.5	6226.36	NA	NA	NA	NA	3	3	1.0	90%	0.90	SD-f
	Timber Cove Rock	4/25/19	1.15	6224.21	NA	NA	NA	NA	NA	3.5	1.8	98%	1.76	SD-f
S1	T. Keys Entrance	4/25/19	0.5	6226.34	NA	NA	NA	NA	4	3.5	0.3	90%	0.27	SD-f
	Kiva Pt.	4/25/19	0.5	6226.34	7.16	1.02 (n=3)	7.03	0.27 (n=3)	3	3	0.6	39%	0.23	SD,D,FG-m

Distribution of Periphyton Biomass at
0.5 m Depth, Spring 2019

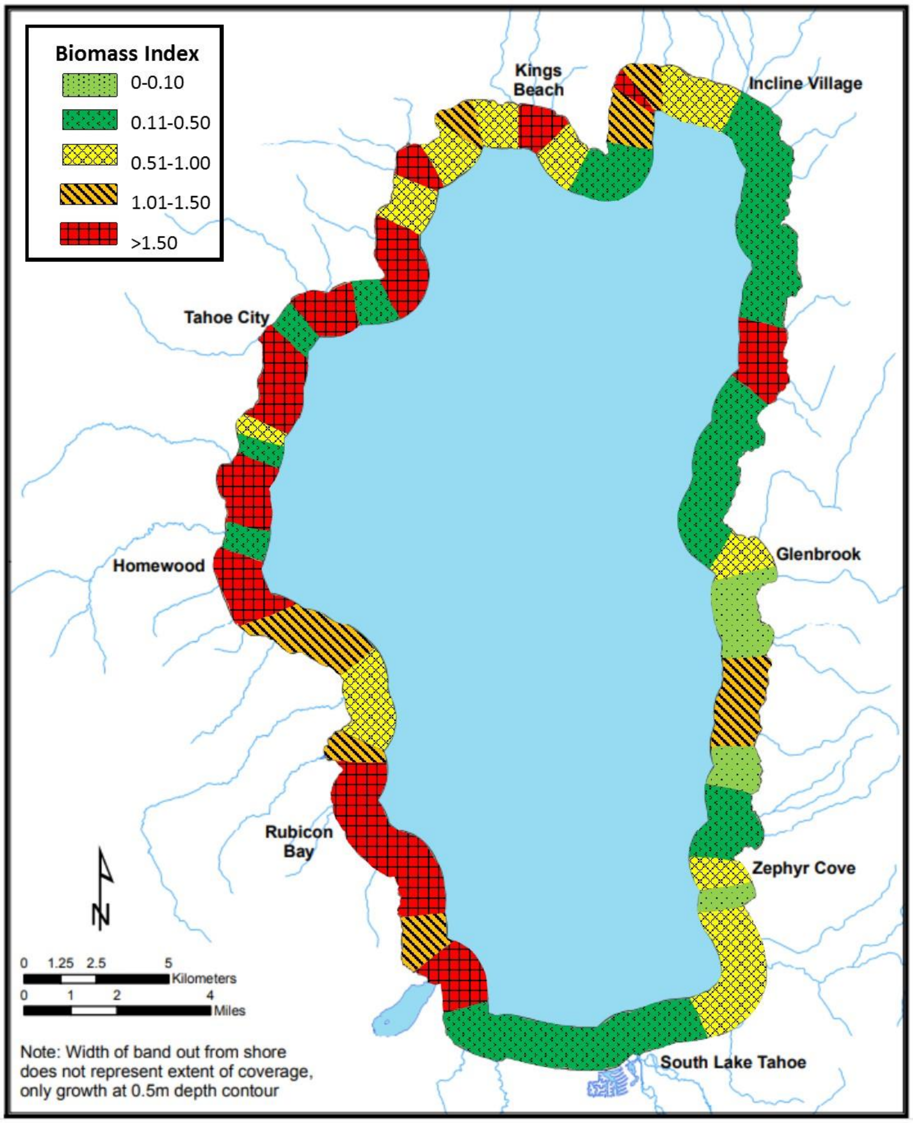


Figure 41. Distribution of peak periphyton biomass measured during the spring synoptic (4/18/19-5/8/19) at 0.5m. Shading indicates levels of biomass measured using a rapid assessment method: Periphyton Biomass Index (PBI). (PBI= Avg. Filament Length X Percent Area Covered with algae.

Heavy Biomass at Lake Forest was observed extending quite a distance offshore of the island there. This region is a shallow shelf and receives inflow from a small tributary, it is possible the widespread heavy growth there was impacted by the stream inflows there.

Heavy periphyton growth was observed over a widespread area of the shelf near Tahoe City including near the Marina in March. The periphyton appeared to be composed of both stalked diatoms and green filamentous algae.

At South and North Meeks Bay sites during the spring synoptic, large patches or mats of periphyton were sloughing/ peeling away from the rocks (Figure 42 shows a large mat of periphyton sloughing from a rock at No. Meeks Bay). Small pieces of sloughed periphyton were observed at the surface at the So. Meeks Bay site (Figure 43).

Along the southwest shore, areas of very heavy biomass were also observed at Gold Coast, E. Bay-Rubicon and Rubicon sites. Heavy periphyton was also observed on a submerged vertical log in deep water slightly offshore at E. Bay-Rubicon (Figure 44). This log was not near streams and was slightly offshore. This growth may have been a result of input of nutrients to surface waters associated with lake mixing. Moderately heavy stalked diatom growth was also observed along shore at 0.5m at E. Bay- Rubicon (Figure 45). There were also several shelf areas where the bottom was relatively shallow and flat where accumulations of white sloughed periphyton could be seen along the bottom.

<u>Predominant Algal Types during 2019 Spring Synoptic</u>

The predominant algal types in the periphyton observed around the lake at 0.5m during the spring synoptic 2019 were primarily small stalked diatoms. Filamentous green algae also were present along with stalked diatoms in certain areas, including many sites along the south-west shore of the lake. At the Pineland site at 1 and 2m on 4/23/19, there was much *Zygnema* present (a filamentous green algae) in addition to stalked diatoms. Some of the *Zygnema* at those depths was conjugating and producing zygospores (resting cysts). Cyanobacteria was also present at 0.5m at multiple sites.

Figure 42. Periphyton sloughing from boulder at the North Meeks Bay site 4/26/19.

Figure 43. Pieces of sloughed periphyton on the lake surface at the South Meeks Bay site 4/26/19.

Figure 44. Thick growth of periphyton on submerged vertical log in deep water offshore of the E.Bay- Rubicon site 4/26/19.

Figure 45. Stalked diatom periphyton growth at 0.5m at the E.Bay- Rubicon site 4/26/19.

Section IV. Nearshore Network Station Additions

Two stations were added to the nearshore water quality monitoring network in November 2017. The new station at Timber Cove is located off of the end of the long pier running from the "Boathouse on the Pier" restaurant. The new station at Camp Richardson is located off of the pier extending from the Camp Richardson marina. Both stations were damaged due to lightning strikes in May 2018 but have since been repaired and re-installed.

Together with the existing set of eight Lake Tahoe nearshore stations, these new stations are generating a high-frequency, spatially distributed data set that allows us to quantify temperature, conductivity, wave height, chlorophyll-*a* fluorescence, dissolved organic matter fluorescence, turbidity, and dissolved oxygen patterns at the perimeter of Lake Tahoe.

Select Data from 2018 Monitoring

Figure 46 provides some examples of data collected in spring 2018 at the Timber Cove site. The plots show Specific Conductance (Sp C), Colored Dissolved Organic Matter (CDOM) and lake temperature during March 1 to May 15, 2018. This was a period in which a couple of significant storm events occurred (March 21-22, 2018 and April 6-7 2018) along with periods of spring snowmelt which caused increased flows in the Upper Truckee River (see Figure 47). Inflow from the Upper Truckee can impact this site as well as potentially Bijou Cr. and stormwater inputs. There are periods of decreased conductivity at Timber Cove and increased CDOM during and following the large storm events. The decreased conductivities likely reflect inflow water, which is often lower in conductivity than the lake and results in "dips" in conductivity relative to typical lake conductivity. Stream water is higher in organics than the lake and results in spikes in CDOM when inflow water is present at the site. The data shown give an idea of how dynamic the plumes of inflow water are, as single point measurements show the signal appearing and disappearing over periods of hours.

Figure 48 provides an example of wave height, turbidity and temperature data collected from four nearshore stations, along northwest (Tahoe Vista), southwest (Rubicon), south (Timber Cove) and east (Glenbrook) shores during May 8-14, 2018. This period included an east wind event on May 11-12. Wave heights were highest at the Rubicon and Timber Cove sites during the east wind event. Turbidity tends to spike in response to increased wave activity along the shore (Roberts et al., 2019). There was a dip in temperature at Glenbrook due to mild upwelling on the east shore in response to the east wind. There also appears to be a slight rise in temperature at Rubicon during the same east wind event period. (The higher baseline turbidity at Tahoe Vista and Glenbrook is due to biofouling and should not be considered representative of baseline conditions in those areas).

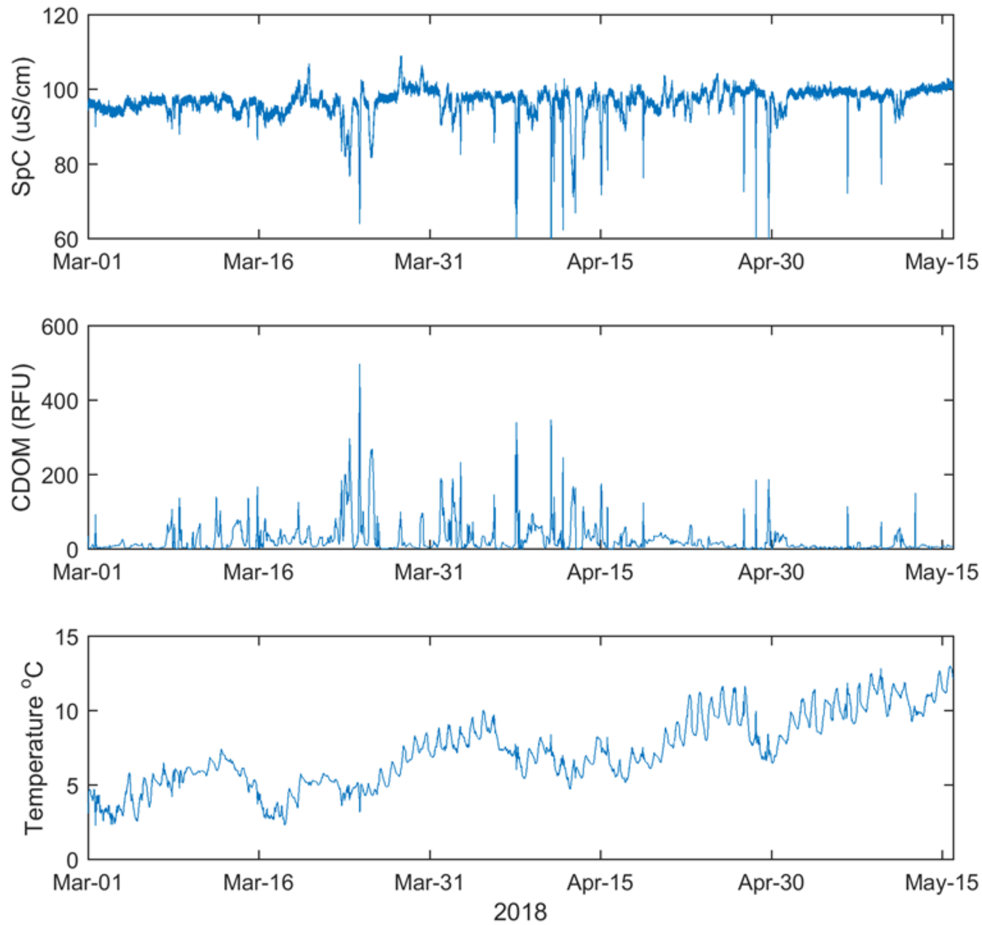


Figure 46. Comparisons of Specific Conductance (Sp C), Colored Dissolved Organic Matter (CDOM), and Temperature at TERC's Timber Cove nearshore station Mar. 1 to May 15, 2018.

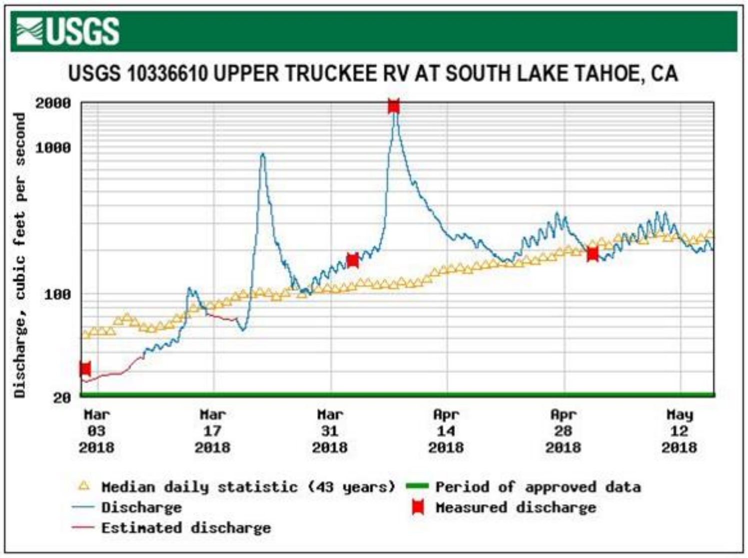


Figure 47. Upper Truckee River discharge March 1 to May 15, 2018. From: **https://nwis.waterdata.usgs.gov/nv/nwis/rt**

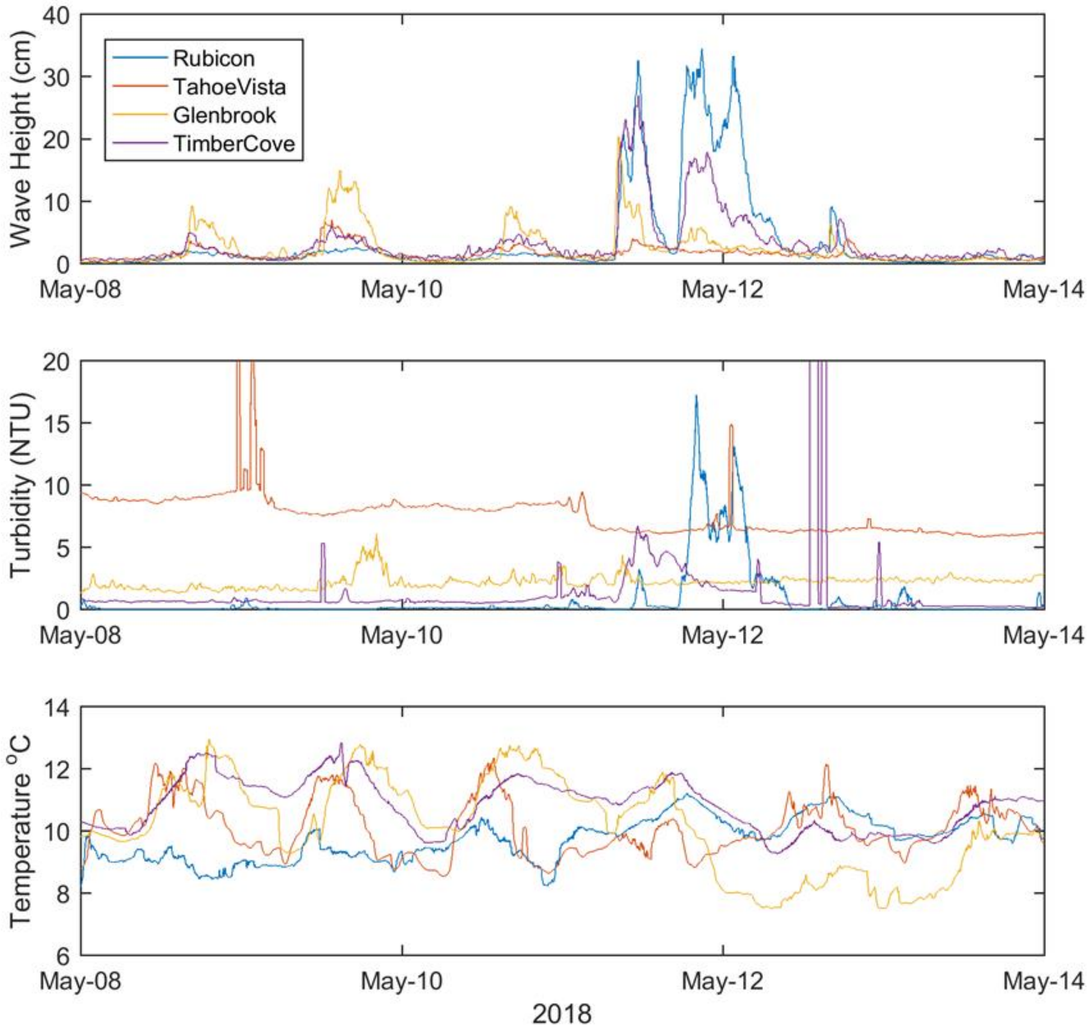


Figure 48. Examples of wave height, turbidity and temperature data collected from TERC's nearshore stations along northwest (Tahoe Vista), southwest (Rubicon), south (Timber Cove) and east (Glenbrook) shores during May 8-14, 2018 which included an east wind event on May 11-12. Turbidity tends to spike in response to waves. Wave heights were highest at the Rubicon and Timber Cove sites during the east wind event. (Note the higher baseline turbidity at Tahoe Vista and Glenbrook is due to biofouling and should not be considered representative of baseline conditions in those areas.)

Select Data from 2019 Monitoring

The data generated from the nearshore monitoring stations is useful for research that seeks to improve Lake Tahoe's water quality. Each nearshore station is a remote sensing instrument that measures temperature, conductivity, wave height, chlorophyll-a fluorescence, dissolved organic matter fluorescence, turbidity, and dissolved oxygen patterns in the littoral zone of Lake Tahoe at a frequency of 5 seconds. The data is then temporarily stored in a logger and transmitted via cellular to a database every hour. The quasi-live data allows real time monitoring to verify that each station is working accordingly to quality standards.

Figure 49 shows some of the data collected during 2019 at the Camp Richardson site. The figure shows water temperature, turbidity and specific conductance data (collected at ~2m depth) and surface wave heights in February 2019. During this period there were two major events caused by high speed winds that can be seen in the plots as a sudden decrease of water temperature. The two events occurred between 02-17-19 and 02-24-19, and are likely due to upwelling. This phenomena describes the water motion from deeper parts of the lakes up to the surface (i.e. cold water from deeper part of the lake moves to the surface of the lake due to the high winds). Furthermore these events brought the water temperature below the temperature at which the water has maximum density (4 °C shown by dotted black line in the figure). This generates a "front" threshold at 4 °C between water at temperatures above and below this temperature and has impacts on the effects of water motion. This is also the first time that the nearshore temperature was lower than 4 °C since data has been recorded (Dr. Derek Roberts, personal communication). The decrease in temperature aligned with spikes in turbidity and wave height. These patterns together with the fact that temperature decreased below the temperature of maximum density (4 °C) leads to question whether the turbidity spike was exclusively caused by the wave activity. It is possible that sediment resuspension associated with currents during upwelling also contributed to the increase in turbidity.

Figure 50 shows wave heights, temperature and Specific conductivity at the Timber Cove, Camp Richardson and Glenbrook nearshore stations between April 1 and May 20, 2019. It is interesting to compare specific conductivity responses at Timber Cove and Camp Richardson. These stations are located on opposite sides of the Upper Truckee River mouth along the south shore. Timber Cove conductivity frequently showed dips in conductivity, while such dips occurred much less frequently at Camp Richardson. When conductivity dipped at Timber Cove, the conductivity barely changed at Camp Richardson. Conversely, when conductivity changed at Camp Richardson the conductivity barely changed at Timber Cove. The dips in conductivity are likely associated with movement of stream plumes (primarily the Upper Truckee River) of water of lower conductivity than the lake over the stations. In addition, on May 12th a northeast wind caused an upwelling event at the two east shore stations (Glenbrook, Sand Harbor) and at Timber Cove along the south shore. Such upwelling is less common in the spring, as upwelling events during the spring at Lake Tahoe are most often observed at the west and southwest nearshore stations. Finally, on May 18th an upwelling event caused by a south wind of up to 12 mph is evident in the data. At Glenbrook and Timber

Cove the temperature decreased about 4 °C, while at Camp Richardson the water temperature decreased about 8 °C.

So among the important pieces of data provided by the nearshore network in 2019 was information on areas of stream influence near the Upper Truckee River and patterns of upwelling in different regions of the lake. Both direction of stream inflow along shore and occurrence of lake upwelling can have ramifications on delivery of nutrients and sediments to different regions and also have impacts on lake clarity.

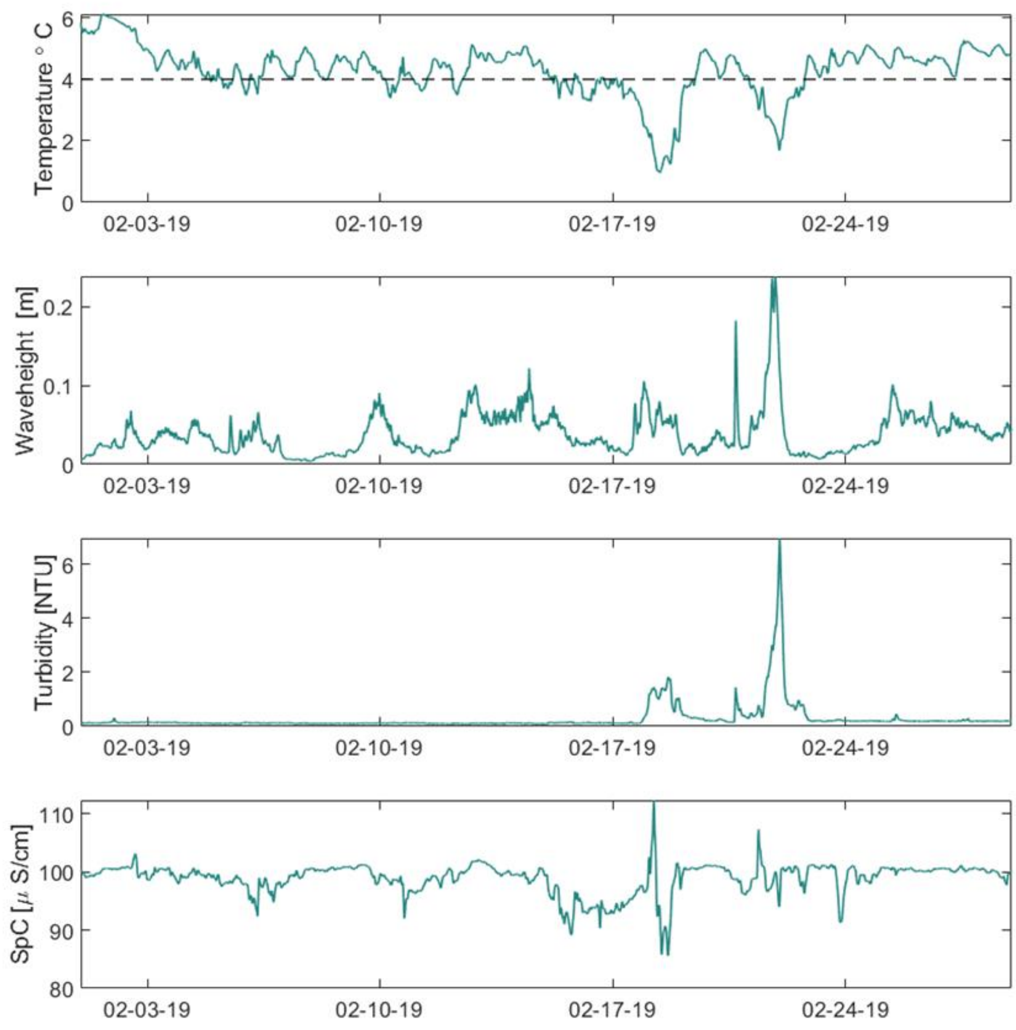


Figure 49. Camp Richardson temperature, wave height, turbidity and specific conductance during February 2019.

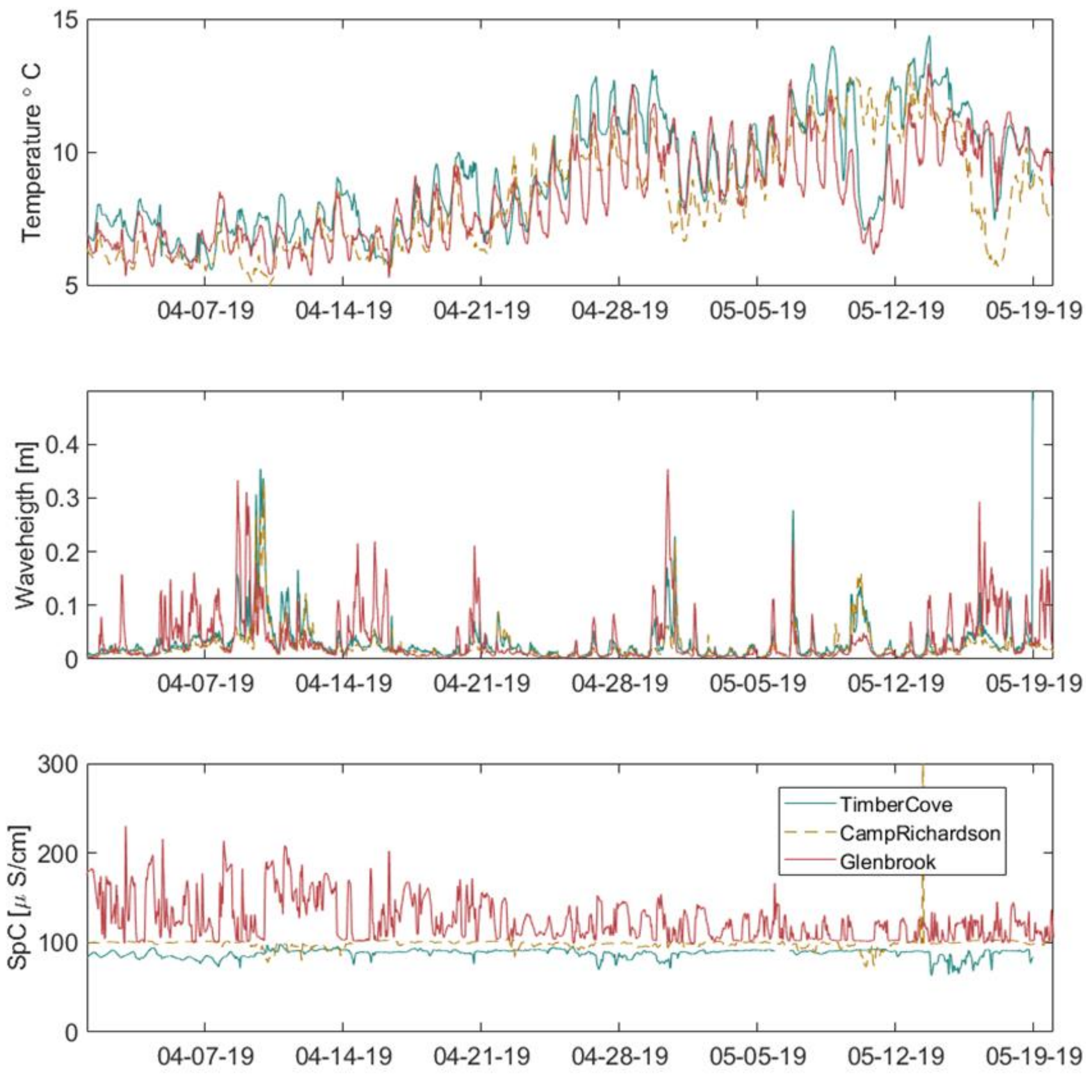


Figure 50. Temperature, wave height and specific conductance at the Timber Cove, Camp Richardson, and Glenbrook nearshore stations between April 1st and May 20th, 2019.

Section V. Project Quality Assurance

This section provides details of the project quality assurance and quality control measures for the primary areas of study associated with this contract. QA/QC provides information on procedures for assuring quality in the research being done and the observation techniques or measures that are used to help verify quality data are being collected. The QA/QC details are presented for the (1) algal growth potential assays; (2) phytoplankton enumeration; (3) periphyton analyses project tasks.

Algal Growth Potential Bioassays QA/QC

(QA/QC) applied to the AGP bioassays was similar to methods used for QA/QC in algal nutrient bioassays, see: "Lake Tahoe Algal Bioassay Procedure" in Hackley et al., (2007). Avoidance of sources of contamination and factors that can compromise samples is a critical quality assurance concern in collection of AGP bioassay samples. Glassware and carboys are carefully cleaned in the lab with Liquinox soap, tap water, 0.1N HCl and deionized water. When sampling on the research boat, standard, clean limnological sampling techniques are employed to prevent contamination. After collection, samples are protected from direct sunlight and kept cool. The bioassays are typically initiated on the same day of collection. Similarly, avoidance of sources of contamination in bioassay set-up is of critical concern.

To distinguish differences among sites in the AGP tests, it is desirable to have low variation among treatment replicates. Table 2 and Appendix Tables (1.a-1.g) show the means and standard deviations for extracted chlorophyll *a* measurements and *in vivo* fluorescence measurements in the AGP experiments. Treatment replication was good using duplicate treatments. The standard deviations were low relative to treatment means for a majority of the replicates. All replicate pairs were used.

Phytoplankton Enumeration QA/QC

Quality assurance for phytoplankton enumeration focuses on careful preparation and settling of known volumes of representative sub-samples in sedimentation chambers. Settling procedures follow Utermöhl's technique and counts were made under a Zeiss Observer A1 inverted microscope. The reliability of the analysis depends upon the random distribution of algal units/cells within the sedimentation chambers. The observed taxa are identified and the number of algal units for each taxon were recorded. Larger taxa settled in 1 cm^2 areas of view were first counted at low. Then smaller species were counted at high magnification along 1 cm long strips or random fields. The data from all counted area, strips and fields are combined in computation of totals for the sample.

Periphyton QA/QC

For QA/QC applied to periphyton monitoring see "Periphyton Quality Assurance Project Plan" in Hackley et al. (2004). Periphyton monitoring is designed to reflect the amount of attached algal biomass present in specific lake locations. There is no standard growth pattern that the collected samples can be compared to; therefore, it is assumed that the collected biomass is representative of the area in which it was collected. Assurances that collected samples are representative rely on replicate samples and expertise of the sampling personnel to place sampling tubes over sections of substrate that reflect the area's growth pattern. During periods of high standing biomass, when within site variability can be high, researchers may collect triplicate or more samples. The additional sample(s) increases the statistical power of the analysis and can help account for the presence of higher variability. Collection of the additional samples is at the discretion of the scientist.

During the 2016-2017, triplicate samples were collected for 9 of 47 routine site samples and 4 of 14 spring synoptic site samples. One site showed substantial variation and was censored. At Kings Beach on 4/25/17 replicates showed large variation (13.47 and 58.62 mg/m^2) and were censored.

During 2017-2018 triplicate samples were collected for 7 of 42 routine site samples and 8 of 11 spring synoptic site samples. No samples were censored, however 6 samples for which triplicate measurements were made had high variation among replicate chlorophyll a or AFDW. These samples had thick growth of stalked diatoms, which are difficult to sample with good replication. The sites with high variation in biomass values included.: Ward Cr. 4/26/18 (mean= 94.69 mg/m^2; c.v.= 31%); Tahoe City Tributary (mean=75.12 mg/m^2; c.v.=50%); Tahoe City 4/26/18 (mean=89.48 mg/m^2; c.v. = 43%); Gold Coast 4/25/18 (mean=85.77 mg/m^2; c.v.=53%); South Fleur du lac 4/25/18 (mean=186.44 mg/m^2; c.v.=52%) and Lake Forest 5/11/18 (mean=60.13 mg/m^2; c.v.=72%). The biomass estimates based on all triplicates were used, however, the high variability should be noted.

During 2018-2019 sampling, (through mid-May) triplicate samples were collected for 18 of 38 routine site samplings and for one site (Pineland 2m on 4/23/19) 6 replicate samples were collected. Triplicate samples were collected at 12 of 13 spring synoptic sites, 9 of these triplicate sets have been analyzed. Extremely heavy growth of stalked diatoms was observed at many sites along the west shore. This heavy growth of stalked diatoms, was difficult to sample with good replication.[3] Substantial variability in replicate chlorophyll *a* was observed in many of the heavy biomass samples. We censored a limited number of replicates which were anomalously high and possibly indicative of excess periphyton drawn into the sampler during sampling. The censored chlorophyll *a* data included: Ward Cr. 0.5m, 4/18/19 (censored replicate with chlorophyll *a* = 917.28 mg/m^2; the other chlorophyll replicates had values of 446.88 and 423.08 mg/m^2); Rubicon Pt. 4/26/19

[3] It is difficult to obtain good replication with very heavy periphyton growth both due to natural variation on the rock and methodological limitations. There can be substantial natural variation in biomass across the rock. There are also limits to the ability of the dual syringe samplers to effectively sample very heavy biomass. When periphyton growth is extremely heavy, the sampler may not collect all the biomass associated with a sampling area (if some of the algae is pushed outside of the sampler when placing on the rock); or conversely may overestimate biomass if excess periphyton from around the sampler is drawn into the sampler.

(censored replicate chlorophyll = 429.14 mg/m^2; the remaining replicates had values of 161.88 and 196.86 mg/m^2)); Pineland 2m (censored two high chlorophyll a values 508.41 mg/m^{2}and 397.15 mg/m^{2}and used 4 remaining replicates: 254.35, 208.56, 184.30, 275.65 mg/m^2). AFDW data was also not used for samples for which chlorophyll *a* data was censored.

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Appendix 1. Summary of data for Algal Growth Potential Assays

Appendix 1.a. Summary of field and experimental data collected for Algal Growth Potential (AGP) experiment done on Lake Tahoe water collected from nearshore and mid-lake sites on 9/12/17. Data for date of collection from various sites is shown in upper left (Date, Time, Surface Temp., Depth collected, chlorophyll *a*, selected observations). On selected dates, extracted chlorophyll *a* was measured, these values are summarized under heading "Extracted Chlor. *a*". Final AGP results are shown at top right of table (in bold). Initial background fluorescence (i.e. fluorescence of filtered lake water) and mean daily *in vivo* fluorescence readings during the AGP experiment are shown along bottom of table.

AGP #17 H_2O Collection 9/12/17	Date Collected	Time Collected	Lake Surface T (°C)	Collection Depth (m)	Lake Chl. *a* (µg/l)	Observations	**Extracted Chlor. *a*** AGP D6 9/18/17	**Final AGP Results Chl. *a* ± s.d. (µg/l)**
Nearshore:								
Sunnyside	9/12/17	12:25	20.5	1	.36±.04		.25 ± .02	**.36 ± .04**
Tahoe City	9/12/17	7:55	19.5	1	.58±.04	Poor Clarity	.48 ± .05	**.58 ± .04**
Kings Beach	9/12/17	8:47	19.5	1	.30±.02		.29 ± .02	**.32 ± .01**
Crystal Bay	9/12/17	9:10	20.0	1	.31±.02		.26 ± .04	**.33 ± .01**
Glenbrook	9/12/17	9:45	19.0	1	.30±.01		.25 ± .01	**.30 ± .01**
Zephyr	9/12/17	10:04	19.0	1	.28±.02		.24 ± .04	**.34 ± .01**
Timber Cove	9/12/17	10:33	19.0	1	.28±.04		.39 ± .03	**.39 ± .01**
Tahoe Keys	9/12/17	10:52	19.5	1	.56±.03	Fair/Poor Clarity	.74 ± .04	**.74 ± .04**
Camp Rich.	9/12/17	11:05	NA	1	.33±.01		.29 ± .02	**.34 ± .01**
Emerald Bay	9/12/17	11:28	20.0	1	.34±.06		.47 ± .01	**.47 ± .01**
Rubicon Bay	9/12/17	12:00	20.5	1	.24±.01		.22 ± .03	**.28 ± .01**
Mid-Lake:								
Mid-lk No.	9/12/17	8:20	19.0	1	.29±.04		.21 ± .03	**.29 ± .04**
Mid-lk So.	9/12/17	10:20	19.5	1	.32±.00		.25 ± .01	**.32 ± 0**

Experiment Daily Fluor.	Backgrd. Fluor. GF/F Fil.	D0 Fluor. 9/12/17 17:00	D1 Fluor. 9/13/17 14:25	D2 Fluor. 9/14/17 14:25	D4 Fluor. 9/16/17 12:35	D6 Fluor. 9/18/17 13:50	D8 Fluor. 9/20/17 14:00	D10 Fluor. 9/22/17 14:15	D13 Fluor. 9/25/17 14:35
Sunnyside	.020	.239	.215±.017	.191± .004	.170± .001	.139± .006	.142± .006	.158± .003	.167± .011
Tahoe City	.059	.389	.384±.020	.392± .016	.304± .003	.297± .002	.287± .005	.282± .008	.255± .028
Kings Beach	.024	.213	.217± .004	.208± .007	.186± .008	.157± .001	.145± .003	.158± .011	.155± .004
Crystal Bay	.023	.205	.224± .005	.203± .005	.178± .015	.170± .004	.171± .011	.175± .021	.170± .004
Glenbrook	.004	.202	.196± .001	.172± .003	.149± .008	.120± .004	.141± .004	.158± .000	.177± .011
Zephyr	.024	.197	.230± .008	.227± .011	.201± .004	.136± .003	.143± .006	.159± .013	.168± .011
Timber Cove	.032	.203	.222± .006	.268± .004	.255± .008	.190± .013	.177± .003	.177± .011	.203± .006
Tahoe Keys	.054	.282	.264± .001	.243± .018	.225± .001	.226± .006	.293± .008	.324± .003	.273± .042
Camp Rich.	.025	.226	.230± .006	.225± .003	.201± .002	.141± .009	.154± .004	.180± .007	.177± .014
Emerald Bay	.058	.306	.251± .021	.208± .004	.204± .006	.251± .008	.293± .006	.261± .015	.265± .035
Rubicon Bay	.022	.191	.194± .005	.182± .001	.160± .001	.128± .008	.135± .004	.140± .003	.153± .000
Mid-Lake:									
Mid-lk No.	.023	.171	.189± .015	.175± .013	.152± .005	.117± .007	.109± .012	.132± .013	.166± .007
Mid-lk So.	.021	.214	.205± .006	.182± .003	.158± .001	.117± .005	.120± .001	.140± .006	.171± .004

Appendix 1.b. Summary of field and experimental data collected for Algal Growth Potential (AGP) experiment done on Lake Tahoe water collected from nearshore and mid-lake sites on 12/8/17.

AGP #18 H_2O Collection 12/8/17	Date Collected	Time Collected	Lake Surface T (°C)	Collection Depth (m)	Lake Chl. *a* (µg/l)	Observations	**Extracted Chlor. *a*** AGP D6 12/14/17			**Final AGP Results Chl. *a* ± s.d. (µg/l)**
Nearshore:										
Sunnyside	12/8/17	13:44	8.0	1	.67±.04		.52 ± .01			**.67 ± .04**
Tahoe City	12/8/17	9:13	7.0	1	.61±.04		.54 ± .01			**.61 ± .04**
Kings Beach	12/8/17	9:54	7.5	1	.75±.10		.50 ± .05			**.75 ± .10**
Crystal Bay	12/8/17	10:15	8.0	1	.78±.08		.51 ± .01			**.78 ± .08**
Glenbrook	12/8/17	10:50	8.0	1	.74±.03		.63 ± NA			**.74 ± .03**
Zephyr	12/8/17	11:14	8.0	1	.72±.04		.50 ± .01			**.72 ± .04**
Timber Cove	12/8/17	11:44	7.0	1	.60±.01		.53 ± .03			**.60 ± .01**
Tahoe Keys	12/8/17	12:00	7.5	1	.56±.01		.54 ± .02			**.56 ± .01**
Camp Rich.	12/8/17	12:15	8.0	1	.67±.02		.55 ± .04			**.67 ± .02**
Emerald Bay	12/8/17	12:43	6.5	1	1.05±.01	Poor Clarity	.60 ± .01			**1.05 ± .01**
Rubicon Bay	12/8/17	13:14	8.0	1	.73±.02		.45 ± .06			**.73 ± .02**
Mid-Lake:										
Mid-lk No.	12/8/17	9:33	8.5	1	.83±.01		.53 ± .04			**.83 ± .01**
Mid-lk So.	12/8/17	11:30	8.0	1	.83±.02		.53 ± .03			**.83 ± .02**
Experiment Daily Fluor.	Backgrd. Fluor. GF/F Fil.	D0 Fluor. 12/8/17 16:15	D2 Fluor. 12/10/17 12:00	D4 Fluor. 12/12/17 18:05	D6 Fluor. 12/14/17	D8 Fluor. 12/16/17 13:45	D10 Fluor. 12/18/17 15:00	D12 Fluor. 12/20/17 13:25	D14 Fluor. 12/22/17 15:45	
Sunnyside	.034	.379	.297±.010	.259± .006	.264± .004	.264± .007	.261± .007	.233± .008	.214± .011	
Tahoe City	.027	.351	.278±.001	.249± .004	.256± .001	.259± .004	.242± .003	.222± .001	.189± .007	
Kings Beach	.038	.346	.278± .001	.237± .008	.240± .001	.251± .004	.233± .004	.223± .006	.202± .002	
Crystal Bay	.036	.364	.283± .002	.242± .004	.249± .004	.255± .007	.240± .006	.227± .001	.203± .010	
Glenbrook	.034	.368	.302± .001	.292± .008	.306± .006	.312± .001	.284± .009	.259± .006	.224± .002	
Zephyr	.028	.379	.292± .006	.254± .006	.260± .006	.260± .003	.254± .003	.227± .011	.202± .011	
Timber Cove	.025	.336	.282± .002	.307± .009	.328± .019	.325± .006	.305± .015	.264± .006	.232± .002	
Tahoe Keys	.036	.326	.285± .008	.293± .000	.318± .003	.320± .006	.301± .008	.274± .013	.210± .010	
Camp Rich.	.037	.363	.297± .006	.293± .002	.295± .009	.293± .003	.290± .006	.265± .013	.236± .011	
Emerald Bay	.110	.593	.469± .004	.434± .004	.438± .004	.404± .008	.371± .021	.343± .022	.292± .021	
Rubicon Bay	.034	.399	.292± .002	.264± .004	.279± .001	.277± .004	.272± .011	.253± .017	.239± .015	
Mid-Lake:										
Mid-lk No.	.027	.367	.283± .006	.237± .000	.239± .005	.249± .005	.239± .000	.224± .001	.200± .004	
Mid-lk So.	.033	.364	.294± .006	.263± .010	.273± .006	.266± .012	.265± .010	.236± .013	.211± .005	

Appendix 1.c. Summary of field and experimental data collected for Algal Growth Potential (AGP) experiment done on Lake Tahoe water collected from nearshore and mid-lake sites on 3/28/18.

AGP #19 H_2O Collection 3/28/18	Date Collected	Time Collected	Lake Surface T (°C)	Collection Depth (m)	Lake Chl. *a* (µg/l)	Observations	**Extracted Chlor. *a*** AGP D7 4/4/18	**Extracted Chlor. *a*** AGP D13 4/10/18	**Final AGP Results Chl. *a* ± s.d. (µg/l)**
Nearshore:									
Sunnyside	3/28/18	14:00	NA	1	.21	Very good Clarity	.49 ± .06	.60 ± .05	**.60 ± .05**
Tahoe City	3/28/18	9:10	5.5	1	.13	Very good Clarity	.62 ± .09	.77 ± .01	**.77 ± .01**
Kings Beach	3/28/18	10:10	6.0	1	.28±.01	Very good Clarity	.88 ± .13	.90 ± .05	**1.00 ± .00**
Crystal Bay	3/28/18	10:30	5.8	1	.66		.71 ± .17	.57 ± .01	**.71 ± .02**
Glenbrook	3/28/18	11:05	6.0	1	.57±.02		.75 ± .09	.82 ± .12	**.82 ± .01**
Zephyr	3/28/18	11:30	6.5	1	.71		1.23 ± 0	.88 ± .01	**1.23 ± .00**
Timber Cove	3/28/18	12:00	6.5	1	.54	Gold-green color	1.16 ± .03	.41 ± .08	**1.16 ± .03**
Tahoe Keys	3/28/18	12:20	6.5	1	.59		.95 ± .04	.46 ± .11	**.95 ± .04**
Camp Rich.	3/28/18	12:30	6.5	1	.39		1.00 ± .15	.51 ± .06	**1.00 ± .15**
Emerald Bay	3/28/18	13:00	5.0	1	1.39	Green color	.88 ± .11	.57 ± .06	**1.39**
Rubicon Bay	3/28/18	13:35	NA	1	.05e	Excellent Clarity	.85 ± .03	1.20 ± .03	**1.20 ± .03**
Mid-Lake:									
Mid-lk No.	3/28/18	9:34	5.5	1	.33±.01	Very good Clarity	.41 ± .04	.48 ± .06	**.48 ± .06**
Mid-lk So.	3/28/18	11:50	6.5	1	.37		.67 ± .06	.72 ± .03	**.76 ± .00**

Experiment Daily Fluor.	Backgrd. Fluor. GF/F Fil.	D0 Fluor. 3/28/18 18:45	D2 Fluor. 3/30/18 12:30	D4 Fluor. 4/1/18 12:05	D6 Fluor. 4/3/18	D7 Fluor. 4/4/18 11:15	D9 Fluor. 4/6/18 12:25	D11 Fluor. 4/8/18 12:45	D13 Fluor. 4/10/18 12:35
Sunnyside	.026	.235±.005	.259±.003	.353± .012	.493± .002	.560± .001	.684± .015	.746± .003	.768± .001
Tahoe City	.028	.212±.008	.209±.001	.316± .001	.492± .006	.529± .006	.721± .004	.819± .008	.852± .036
Kings Beach	.033	.352± .009	.371± .006	.487± .001	.624± .030	.678± .021	.800± .016	.861± .003	.726± .013
Crystal Bay	.038	.500± .008	.411± .004	.463± .033	.515± .018	.549± .013	.570± .010	.574± .023	.516± .023
Glenbrook	.029	.485± .011	.387± .025	.472± .011	.563± .028	.584± .018	.659± .014	.683± .008	.601± .012
Zephyr	.045	.609± .012	.572± .013	.724± .034	.842± .018	.909± .004	.938± .006	.850± .004	.735± .006
Timber Cove	.131	.642± .001	.635± .012	.930± .025	1.07± .028	1.09± .057	1.024± .065	.859± .027	.672± .006
Tahoe Keys	.062	.522± .006	.509± .002	.718± .004	.892± .018	.918± .005	.893± .028	.801± .000	.640± .011
Camp Rich.	.081	.492± .006	.497± .006	.691± .009	.855± .018	.908± .001	.888± .006	.782± .005	.663± .004
Emerald Bay	.131	.746± .028	.614± .011	.580± .019	.558± .013	.576± .020	.565± .008	.548± .016	.512± .007
Rubicon Bay	.027	.177± .001	.199± .001	.302± .013	.596± .018	.710± .025	1.075± .035	1.335± .078	1.42± .028
Mid-Lake:									
Mid-lk No.	.027	.271± .004	.224± .002	.288± .003	.334± .001	.351± .015	.399± .003	.448± .011	.466± .014
Mid-lk So.	.033	.425± .000	.373± .003	.445± .003	.511± .002	.541± .011	.585± .003	.622± .003	.595± .008

Appendix 1.d. Summary of field and experimental data collected for Algal Growth Potential (AGP) experiment done on Lake Tahoe water collected from nearshore and mid-lake sites on 6/8/18.

AGP #20 H_2O Collection 6/8/18	Date Collected	Time Collected	Lake Surface T (°C)	Collection Depth (m)	Lake Chl. *a* (μg/l)	Observations	**Extracted Chlor. *a*** AGP D6 6/14/18		**Final AGP Results Chl. *a* ± s.d. (μg/l)**
Nearshore:									
Sunnyside	6/8/18	13:05	13.0	1	.08±.00		.12 ± .03		**.14 ± .00**
Tahoe City	6/8/18	8:10	12.0	1	.22±.04		.20 ± .01		**.22 ± .04**
Kings Beach	6/8/18	9:10	12.5	1	.17±.01		.14 ± .02		**.17 ± .01**
Crystal Bay	6/8/18	9:35	14.0	1	.11±.01		.11 ± .01		**.12 ± .01**
Glenbrook	6/8/18	10:20	14.0	1	.12±.01		.15 ± .01		**.15 ± .01**
Zephyr	6/8/18	10:40	14.5	1	.13±.02		.19 ± .01		**.20 ± .00**
Timber Cove	6/8/18	11:15	15.5	1	.09±.01		.22 ± .01		**.27 ± .01**
Tahoe Keys	6/8/18	11:30	14.8	1	.12±.00		.29 ± .03		**.29 ± .03**
Camp Rich.	6/8/18	11:43	14.0	1	.12±.02		.13 ± .05		**.14 ± .02**
Emerald Bay	6/8/18	12:15	17.0	1	.25±.01		.19 ± .03		**.25 ± .01**
Rubicon Bay	6/8/18	12:40	15.5	1	.11±.01		.12 ± .02		**.13 ± .00**
Mid-Lake:									
Mid-lk No.	6/8/18	8:30	12.0	1	.13±.01		.12 ± .01		**.13 ± .01**
Mid-lk So.	6/8/18	10:50	14.0	1	.10±.02		.13 ± .00		**.13 ± .00**
Experiment Daily Fluor.	Backgrd. Fluor. GF/F Fil.	D0 Fluor. 6/8/18 18:20	D2 Fluor. 6/10/18 12:10	D4 Fluor. 6/12/18 13:00	D6 Fluor. 6/14/18 14:55	D8 Fluor. 6/16/18 12:35	D11 Fluor. 6/19/18 13:15	D13 Fluor. 6/21/18 13:45	
Sunnyside	.014	.128±.002	.164±.001	.136± .001	.135± .002	.140± .004	.139± .003	.144± .007	
Tahoe City	.011	.202±.002	.200±.001	.147± .004	.153± .006	.158± .002	.167± .001	.170± .001	
Kings Beach	.011	.175± .001	.190± .007	.146± .002	.145± .001	.145± .007	.163± .008	.174± .005	
Crystal Bay	.016	.139± .008	.155± .004	.124± .004	.124± .000	.131± .005	.126± .008	.127± .001	
Glenbrook	.015	.152± .007	.163± .001	.125± .011	.137± .004	.145± .008	.140± .006	.159± .001	
Zephyr	.028	.161± .000	.197± .001	.190± .000	.183± .006	.162± .002	.167± .011	.193± .002	
Timber Cove	.024	.123± .001	.198± .002	.252± .011	.234± .007	.164± .008	.129± .011	.140± .002	
Tahoe Keys	.019	.141± .003	.217± .005	.235± .002	.231± .001	.186± .004	.157± .001	.177± .001	
Camp Rich.	.012	.157± .001	.171± .013	.141± .001	.148± .006	.133± .005	.140± .008	.143± .003	
Emerald Bay	.052	.261± .001	.244± .001	.217± .006	.198± .001	.197± .005	.181± .001	.172± .011	
Rubicon Bay	.013	.166± .003	.161± .001	.128± .006	.124± .001	.124± .002	.147± .019	.170± .042	
Mid-Lake:									
Mid-lk No.	.007	.153± .006	.158± .001	.110± .000	.111± .007	.111± .007	.118± .000	.135± .001	
Mid-lk So.	.016	.134± .004	.143± .003	.132± .007	.145± .001	.138± .001	.136± .002	.139± .001	

Appendix 1.e. Summary of bioassay fluorescence, and Day 6 chlorophyll *a* data for Algal Growth Potential (AGP) experiment done on Lake Tahoe water collected from nearshore and mid-lake sites on 10/16/18, (note n=2 for all except background where n=1). Note see Table 2 for more data.

	Background Fluor. 10/16/18	Day 0 Fluor. Mean 10/16/18 18:05	Day 0 Fluor. S.D. 10/16/18 18:05	Day 1 Fluor. Mean 10/17/18 14:40	Day 1 Fluor. S.D. 10/17/18 14:40	Day 3 Fluor. Mean 10/19/18 13:00	Day 3 Fluor. S.D. 10/19/18 13:00	Day 4 Fluor. Mean 10/20/18	Day 4 Fluor. S.D. 10/20/18
Sunnyside	0.012	0.132	0.004	0.133	0.002	0.126	0.001	0.115	0.001
Tahoe City	0.015	0.148	0.007	0.146	0.000	0.146	0.002	0.129	0.003
Kings Beach	0.013	0.158	0.004	0.144	0.001	0.140	0.001	0.139	0.013
Crystal Bay	0.023	0.138	0.013	0.125	0.003	0.133	0.004	0.133	0.004
Glenbrook	0.014	0.134	0.005	0.128	0.002	0.137	0.004	0.131	0.006
Zephyr	0.004	0.122	0.006	0.125	0.006	0.142	0.004	0.148	0.000
Timber Cove	0.018	0.114	0.008	0.116	0.002	0.161	0.016	0.164	0.006
Tahoe Keys	0.021	0.138	0.004	0.138	0.001	0.135	0.004	0.136	0.002
Camp Rich.	0.013	0.131	0.006	0.126	0.001	0.116	0.003	0.124	0.004
Emerald Bay	0.034	0.221	0.008	0.193	0.003	0.179	0.003	0.176	0.001
Rubicon Bay	0.011	0.136	0.001	0.131	0.002	0.124	0.002	0.121	0.004
Mid-lk No.	0.018	0.151	0.004	0.134	0.002	0.143	0.016	0.143	0.009
Mid-lk So.	0.014	0.152	0.006	0.128	0.000	0.120	0.002	0.118	0.003
	Day 6 Fluor. Mean 10/22/18 13:25	Day 6 Fluor. S.D. 10/22/18 13:25	Day 9 Fluor. Mean 10/25/18 17:40	Day 9 Fluor. S.D. 10/25/18 17:40	Day 10 Fluor. Mean 10/26/18 14:25	Day 10 Fluor. S.D. 10/26/18 14:25		Day 6 Chlor. a Mean 10/22/18 15:00	Day 6 Chlor. a S.D. 10/22/18 15:00
Sunnyside	0.124	0.006	0.107	0.001	0.106	0.001		0.20	0.01
Tahoe City	0.146	0.001	0.111	0.006	0.104	0.006		0.27	0.02
Kings Beach	0.148	0.004	0.096	0.005	0.100	0.003		0.27	0.01
Crystal Bay	0.151	0.003	0.092	0.003	0.093	0.002		0.29	0.05
Glenbrook	0.138	0.002	0.099	0.004	0.099	0.001		0.24	0.00
Zephyr	0.153	0.001	0.112	0.006	0.096	0.011		0.28	0.01
Timber Cove	0.167	0.006	0.109	0.003	0.094	0.008		0.25	0.03
Tahoe Keys	0.147	0.001	0.114	0.001	0.103	0.006		0.26	0.01
Camp Rich.	0.119	0.004	0.104	0.004	0.104	0.003		0.20	0.00
Emerald Bay	0.186	0.006	0.184	0.004	0.190	0.006		0.35	0.02
Rubicon Bay	0.127	0.003	0.105	0.003	0.102	0.005		0.22	0.01
Mid-lk No.	0.152	0.008	0.113	0.001	0.115	0.000		0.28	0.01
Mid-lk So.	0.123	0.004	0.110	0.007	0.111	0.003		0.18	0.01

Appendix 1.f. Summary of bioassay fluorescence, and Day 8 chlorophyll a data for Algal Growth Potential (AGP) experiment done on Lake Tahoe water collected from nearshore and mid-lake sites on 12/4/18, (note n=2 for all except background where n=1). Note see Table 2 for more data.

	Background Fluor.	Day 0 Fluor. Mean 12/4/2018 19:15	Day 0 Fluor. S.D. 12/4/2018 19:15	Day 2 Fluor. Mean 12/6/2018 14:30	Day 2 Fluor. S.D. 12/6/2018 14:30	Day 4 Fluor. Mean 12/8/18 13:10	Day 4 Fluor. S.D. 12/8/18 13:10	Day 8 Fluor. Mean 12/12/18 13:50	Day 8 Fluor. S.D. 12/12/18 13:50
Sunnyside	0.038	0.038	0.004	0.241	0.003	0.216	0.005	0.192	0.001
Tahoe City	0.041	0.041	0.007	0.229	0.009	0.198	0.002	0.164	0.002
Kings Beach	0.038	0.038	0.004	0.227	0.006	0.199	0.004	0.175	0.004
Crystal Bay	0.03	0.030	0.013	0.221	0.006	0.199	0.001	0.173	0.001
Glenbrook	0.038	0.038	0.005	0.230	0.001	0.200	0.002	0.181	0.006
Zephyr	0.035	0.035	0.006	0.225	0.006	0.223	0.002	0.194	0.010
Timber Cove	0.038	0.038	0.008	0.216	0.004	0.207	0.006	0.181	0.006
Tahoe Keys	0.035	0.035	0.004	0.231	0.007	0.223	0.001	0.198	0.001
Camp Rich.	0.03	0.03	0.006	0.228	0.004	0.211	0.011	0.180	0.004
Emerald Bay	0.075	0.075	0.008	0.329	0.001	0.308	0.008	0.259	0.018
Rubicon Bay	0.031	0.031	0.001	0.241	0.004	0.230	0.012	0.195	0.004
Mid-lk No.	0.032	0.032	0.004	0.257	0.002	0.235	0.001	0.194	0.006
Mid-lk So.	0.031	0.031	0.006	0.248	0.007	0.218	0.009	0.183	0.017

	Day 10 Fluor. Mean 12/14/18 16:55	Day 10 Fluor. S.D. 12/14/18 16:55	Day 11 Fluor. Mean 12/15/18 11:40	Day 11 Fluor. S.D. 12/15/18 11:40		Day 8 Chlor. a Mean 12/12/18	Day 8 Chlor. a S.D. 12/12/18
Sunnyside	0.192	0.010	0.183	0.004		0.29	0.03
Tahoe City	0.181	0.006	0.160	0.008		0.28	0.00
Kings Beach	0.177	0.008	0.175	0.006		0.28	0.01
Crystal Bay	0.182	0.005	0.166	0.001		0.28	0.01
Glenbrook	0.184	0.008	0.178	0.004		0.28	0.00
Zephyr	0.210	0.001	0.193	0.003		0.34	0.01
Timber Cove	0.190	0.001	0.179	0.003		0.32	0.03
Tahoe Keys	0.203	0.010	0.194	0.014		0.33	0.01
Camp Rich.	0.190	0.001	0.181	0.002		0.30	0.00
Emerald Bay	0.256	0.020	0.254	0.033		0.54	0.01
Rubicon Bay	0.203	0.004	0.189	0.001		0.34	0.05
Mid-lk No.	0.218	0.000	0.195	0.006		0.29	0.01
Mid-lk So.	0.197	0.001	0.185	0.005		0.32	0.04

Appendix 1.g. Summary of bioassay fluorescence, and Day 5 chlorophyll *a* data for Algal Growth Potential (AGP) experiment done on Lake Tahoe water collected from nearshore and mid-lake sites on 4/4/19, (note n=2 for all except background where n=1). Note see Table 2 for more data.

	Background Fluor.	Day 0 Fluor. Mean 4/4/19 19:15	Day 0 Fluor. S.D. 4/4/19 19:15	Day 2 Fluor. Mean 4/6/19 16:00	Day 2 Fluor. S.D. 4/6/19 16:00	Day 4 Fluor. Mean 4/8/19 17:15	Day 4 Fluor. S.D. 4/8/19 17:15	Day 5 Fluor. Mean 4/9/19 17:55	Day 5 Fluor. S.D. 4/9/19 17:55
Sunnyside	0.082	1.195	0.007	0.870	0.038	0.833	0.001	0.788	0.020
Tahoe City	0.09	0.545	0.001	0.679	0.011	0.826	0.037	0.905	0.042
Kings Beach	0.081	1.175	0.035	0.972	0.027	0.845	0.014	0.827	0.005
Crystal Bay	0.085	1.090	0.028	0.972	0.013	0.827	0.005	0.826	0.028
Glenbrook	0.064	1.175	0.035	0.951	0.016	0.866	0.016	0.863	0.006
Zephyr	0.111	1.305	0.021	1.035	0.021	0.968	0.021	0.960	0.004
Timber Cove	0.16	1.160	0.014	1.000	0.015	0.792	0.021	0.769	0.007
Tahoe Keys	0.432	1.330	0.014	1.575	0.007	1.595	0.007	1.565	0.021
Camp Rich.	0.09	0.831	0.013	0.856	0.031	0.906	0.040	0.942	0.029
Emerald Bay	0.154	0.629	0.004	0.575	0.011	0.565	0.011	0.571	0.010
Rubicon Bay	0.06	0.624	0.004	0.711	0.024	0.876	0.011	0.927	0.023
Mid-lk No.	0.068	0.835	0.016	0.766	0.006	0.785	0.019	0.848	0.004
Mid-lk So.	0.061	0.944	0.028	0.863	0.001	0.885	0.042	0.891	0.005

	Day 8 Fluor. Mean 4/12/19 23:55	Day 8 Fluor. S.D. 4/12/19 23:55	Day 11 Fluor. Mean 4/14/19 18:20	Day 11 Fluor. S.D. 4/14/19 18:20	Day 13 Fluor. Mean 4/16/19 16:00	Day 13 Fluor. S.D. 4/16/19 16:00		Day 5 Chlor. a Mean 4/9/19 19:15	Day 5 Chlor. a S.D. 4/9/19 19:15
Sunnyside	0.777	0.011	0.651	0.006	0.582	0.011		0.90	0.08
Tahoe City	0.881	0.148	0.763	0.147	0.676	0.087		1.09	0.07
Kings Beach	0.803	0.025	0.661	0.038	0.592	0.049		1.21	0.06
Crystal Bay	0.715	0.016	0.542	0.012	0.455	0.011		1.03	0.04
Glenbrook	0.817	0.031	0.690	0.030	0.625	0.029		1.19	0.11
Zephyr	0.905	0.013	0.773	0.007	0.698	0.026		1.40	0.21
Timber Cove	0.724	0.015	0.579	0.023	0.507	0.001		0.83	0.04
Tahoe Keys	1.480	0.042	1.280	0.028	1.155	0.007		1.84	0.20
Camp Rich.	0.932	0.024	0.745	0.006	0.679	0.004		1.11	0.00
Emerald Bay	0.583	0.001	0.539	0.001	0.514	0.013		0.75	0.06
Rubicon Bay	1.030	0.014	0.862	0.002	0.799	0.013		1.12	0.03
Mid-lk No.	0.880	0.011	0.732	0.018	0.615	0.008		1.07	0.04
Mid-lk So.	0.888	0.011	0.719	0.016	0.624	0.035		1.14	0.05