UC Davis Tahoe Environmental Research Center

Sampling Plan and Protocols for Clear Lake, California

Version 1.1

(Project No. P1720013, California Department of Fish and Wildlife)

Produced by (in alphabetical order):

Alicia Cortes, Alex Forrest, Nick Framsted, Tina Hammell, Anne Liston, Steve Sadro, Geoffrey Schladow, Steve Sesma, Samantha Sharp, Drew Stang, Micah Swann, Lidia Tanaka, Raph Townsend, Shohei Watanabe

Project Objectives are to understand the dominant processes in the Clear Lake watershed and in the lake itself that are negatively impacting the rehabilitation of the lake water quality and ecosystem health. The data acquisition that will be needed will form the basis of a long-term monitoring strategy to measure status and trends in the future. A set of numerical models, calibrated and validated with these data, will be developed to inform local and State decision-making.

1. Stream Monitoring

1.1 In-situ gauges

FTS turbidity stations and Campbell Scientific dataloggers have been co-located with Department of Water Resources (DWR) gauging stations at three locations on inflowing creeks (Table 1, Fig. 1). Lake level and rainfall from those gauging stations are available at the California Nevada River Forecast Center website (https://www.cnrfc.noaa.gov).

Each station has an FTS DTS-12 SDI turbidity sensor (Fig. 2). The turbidity station has been programmed to record and transmit data every 10 minutes by executing the following measurement cycle:

1. Powering up the sensor head.
2. Calibrating the analog to digital converter circuitry.
3. Read the water temperature
4. Do a wipe if the water temperature is not too low
5. Acquiring 100 samples at 20 samples per second.
6. Perform statistical calculations as required.

The turbidity sensor has a range 0-1,500 NTU, a resolution 0.01 NTU, an accuracy of 2% of full-scale reading in the range 0-500 NU, and 4% of full-scale reading in the range of 500-1500 NTU. Temperature accuracy is +/- 0.1 deg. C. Data are uploaded via modem after every reading to the Environmental Dynamics Lab (EDL) of the Department of Civil and Environmental Engineering at the University of California, Davis. Data will be stored on an Amazon Web Services (AWS) account, that will provide redundant storage and accessibility through the website which will be developed and shared in the near future.

Table 1. Details of FTS turbidity stations and data availability

ID	Creek	Road/ Near by	GPS coordinates	Stage and Rain Website
MUPC1	Middle Creek	Rancheria Road	39.18º N, 122.91º W	https://www.cnrfc.noaa.gov/graphicalRVF.php?id=MUPC1
SKPC1	Scott's Creek	Eickhoff Rd	39.10º N, 122.96º W	https://www.cnrfc.noaa.gov/graphicalRVF.php?id=SKPC1
KCVC1	Kelsey Creek	Kelsey Creek Dr.	38.93º N, 122.84º W	https://www.cnrfc.noaa.gov/graphicalRVF.php?id=KCVC1

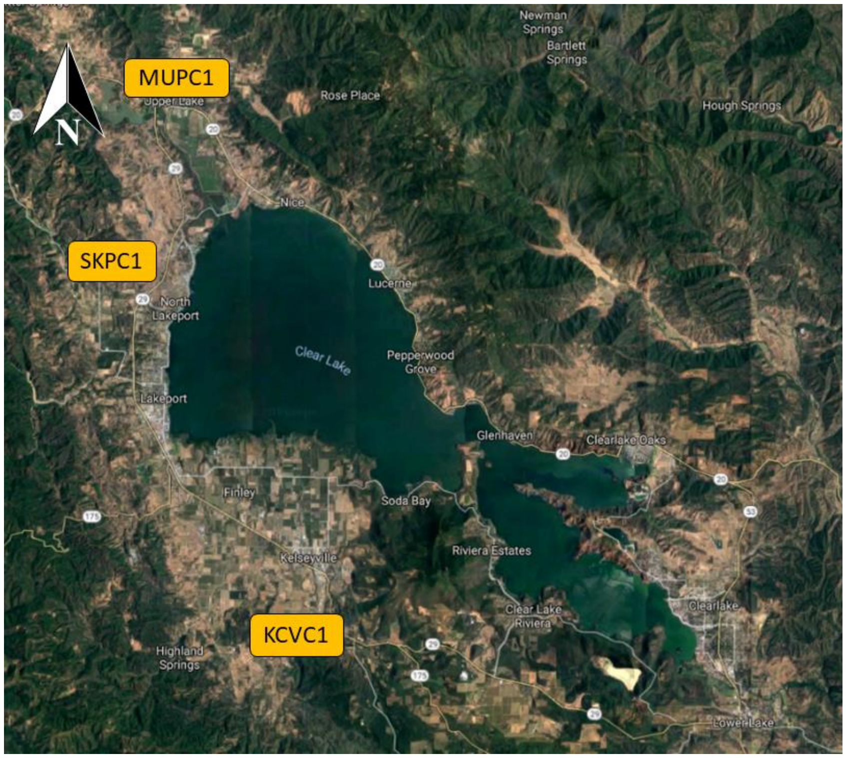

Fig. 1. Map showing the location of the FTS turbidity stations (see Table 1).

Fig. 2. FTS digital turbidity DTS-12 sensor

1.2 <u>Stream water quality grab sampling</u>

Samples will be taken at each gauge station site approximately every 2 weeks during the flow season and to coincide with hydrograph peaks (storms) to the extent possible. Sampling will be coordinated with the County Water Resources Department, who currently sample at monthly intervals. Water samples are to be taken following the Lake County sampling methods to maintain continuity (see Appendix 1). The specific constituents sampled and timing of sample collection are shown in Table 2. See section 2.8 for details on laboratory analysis and sample handling.

Staff shall maintain a field notebook to include basic information about each sampling event (e.g., date, time, and weather conditions), remarkable observations, and a log of sample

Table 2. Constituents to be sampled for and analyzed for streams

	Constituent	Description	Detection level	Bi-weekly	Storm
Nutrients	NO_3+NO_2	Dissolved Nitrite + Nitrate Nitrogen	0.002 mg/L	X	X
	SRP	Dissolved Orthophosphate Phosphorus	0.001 mg/L	X	X
	TDN	Total Dissolved Nitrogen	0.002 mg/L	X	X
	TDP	Total Dissolved Phosphorus	0.002 mg/L	X	X
	PP	Particulate Phosphorus	0.002 mg/L	X	X
Sediment	TSS	Total Suspended Solids	0.001 mg/L	X	X
	AFDW	Ash Free Dry Weight	0.001 mg/L	X	X
	FSP	Fine Sediment Particles by count	0.5 - 16 µm	X	X
	FSP	Sediment size distribution	2–2000 µm	X	X
Turbidity	Lab Turbidity	Laboratory Turbidity	0.01 NTU	X	X
QA/QC	Blanks	Source and Field blanks		X	X
	Replicates	Replicates		X	X

Data will be maintained in an SQL data base that is stored and backed up on the cloud using AWS.

2. Lake Monitoring

2.1 Weather Stations

Approximately seven meteorological stations will be installed around the shoreline of Clear Lake on private docks and buildings to characterize the spatially and temporally varying meteorology around the lake (Fig. 3). There are several existing meteorological stations in the area but most are away from the lake. The wind field is a key input to a 3D hydrodynamic lake model and thus critical to characterize properly. The complex surrounding topography contributes to the variability of the wind magnitude and direction across the lake. Data from the meteorological stations will be interpolated to obtain time-varying, spatially distributed wind fields for the model.

Davis Instruments *Wireless Vantage Pro2 Plus* meteorological stations will be utilized (https://www.davisinstruments.com/solution/vantage-pro2/). Each station records wind speed and direction, rain, solar radiation, UV radiation, air temperature and relative humidity every 15 min. A Vantage Connect system will send the data to the WeatherLink Cloud using a cell modem every hour (Fig. 4). From the WeatherLink Cloud, the data can be accessed via smartphone with the WeatherLink Mobile App (iOS and Android). The data will also be archived on our Amazon Web Services (AWS) account.

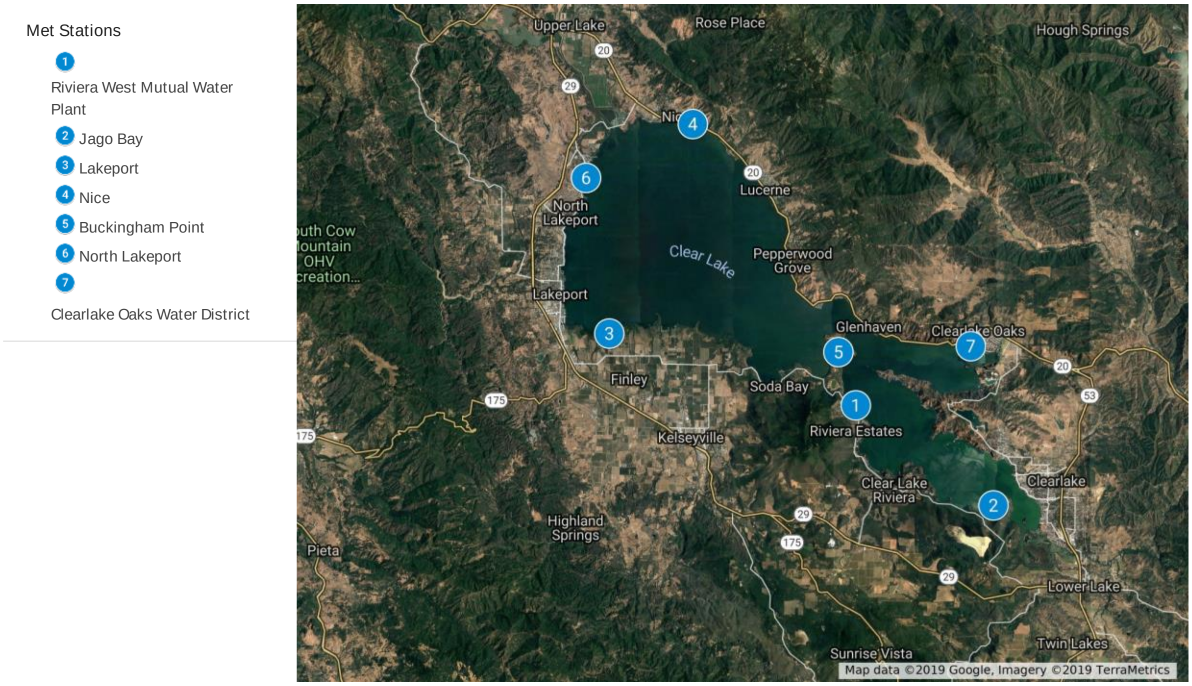

Fig. 3. Proposed meteorological station on the shoreline of Clear Lake

Fig. 4. Weather station equipment (left) Davis Instruments Vantage Pro 2, and (right) Vantage Connect.

2.2 <u>In-lake Temperature-DO Moorings</u>

Seven "permanent" water quality stations (or moorings) are to be deployed in Clear Lake to measure water temperature and dissolved oxygen concentrations (Fig. 5, Table 3). These stations will have no surface expression to reduce chances of theft or vandalism. They will each have a 150 lb steel anchor, making it extremely difficult for a recreational fisherman to disturb if accidently snagged.

Each station consists of up to 12 RBRsolo[3] and RBR TR-1060 temperature loggers (accuracy ±0.002 deg C and resolution ±0.00005 deg C). The stations also had 1 or 2

RBRvirtuoso[3] dissolved oxygen (DO-RBR) sensors (accuracy maximum of ±8µM or ±5% and resolution <1µM or saturation 0.4%) 0.5 m and 2 m off the bottom (Table 4). Only the three deepest stations had two near-sediment DO sensors (UA-06, OA-04, LA-03). In addition, those deep arrays had an epilimnetic dissolved oxygen sensor from PME (miniDOT, DO-MD) 3.5 m below the surface (accuracy of 5% of measurement or 0.3 mg L^{-1}, whichever is larger, and resolution of 0.01 mg L^{-1}). The moorings will be deployed in the approximate locations shown in Fig. 5. The precise locations will be recorded at the time of deployment. GPS coordinates of each mooring will be retaken each time the mooring is lifted and replaced for downloading/servicing (Table 3). Similarly, the instrument depths will be recorded each time a mooring is lifted and replaced. An Onset HOBO U20-001-01water depth sensor will be installed on each mooring line to allow for the precise depth of each logger to be known and allowance for changing water levels to be made during the data processing. These sensors have a 10 m depth range, are accurate to 0.5 cm and have a resolution of 0.21 cm. A Sonotronics coded acoustic pinger will also be attached to each mooring line. This will assist with retrieval for downloading and in the unlikely event the mooring line breaks, it will allow the location and retrieval of the instruments.

Depending on funding availability, we are considering adding six extra DO loggers (PME, miniDOT) to some of our mooring arrays to compute metabolism. The depths of these loggers are still to be determined, but we are planning to have them in the deepest arrays of each basin (UA-06, OA-04, LA-03) at the surface and mid water column.

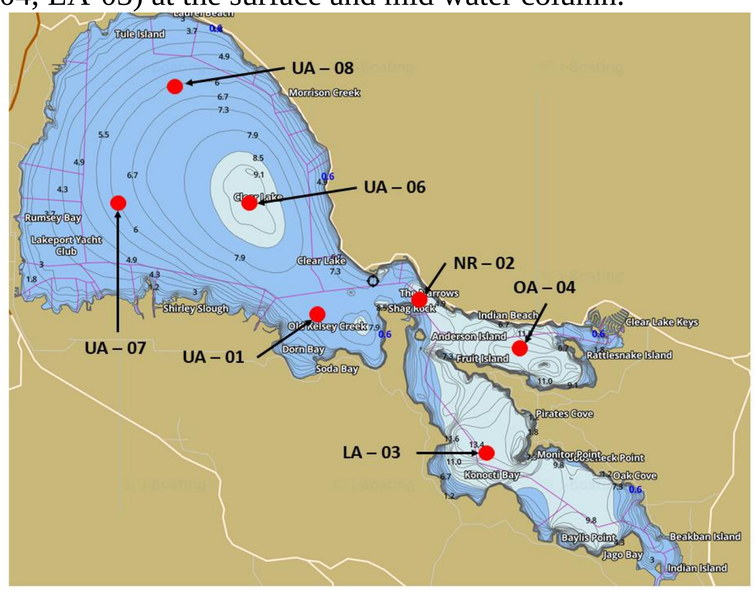

Fig. 5. Mooring locations (red dots) in Clear Lake

Table 3. GPS locations and nominal depths of moorings

Station #	Latitude (deg. N)	Longitude (deg. W)	Depth (m)
UA-01	39.024	122.788	8
UA-06	39.061	122.817	9
UA-07	39.061	122.873	6
UA-08	39.094	122.847	6
NR-02	39.028	122.745	9
OA-04	39.0127	122.699	12
LA-03	38.983	122.717	13

Table 4. Relative depths, height above the bottom, and arrangement of sensors on each mooring

UA - 01 (Total Depth = 8m)		
Instrument	Depth (m)	Dist. From Bot. (m)
UA-01-T7	2	6
UA-01-P/AP	2	6
UA-01-T6	2.5	5.5
UA-01-T5	3	5
UA-01-T4	4	4
UA-01-T3	5	3
UA-01-T2	6	2
UA-01-T1	7	1
UA-01-D1	7.5	0.5

UA - 06 (Total Depth = 9m)		
Instrument	Depth (m)	Dist. From Bot. (m)
UA-06-T9	2	7
UA-06-P/AP	2	7
UA-06-T8	2.5	6.5
UA-06-T7	3	6
UA-06-MD3	3.5	5.5
UA-06-T6	4	5
UA-06-T5	5	4
UA-06-T4	6	3
UA-06-T3	7	2
UA-06-MD2	7	2
UA-06-T2	7.5	1.5
UA-06-T1	8	1
UA-06-D1	8.5	0.5

UA - 07 (Total Depth = 6m)		
Instrument	Depth (m)	Dist. From Bot. (m)
UA-07-T5	2	4
UA-07-P/AP	2	4
UA-07-T4	2.5	3.5
UA-07-T3	3	3
UA-07-T2	4	2
UA-07-T1	5	1
UA-07-D1	5.5	0.5

UA - 08 (Total Depth = 6m)		
Instrument	Depth (m)	Dist. From Bot. (m)
UA-08-T5	2	4
UA-08-P/AP	2	4
UA-08-T4	2.5	3.5
UA-08-T3	3	3
UA-08-T2	4	2
UA-08-T1	5	1
UA-08-D1	5.5	0.5

NR - 02 (Total Depth = 9m)		
Instrument	Depth (m)	Dist. From Bot. (m)
NR-02-T8	2	7
NR-02-P/AP	2	7
NR-02-T7	2.5	6.5
NR-02-T6	3	6
NR-02-T5	4	5
NR-02-T4	5	4
NR-02-T3	6	3
NR-02-T2	7	2
NR-02-T1	8	1
NR-02-D1	8.5	0.5

OA - 04 (Total Depth = 12m)		
Instrument	Depth (m)	Dist. From Bot. (m)
OA-04-T11	2	10
OA-04-P/AP	2	10
OA-04-T10	2.5	9.5
OA-04-T9	3	9
OA-04-MD3	3.5	8.5
OA-04-T8	4	8
OA-04-T7	5	7
OA-04-T6	6	6
OA-04-T5	7	5
OA-04-T4	8	4
OA-04-T3	9	3
OA-04-D2	10	2
OA-04-T2	10.5	1.5
OA-04-T1	11	1
OA-04-D1	11.5	0.5

LA - 03 (Total Depth = 13m)		
Instrument	Depth (m)	Dist. From Bot. (m)
LA-03-T12	2	11
LA-03-P/AP	2	11
LA-03-T11	2.5	10.5
LA-03-T10	3	10
LA-03-MD3	3.5	9.5
LA-03-T9	4	9
LA-03-T8	5	8
LA-03-T7	6	7
LA-03-T6	7	6
LA-03-T5	8	5
LA-03-T4	9	4
LA-03-T3	10	3
LA-03-D2	11	2
LA-03-T2	11.5	1.5
LA-03-T1	12	1
LA-03-D1	12.5	0.5

T: temperature sensor
P/AP: pressure and acoustic pinger sensors
D: dissolved oxygen sensor- RBR
MD: dissolved oxygen sensor – PME miniDOT

The sampling frequency and battery duration of the instruments are as shown in Table 5. The planned frequency of instrument retrieval and downloading is every 3-6 months (90 -180 days). The sampling frequency for the T sensors will be set at every 10 seconds. This will allow battery life of 8 years. The DO-RBR sensor has a time constant of 10-30 s, so 30 s sampling will be utilized. The DO battery will nominally last for 2 years, but it will be replaced annually. The DO-MD sensor will sample every 10 min. The DO wiper (for removing bio-fouling) will be programmed to wipe every hour. The battery life should be approximately 9 months at this rate. Its battery will be replaced at every visit. The pressure sensors will also be programmed to sample at 1 h intervals.

Table 5. Battery life of instruments

DO Wiper	
Sampling interval (min)	Battery Life (days)
15	81
30	157
45	229
60	298
120	538

DO Sensor	
Sampling interval (min)	Battery Life (days)
0.5	25.2
1	25.2
2	47.1
3	70
4	94
5	117

Thermistors	
Sampling interval (min)	Battery Life (days)
0.5	147
1	294

The nominal mooring layout is shown in Fig. 6. The instruments will be cable tied and taped to 3/8" double braid polyester yacht braid. This rope has a working strength of 4200 lb, and has low stretch properties. The buoy is a 12" trawl float (https://www.seamar.com/item/YUN10M-8/TFLOAT-12-SIDE-LUG-OR-437-FM/) with 27 lb of buoyancy. The mooring rope will be terminated at one lug, and retrieval will be by hooking a retrieval line to a second lug.

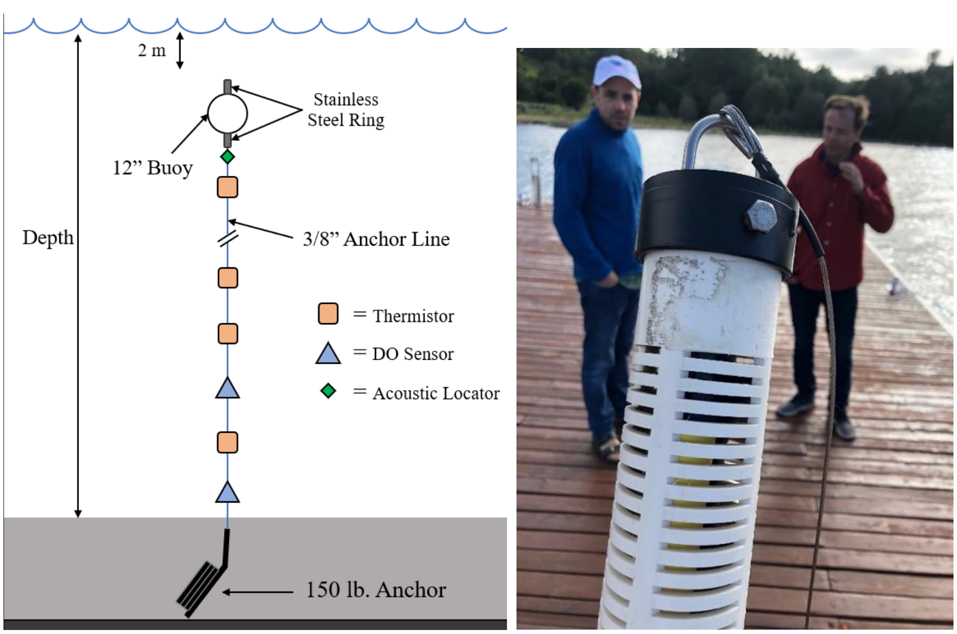

Fig. 6. (left) Mooring arrangement. (right) Casing for shoreline temperature loggers This mooring layout does not allow temperature measurements in the top 2 m surface layer.

Surface temperatures will be estimated in two ways. First, Hobo Water Temp Pro V2 temperature loggers (accuracy +/- 0.2 deg C and resolution +/- 0.02 deg C) will be located at the 6 docks where meteorological stations are located around the lake. Second, we will endeavor to find a marker piling within the lake where we will hang a set of 4 Onset loggers every half a meter between 0-2 m below the water surface.

All raw data files from the moorings will be stored in a cloud based storage (AWS), and processed data will be uploaded to SQL database.

2.3 Lake Profiling and Field Sampling

Profiling of the lake will take place at 6-week intervals using a Seabird SBE-19 profiler The SBE-19 samples at 4 Hz. When lowered at 0.5 m/s, this will produce a profile with 12.5 cm vertical resolution. The profiler measures temperature, conductivity, depth, turbidity, DO, and pH. Measurements of photosynthetically active radiation (PAR) will be made throughout the water column using a LiCOR L250 light meter equipped with upwelling and downwelling Li192 quantum sensors and used to compute transmissivity and attenuation coefficients. Profiles will be taken adjacent to all moorings, the three existing long-term DWR sample sites, and up to 4 other locations to be determined in conjunction with Clear Lake stakeholder groups.

In addition, discrete water samples (5 L minimum volume) will be taken with a Van Dorn (or similar sampler) at 4 depths at each mooring station. All water samples will be collected and decanted into acid washed bottles that are triple rinsed with ambient water at the time of collection. Whole water samples will be collected from each depth and stored in 2 L low-density dark polyethylene bottles on ice in coolers. For phytoplankton analysis, an aliquot of 100 ml of discrete water samples from 5 selected locations (see details below*) will be collected in clear glass bottles and immediately preserved with 1-ml Lugol's iodine solution. An air space will be left between top fill line and lid, and the sample bottles will be kept in the dark on ice in a cooler. Note: all of the sample water from a particular site will come from the same Van Dorn bottle. The tentative plan for sampling depths is collecting:

- Four samples at all sites distributed in the following manner: 1 sample 0.5 m below the surface, 2 near the bottom (0.5 m and 2 m off the bottom), and 1 mid-water column.
- Tentative plan for phytoplankton sampling at 5 mooring stations:
    - One near surface sample at 5 sites (LA-03, OA-04 and transect: UA-08, UA-06, UA-01) during the period from mid-Fall through early Spring.
    - Two samples (near surface and mid-water column) at the deepest site of each basin (UA-06, OA-04, LA-03), plus one near surface sample at 2 shallow sites (UA-08, UA-01) during the period from Spring to early Fall. Total number of samples: 84 per year.

Thus, we should collect 28 discrete water samples and 7 profiles at each mooring during each sampling campaign, excluding phytoplankton sampling.

The water samples will be analyzed for the following nutrients and water quality constituents.

Table 6. Constituents to be sampled for and analyzed for lake water. Major ions will be sampled twice a year corresponding to the wet and dry seasons.

	Constituent	Description	Detection level	Bi-weekly
Nutrients	NO_3+NO_2	Dissolved Nitrite + Nitrate Nitrogen	0.002 mg/L	X
	SRP	Dissolved Orthophosphate Phosphorus	0.001 mg/L	X
	TDN	Total Dissolved Nitrogen	0.002 mg/L	X
	TDP	Total Dissolved Phosphorus	0.002 mg/L	X
	PP	Particulate Phosphorus	0.002 mg/L	X
Organic matter	PC	Particulate Carbon	0.01 mg/L	X
	PN	Particulate Nitrogen	0.01 mg/L	X
	DOC	Dissolved Organic Carbon	0.05 mg/L	X
Chlorophyll	Chl-a	Chlorophyll-a	0.5 µg/L	X
Phytoplankton	Phyto	Identification and enumeration		X
Sediment	TSS	Total Suspended Solids	0.001 mg/L	X
	AFDW	Ash Free Dry Weight	0.001 mg/L	X
	FSP	Fine Sediment Particles by count	0.5 - 16 µm	X
	FSP	Sediment size distribution	2–2000 µm	X
Turbidity	Lab Turbidity	Laboratory Turbidity	0.01 NTU	X
Field Parameters	WT	Water Temperature	0.5°C	X
	AT	Air Temperature	0.5°C	X
	SC	Specific Conductance	1 µS/cm	X
	pH	pH	0.1	X
	DO	Dissolved Oxygen	0.1 mg/L	X
	DO%	Dissolved Oxygen percent saturation	0.0	X
	BP	Barometric Pressure	1 mm Hg	X
QA/QC	Blanks	Source and Field blanks		X
	Replicates	Replicates		X

2.4 Benthic Sediment Sampling

Analysis of existing Clear Lake sediment phosphorus and nitrogen data

Since 2008 Lake County has been collecting 10 cm deep sediment cores from three sites within the lake, 8 – 10 times per year. Each core is divided into 5 discrete 2cm sections at the time of collection and each section analyzed for Phosphorus (Loosely Bound, Iron Bound and Calcium Bound phosphorus) and nitrogen (NO3-N and TKN). We will analyze the existing dataset with the following objectives: 1) Characterize spatial and temporal scales of variability in sediment N and P; 2) Calculate total N and P sediment pools and estimate rates of internal loading using mass balance methods originally used by Richardson et al. (1994); 3) Assess the sampling design currently being used by Lake County and recommend any modifications based on an understanding of spatial and temporal variability in N and P.

Measurement of sediment oxygen demand and P and N fluxes

Oxygen demand, and P and N fluxes will be measured from sediments collected quarterly from 3 – 6 sites using a gravity corer and polycarbonate tubes. At each site, 4 – 6 replicate cores will be collected and capped with overlaying water to minimize disturbance to the sediments. Cores will be stored in coolers in the dark at ambient temperatures and transported to the lab within 6 hours of collection. A total of 20 L of ambient water will be collected from each site in high density polyethylene carboys to use during laboratory incubations. Sediment cores will be incubated directly within the polycarbonate tubes in which they were collected from the field.

The overlaying water in each core incubation chamber will be removed by siphoning and replaced with 1.0 µ filtered (Whatman GF/F) and oxygenated ambient water. Samples will be allowed to rest in the dark at ambient temperatures for 12-24 h prior to the start of incubations. Cores will be incubated at ambient lake temperatures for 3-5 days. Sediment P and N flux will be determined by measuring changes in concentration within the overlaying water within each incubation chamber and evaluated in relation to rates of oxygen demand and/or changes in redox potential. Dissolved oxygen within the overlaying water of each chamber will be measured non-invasively using a PreSens optical dissolved oxygen system (Fibox4) and a redox measured using a Mettler/Toledo redox probe. At the completion of each incubation, sediment samples will be collected from each core and analyzed for PC and PN (see laboratory methods section 2.8), three forms of bound Phosphorus (Loosely Bound, Iron Bound and Calcium Bound phosphorus), and nitrogen (NO3-N and TKN). Nutrient flux rates from sediment incubations will be scaled up for each basin to estimate internal P and N loading rates for the entire lake.

2.5 Sediment traps

We will estimate sediment deposition in the bottom of Clear Lake using sediment traps (Bloesh and Burns, 1980, Vicente et al. 2005). Sediment traps consist of clear cylindrical tubes with no lid and have a certain aspect ratio (height:diameter) based on the turbulence of the system. Given the size of Clear Lake, an aspect ratio of ~ 6 is acceptable. We will build sediment traps with clear acrylic pipe ~ 7 cm diameter and 0.46 m long, close only at the base. We will have duplicate traps at the sampling depths attached to a thinner 1 in pipe with both ends open (Fig. 7). A secondary rope will run through the thinner pipe and it will have a snap shackle on each end. We will use them to clip the sediment trap structure to the main mooring line (sub-surface buoy, rope, weight), where we will have two knots and wide loops to hold the sediment trap in place at the depth of sampling. The main mooring line consist of a rope with a sub-surface buoy (~2 m deep) and a weight at the bottom (concrete-filled bucket).

We will have sediment traps at 3 locations in the lake, located at the deepest site of each basin (UA-06, OA-04, LA-03). Traps would sit ~1 m above the bottom (trap should not be directly on lake bottom due to trapping re-suspended bottom sediments). Useful measurements taken from sediment caught in traps include organic matter content (OM) and total suspended sediments (TSS) to calculate sediment fluxes in Clear Lake.

Due to the high level of mixing in Clear Lake, it may not be feasible to calculate resuspension rates by using traditional methods of placing traps higher in the water column. Traps higher up in the water column can still be influenced by resuspension of bottom sediments in shallow, polymictic lakes (Bloesch 1994). There are other methods of calculating resuspension rates such as using TFe as a tracer for distinguishing resuspended lake sediments and settling sediments outlined in de Vicente et al. (2012), and this may be an available option for Clear Lake. Otherwise, without calculating resuspension rates, we cannot accurately estimate sedimentation rates since re-suspended sediments will skew estimates.

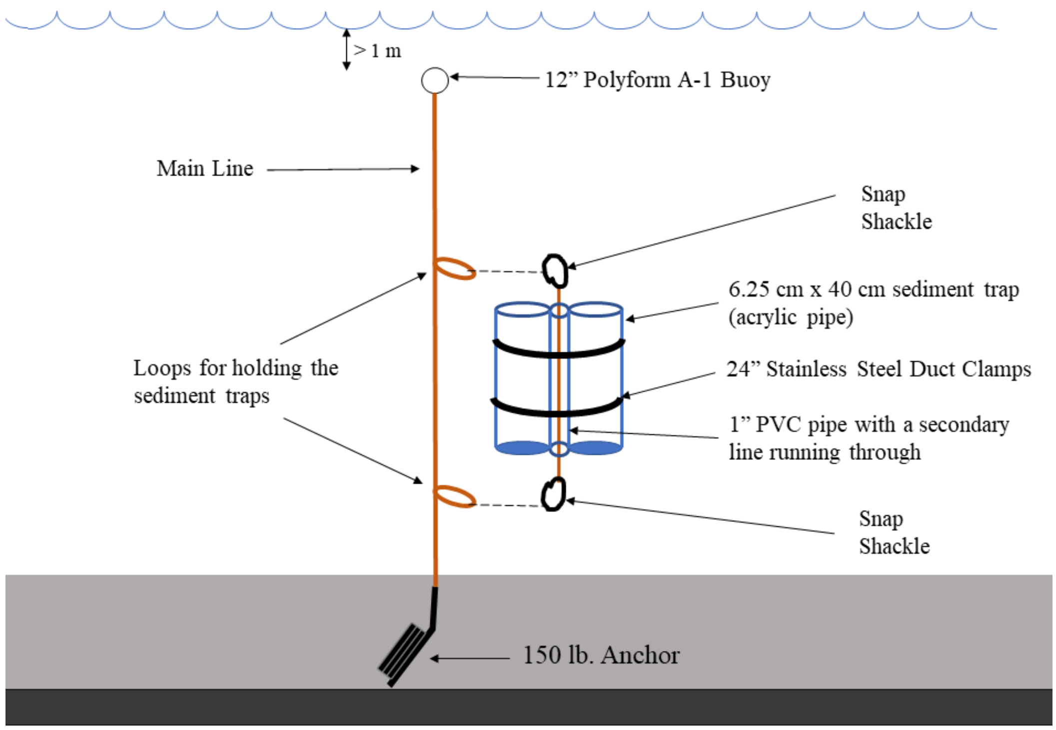

Fig. 7. Diagram of the sediment traps to deploy in Clear Lake

2.6 <u>In-lake ADCP measurements</u>

A Nortek Sentinel 1000 acoustic Doppler Current profiler (ADCP) will be used periodically to provide data on lake currents, lake waves and echosondes of fish and zooplankton distributions. This will be used in two modes:

(i) Bottom mounted adjacent to one of the mooring buoys

(ii) Boat mounted for transects of the lake basins.

Both raw and processed data will be stored on AWS.

2.7 <u>Bathymetric surveys</u>

A bathymetric survey of Clear Lake has not been conducted since 2002. The resolution currently possible is far superior, and would provide new information on the variability of substrate material, sub-surface water and bubble seeps, improved lake boundary conditions needed for 3-D modeling, historical artifacts and information on the differentiation of benthic substrates. The latter are important in connection with determining the benthic oxygen demand.

The present budget precludes bathymetric surveying, as this would take approximately 4-6 weeks of field work and 3 months of subsequent data processing. However, we will attempt to map specific locations of the lake as time permits.

Data will be similarly treated as ADCP data above.

2.8 Laboratory methods

Samples will be transported from the field to UC Davis stored on ice in coolers within 12 hours of collection and filtered upon arrival. Filtered samples will be transported by next-day Fedex to the TERC analytical laboratory within 1 day of arrival at UC Davis. FedEx labels will be created the day before with the same ship to address as for the stream water samples. SAMPLES SHOULD NOT BE FEDEXED ON FRIDAYS. All dissolved nutrient, particulate C, N, and P, and Chlorophyll-a samples will be filtered through pre-combusted (500 °C for 2h) Whatman GF/F filters (0.7 µm nominal pore size). Total Suspended solids will be collected on Whatman GF/F filters (0.7 µm nominal pore size) and dried at 60 °C until a constant weight and weighed to the nearest 0.1 mg, after which they will be combusted at 500 °C for 2h and re-weighed to get Ash Free Dry Weight.

Stoichiometric analysis of particulate organic matter (PC, PN, and PP) will be used as a broad assessment of overall organic matter quality. Soluble reactive phosphorus and nitrate+nitrite will be determined by TERC method on a flow-through discrete analyzer. Oxidative reduction (Valderrama 1981) will be used for total dissolved nutrients and particulate phosphorus determinations by TERC lab or UCD analytical lab (https://anlab.ucdavis.edu/). Dissolved organic nitrogen and phosphorus concentrations will be computed as the difference between inorganic and total fractions. DIN:TP and PN:PP ratios will be used as an indicator of nutrient limitation status. Particulate carbon and nitrogen concentrations will be determined using a Costech Elemental Analyzer (Sadro Lab). Dissolved organic carbon (DOC) will be measured on a Shimadzu TOC/TON analyzer (TERC lab). Periodic measurements of major anions and cations will be made using Ion Chromatography (UCD Analytical lab). Chlorophyll-a samples will be measured on a Turner 10-AU fluorometer after 24 h extraction in 90% methanol and chlorophyll-a used to model phytoplankton biomass (TERC lab).

Phytoplankton samples will be sent to the Watershed Sciences Center at UC Davis for enumeration and identification following Utermöhl method. The preserved sample is gently mixed and a sub-sample is placed in a sedimentation chamber. When the phytoplankton have settled to the bottom of the chamber, they are identified, usually at species level, and counted using a Zeiss inverted microscope. If a large number of buoyant cyanobacteria is present, a drop of diluted detergent is added to the chamber before closing it with the cover slide.

Staff shall maintain a field notebook to include basic information about each sampling event (e.g., date, time, and local weather conditions), remarkable observations, and a log of sample transmittal. Blanks and replicate samples, and field data also are collected during sampling events.

At least 48 hours prior to each lake sampling trip, contact the Big Valley Rancheria cyanobacterial sampling program, to arrange to pick up sample bottles for taking surface water samples for their cyanobacterial sampling program. Contact information as follows:

Big Valley Rancheria Environmental Director Sarah Ryan: ryan@big-valley.net (707) 263-3924 x132.

QA/AC for the Clear Lake project will follow the TERC QA/QC manual. Collection bottles from the field, sample bottles and filters will be cleaned properly and labeled properly. Samples, once collected, will be kept cooled and filtered ASAP after collection. For every sampling event, there will be one field duplicate collected, one field blank collected (while filtering samples) and one source blank collected at the time of bottle cleaning. We will also collect filter blanks with nothing added to the filter and filters with DI water passed through them. Each sample will be transported to the lab where it will be analyzed. Holding times will be adhered to. In the lab, SOPs will be followed, lab duplicates and lab spikes will be added to each run for every 10 samples on a run as well as two laboratory DI blanks per run. Each chemistry run will go through our rigorous QA/QC standards to assure accurate data is produced.

Data will be maintained in an SQL data base that is stored and backed up on the cloud using AWS.

2.9 Field Safety

A Field Safety Plan to insure the security of the team is included as Appendix 2.

3. References

Liston, A., T. Hammell, V. Edirveerasingam, B. Allen, S. Hackley, J. Reuter and G. Schladow. 2013 Laboratory Procedure, Field Protocol and Quality Assurance Manual (Updated March 28, 2013), Tahoe Environmental Research Center, University of California, Davis. 158 p.

Appendix 1: Lake County Stream Sampling Method

Before sampling:

- Request Fed Ex labels for the sample bottles.
- Once in the field:
- Field sampler should wear gloves to protect the sample. Wear a new set of gloves at each site.
- Take probe measurements first, before taking water samples. Have someone write down the results from the meter onto the data sheet (Fig. A1). Try to fill out as much of the data sheet as possible, if there is no data or you could not get a measurement, write in "N/A" or draw a line through the data field.
- When sampling for water, remember to only triple rinse the NON PRESERVED BOTTLES. Preserved bottles will have a sticker on the side indicating the preservative within, usually a strong acid or base. (Fig. A2)
- Make sure your sampling container is clean of debris and the weight is firmly attached (Fig. A3). We use a 5 lb vinyl covered weight and Gorilla tape.
- Rinse the sampling container three times with river water, allow the container to fill 1/3, shake the water around the container and dump away from sample location (on the road or downstream).
- After rinsing, lower the sampling container below to 1-3 ft below the surface. Allow the container to fully fill with water. Dropping it from a greater height helps it submerge faster.
- Pull up the sample container.
- Start with the unpreserved bottles and triple rinse each of those bottles by filling 1/3, shaking, and dumping away from sample site.
- After all unpreserved bottles are rinsed, fill each bottle, including preserved bottles, leaving an inch between top fill line and lid.
- You might have to refill your sample container in order to fill all containers.
- All sample bottle lids should be tightened and labels should correspond to that sample site.
- Transport all bottles in their coolers with a few ice packs to keep the temperature chilled. Arrange Fed Ex pick up.
- Make sure the date and time of sampling is recorded on the data sheet.

Sample Site:		Location Description and GPS:
Date:	Time:	Date of Last Storm Event:
Researcher (s) Name:		Sample Channel location (Circle one or two) Right Channel / Mid Channel / Left Channel / Thalwe
Notes:		

Site Characteristics

Cloud cover	no clouds; partly cloudy; cloudy sky (overcast);	Wind Direction (From) _____	N / W / E / S
Precipitation	none ; misty; foggy; drizzle; rain; snow;		
Wind	calm; breezy; windy;	Wind Intensity (Beaufort) _____	
Water Murkiness	clear water; cloudy water (>4" visibility), murky (<4" visibility). *(this pertains to the water itself, not to scum)*		
Flow Conditions	dry creekbed; isolated pools; trickle (<0.1cfs); full waterway no observed flow; >0.1cfs	Signs of disturbance & approx date/ time	
Estimated Flow	<0.1cfs; 0.1 - 1 cfs; 1 - 5 cfs; 5 - 20 cfs; 20 - 50 cfs; 50 - 200 cfs; >200 cfs	Wildfire:	
Sample color	none; amber; yellow; green; brown; gray; other:	Erosion:	
Sample odor	none; fresh algae smell; chlorine; sulfide (rotten eggs); sewage; other	Construction:	
Other (presence:)	algae or water plants; oily sheen; foam or suds; leaf litter; trash; other	Other:	

Water Quality Measurements				Sample Depth:	Last Callibration Date:	
Instrument ID	Parameter	Unit	Result	Repeated Measure Result	Bracket / Resolution	Notes
	Temp	°C				
	Specific Cond.	µS / cm				
	D.O.	%				
	D.O.	mg/L				
	pH	-				
HACH 2100 Q	Turbidity	NTU				
HI 96735	Hardness					

Sampling					Sample Depth:		
Bottle Label	Analyte	Bottle Type	Bottle Color	Preservative	Approx. depth of sample (Ft)	Collection device (grab, pole, bucket, etc.)	DUP? Y/ N

Fig. A1. Example data sheet for probe+meter measurements and SWAMP site observations.

Fig. A2. Unpreserved bottle on left, bottle with preservative on right. DO NOT TRIPLE RINSE BOTTLES WITH PRESERVATIVE.

Fig. A3. Sampling container for stream water sampling. The container is 3qt. with a 5lb vinyl coated hand weight taped at the side opposite the handle.

Appendix 2: Boat Safety Plan

Project Description

Boating operations will be taking place on Clear Lake using the R/V Ted Frantz. Operations will take place almost every month of the year for several years. These operations include deployment and retrieval of moorings, downloading of data from in situ sensors, water column profiling, installation and retrieval of ADCPs, utilization of side scan sonar, collection of water samples, as well as a range of similar activities.

Work Plan

The vessel will be permanently moored on a buoy near Lakeport. A small rubber dingy will be used by the crew to transit between shore and the vessel. Minimal equipment will be stored inside the locked cab of the vessel at night to minimize the risk of vandalism. All on-water activities will be completed during daylight hours, although the vessel is equipped with running lights.

Safety Considerations

Man Overboard

While working onboard the research vessel (and while transiting to/from shore), all field staff will wear a life jacket at all times. In the event of a man overboard situation a throw rope and life ring will be stored within arm's reach of the crew on the work deck. The primary goal is to reach the victim and return them safely to the vessel.

Vandalism

If any suspicious activity is observed during fieldwork, the incident should be immediately reported to Lake County Sheriff's department at (707) 263 2690.

Heat Exhaustion and Dehydration

In summer months the crew will spend the majority of each day exposed to the sun and should take the proper steps to mitigate any risks of heat exhaustion and dehydration. Heat exhaustion is caused by depletion of salts and water in your body. Common symptoms include confusion, dark-colored urine, dizziness, fainting, fatigue, headache, nausea and vomiting, profuse sweating, pale skin and rapid heartbeat. If a team member exhibits these symptoms, he or she should be placed under shaded, provided with water, and monitored for any change. If conditions deteriorate, the crew member will be transported to a local hospital for further treatment. The team will bring at a minimum 2 liters of water per person per day of fieldwork.

Hypothermia

Hypothermia is a concern winter months. Hats and gloves in tandem with wearing multiple layers can help to mitigate the risk of this hazard. Crew members will bring a surplus supply of dry clothes (especially socks), in the event of rain or falling in water.

Communication

Although most parts of Clear Lake have adequate cell phone coverage, UCD researchers will bring a satellite phone to have a reliable connection in all circumstances. The vessel also has a ship-to-shore radio, which can be used to communicate to local law enforcement. A SPOT GPS will also be available with an active SOS feature. The field crew will check in with the PI or co-PIs daily for a progress update.

Medical

A fully stocked first aid kit will be stored on the vessel in the case of any incident that would require minor medical attention. In the case that an emergency that would necessitate professional medical treatment the following medical facilities with 24 hour emergency services are available in the Clear Lake region:

Adventist Health Clear Lake
Address: 15630 18th Ave, Clearlake, CA 95422
Phone: (707) 994-6486

Sutter Lakeside Hospital
Address: 5176 Hill Rd E, Lakeport, CA 95453
Phone: (707) 262-5000

Project Personnel:

Geoff Schladow	Principal Investigator (PI)	(530) 902-2272
Alex Forrest	Co-PI	(530) 219-0946
Steve Sadro	Co-PI	(805) 722-2122
Samantha Sharp	Graduate Student	(831) 331-5391
Micah Swann	Graduate Student	(310) 837-0300
Drew Stang	Graduate Student	(360) 391-8432
Raph Townsend	Technical staff	(530) 386-2454
Anne Liston	TERC Safety Director/Chemist	530-414-1371
Nicholas Framsted	Technical Staff	
Shohei Watanabe	Data manager	(530) 400-4482
Lidia Tanaka	Phycologist	
Tina Hammell	Chemist	530-803-2177
Steve Sesma	Chemist	775-223-2784
Brant Allen	TERC Field Safety Director	(530) 604-6551

Field Staff Training

Personnel	Role	MOTC Trained	First Aid / CPR	AED	Last Lab Safety Training
Micah Swann	Field Crew	2/6/18			Oct 2018
Nicholas Framsted	Field Crew	2/6/18			Oct 2018
Drew Stang	Field Crew	2/6/18			Oct 2018

Emergency Contacts

Clear Lake Police Department	(707) 994-8251

For Emergencies Dial 9aa

Equipment and Supplies

Boating Safety Equipment aboard each vessel

- Inflatable Life Raft
- Survival suits
- Life jackets
- Life rings
- Marine radio
- Multiple cell phones and charger
- Flares
- Air horn
- Radar
- GPS
- Two paddles
- Boat hook

Misc Supplies

- Spare gasoline tank

Research Vessel
R/V Ted Frantz

- 25ft Design Concepts Aluminum hull
- Inboard Motor
- Safety equipment listed above on board at all times

Afloat Risk Assessment and Management Instructions

It is vital to the safety of the crew and to the success of the mission that the coxswain and crew understand and evaluate the full impact of risk versus gain for each tasking. This must be a continuous, systematic process of identifying and detecting hazards, assessing risk, and implementing and monitoring risk controls.

1. Using the worksheet on the opposite side, review each of the Risk Factors and assign a numerical score as indicated. Score each element according to currently available information. Score items according to the examples given and your instincts. Absence of data automatically sets the score to maximum point value. To identify hazards, consider:

   P*lanning*
   E*vent* Complexity
   A*sset* Selection (including Personnel and Equipment)
   C*ommunications* (and Supervision)
   E*nvironmenta*l Conditions

2. Consider the effects of environment on the ability to maintain communications throughout mission, both internal w/crew and external w/unit. Consider the condition of the vessel and associated equipment as factors in the mission environment.

3. If Risk Assessment is determined to be excessive, review the ***Control Options*** and determine if the risks can be reduced or controlled.

   Below are ***Control Options*** to assist in risk control or reduction. Review the options and reassess the risks as appropriate.

   Spread-out – Disperse the risk by increasing the time between events or using additional assets.

   Transfer – If practical, locate a better-suited asset to conduct the mission (i.e. different type of asset or crew).

   Avoid – Circumvent hazard: Wait for risk to subside (i.e. wait until daylight or weather passes).

   Accept – In some cases the benefit might justify the assumption of risk. In these cases a decision to accept risk may be made with the stipulation that risk is reevaluated as the mission progress. (No adjustment to Risk Assessment)

   Reduce – Reduce or limit risk exposure, use of PPE, additional training or rest, stress reduction.

4. Although one could selectively evaluate Risk Factors with a mind toward achieving an acceptable Risk Factor score, doing that would subvert the intent of this tool. This is intended to help everyone on the crew shift their thinking from a land based mindset, to the hazards of the maritime environment. All members of the crew should participate in the Risk Assessment scoring. This Risk Assessment process should continue throughout the mission as conditions evolve.