Rehabilitation of Clear Lake, CA

2019 Annual Report to the California Department of Fish and Wildlife

Project No. P1720013

For the period: January 2019 to December 2019

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UC DAVIS
Tahoe Environmental Research Center

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Introduction

The 2019 Annual Progress Report is divided into two separate sections. In Part A, we describe the work undertaken by the UC Davis Tahoe Environmental Research Center (TERC) in understanding and characterizing the physical, chemical and biological aspects of Clear Lake and its watershed. In Part B, we describe the work undertaken by the UC Davis Center for Regional Change (CRC) in characterizing the soco-economic characteristics of the Clear Lake region.

PART A: UC Davis Tahoe Environmental Research Center (TERC)

1. Stream Monitoring

1.1. In-Stream Gauges

High-frequency measurements of discharge and turbidity in the primary inflowing streams into the lake are essential to evaluate their contribution to the lake's pool of nutrients and sediments. FTS DTS-12 Turbidity and water temperature sensors and Campbell Scientific data loggers were installed by TERC staff in December 2018 at three locations on Clear Lake's major inflowing tributaries (Kelsey, Middle, and Scotts; Fig. 1). These sensors were co-located with existing Department of Water Resources (DWR) gauging stations. Stream turbidity and temperature data are recorded and transmitted to Cloud storage every 10 minutes.

During the 2018-2019 storm season, these sites were inspected and maintained every 3 months. In July 2019 the turbidity sensors were removed from the creeks due to minimal flow levels and sent to the manufacturer for annual calibration. In November 2019 the sensors were redeployed prior to the onset on the 2019-2020 storm season.

Our continuous stream turbidity measurements captured the large sediment loads occurring during the rainy season early in 2019 (Fig. 2).

1.2. Stream Water Quality Grab Sampling

We plan to use grab sample data to calibrate stream nutrient and sediment loading models from the continuous turbidity data. As part of Mendocino Complex post-fire water quality monitoring program, Lake County Water Resources Department, in conjunction with the Big Valley Band of Pomo Indians, conducted 7 stream storm sampling events throughout the Clear Lake watershed during the 2018-2019 storm season. Samples were collected at the hydrograph peak during rain events. Due to flooding issues, Scotts Creek was only accessible during three events.

The limited number of grab samples collected since the wildfire are insufficient to adequately calibrate a watershed model. In the coming winter, we are planning to coordinate intensive stream water quality grab sampling during storm events using student volunteers to improve model calibration, but a more comprehensive stream sampling program is required for a comprehensive watershed model. During these intensive sampling events, stream samples will be collected every three hours across the full duration of a storm event. These reliable in-situ measurements, in conjunction with a more extensive post-fire dataset, will allow us to calibrate our continuous stream turbidity records to compute external phosphorus and sediment loads into Clear Lake. UC Davis is also providing funding to the County to increase their frequency of water quality sampling on the streams.

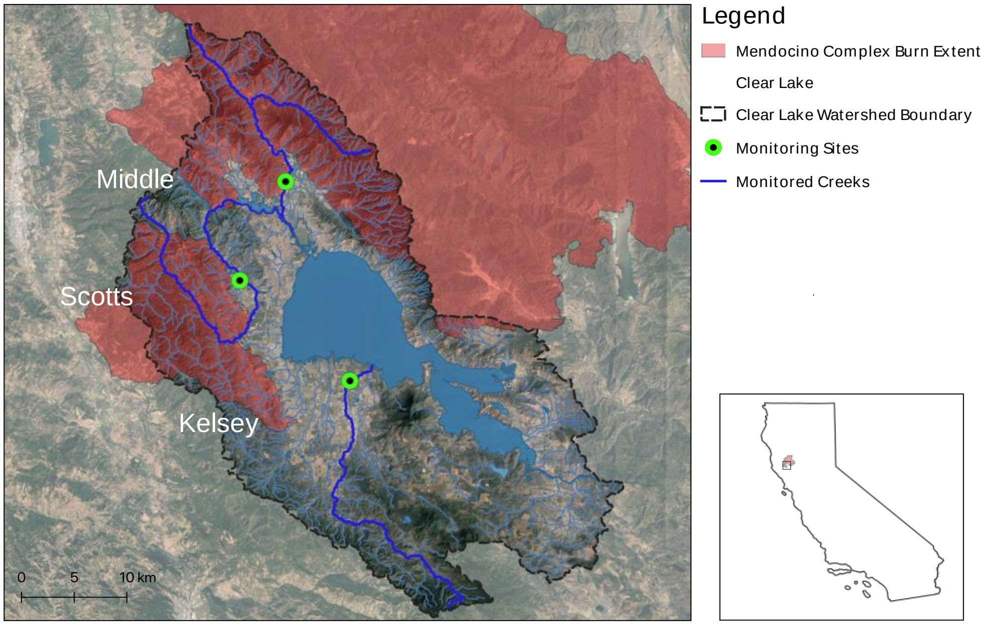

Fig. 1. Location of turbidity sensors (green circles) relative to the Mendocino Complex Burn Extent

2. Lake Monitoring

2.1. Weather Stations

Meteorological data are a fundamental driver of lake mixing dynamics. Seven meteorological stations were 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) in March 2019. We are measuring air temperature, relative humidity, solar radiation, rain, wind speed and direction every 15 minutes with Davis Instruments Wireless Vantage Pro2 Plus meteorological stations. Data are transmitted via a cellular network to the Cloud after every sampling interval and are accessible in real-time. As an example, wind roses (an indicator of wind directions) from the seven stations are shown in Fig. 3, which confirms the across lake variability of the wind field, and thus, the complexity of the mixing dynamics in this polymictic lake. Since installation, these sites have been inspected and maintained every 6 months. We are currently working to develop an on-line, dynamic graphical interface that plots this data in real-time.

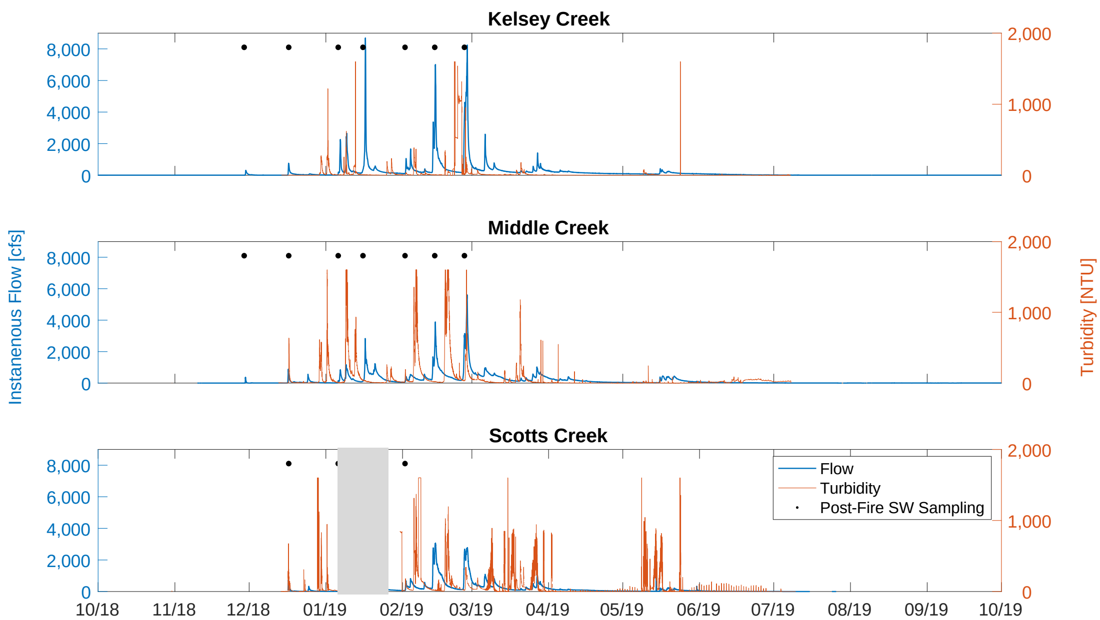

Fig. 2. Hourly average time series of discharge (blue) and turbidity (orange) measured at the three monitored creeks (Kelsey, Middle, and Scotts) during the 2018-2019 water year. Black dots show the dates of Lake County's post-fire stream sampling events. Gray rectangle marks when the turbidity sensor at Scotts Creek was clogged

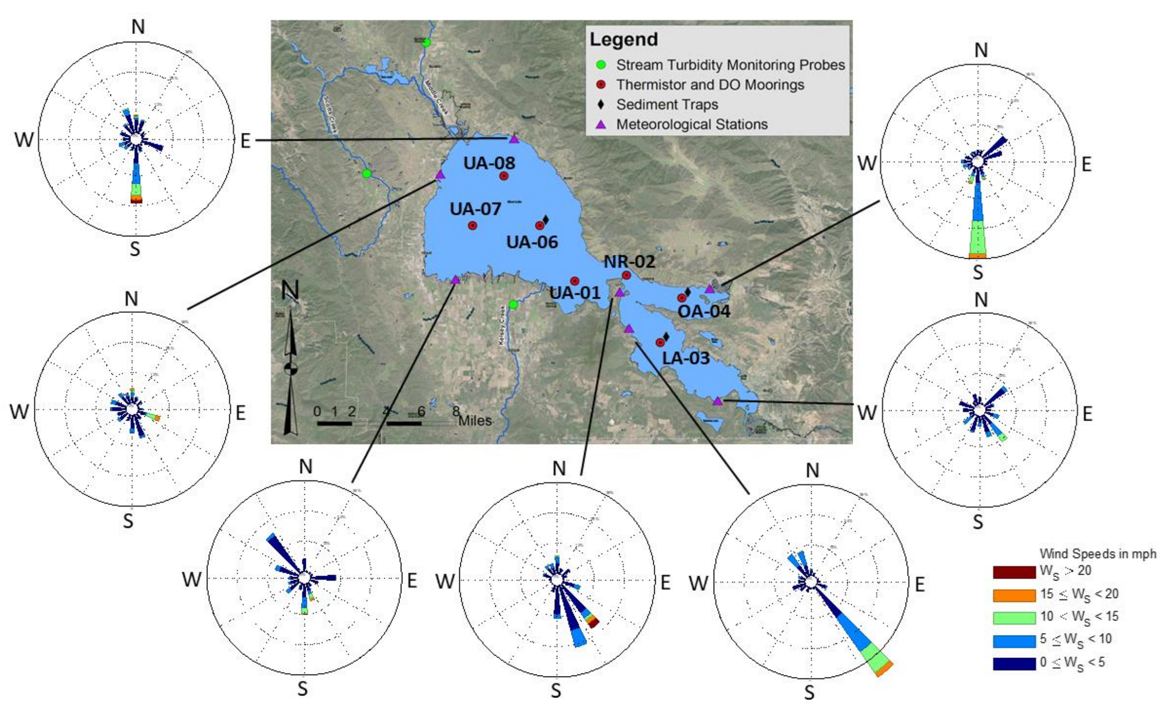

Fig. 3. Locations of monitoring stations: stream turbidity (green circles), water temperature and dissolved oxygen (DO) lake moorings (red circles), sediment traps (black diamond), and meteorological stations (purple triangle). Wind roses illustrate the spatial variability of the wind field

2.2. In-Lake Temperature-DO Moorings

Seven "permanent" sub-surface water quality stations (or moorings) were deployed in Clear Lake to measure water temperature and dissolved oxygen concentrations since March 2019 to characterize the temporal and spatial changes of lake thermal stratification and oxygen distribution (Fig. 3). Every 3 months these are retrieved, downloaded, cleaned and redeployed to continue the data record. Each station has a set of temperature sensors spaced ~1 m throughout the water column that record water temperature every 10 sec. In addition, the moorings have one to three wiped, dissolved oxygen (DO) sensors which record data every 30 seconds. Results from our mooring deployments between March and October 2019 show how thermal stratification can build up from time scales of days to nearly a month (as evident by the range of colors from top to bottom seen on Days 115 - 135). This stratification can quickly vanish as demonstrated during the spring (Day 100-105, and Day 138-145) of the shown period (Fig. 4). Summer temperatures were warmer than in spring, yet the stratification weakened by half. Strongly stratified periods were coincident with anoxic/hypoxic (low DO) conditions in the near-bottom water column. Anoxic conditions, as seen in the current data set, often cause the release of nutrients from the sediments into the water column. This is frequently referred to as internal loading. Our observations also highlight the significant spatial variability of the thermal structure and dissolved oxygen distribution at a given time across the lake (data not shown).

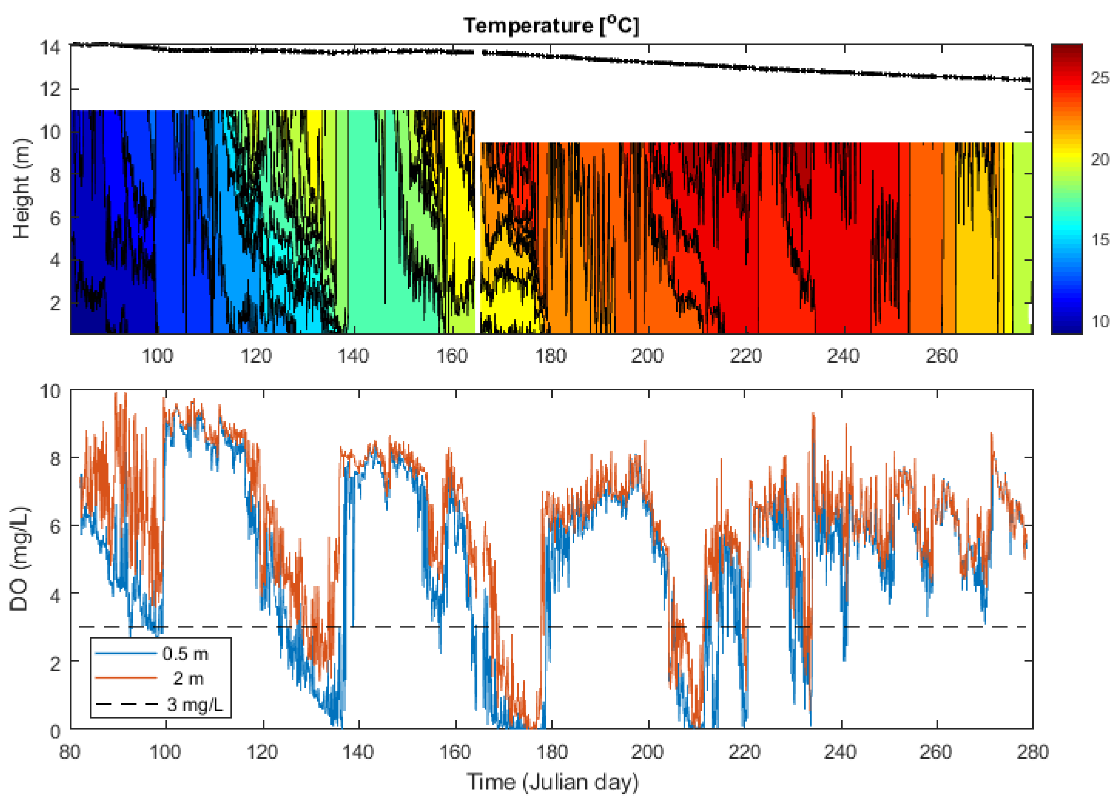

Fig. 4. Ten-minute averaged temperature (top) and lake bottom dissolved oxygen concentration (bottom) time series at the deepest site of the lake (Lower Arm) between March and October 2019. Blackline in the top panel shows the changes in water surface elevation. The dashed line in bottom panels marks a threshold of 3 mg/L of dissolved oxygen. DO concentrations below this threshold are referred to as hypoxia.

2.3. In-Shore and Offshore Surface Water Temperatures

Given that our permanent sub-surface moorings do not measure surface water temperatures, we are using two different approaches to do so. Surface temperatures at in-shore locations have been measured with Hobo Water Temp Pro V2 temperature loggers every 10 minutes at the docks where meteorological stations are located along the perimeter of the lake (Fig. 3). Data from these loggers are downloaded every 3 months (Fig. 5).

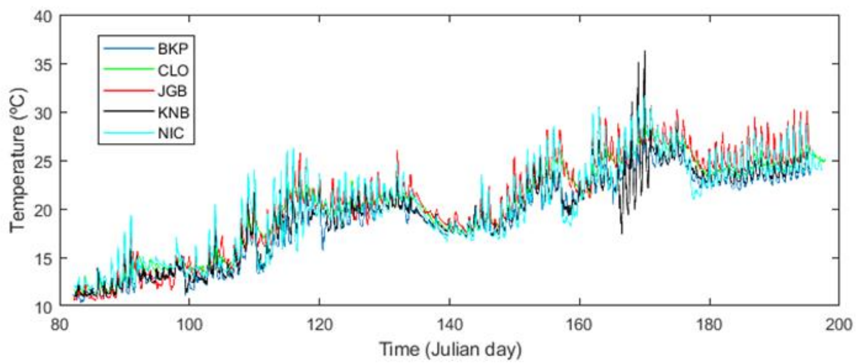

Fig. 5. Time series of water temperature from 5 of the in-shore loggers installed next to the meteorological station along the perimeter of the lake

In addition, we deployed three shallow thermistor arrays at the near-surface of Clear Lake in safe areas away from boats but representative of the off-shore lake surface conditions. To achieve that, we have attached our shallow thermistor arrays to navigation markers across the lake (Upper Arm, Narrows, Lower Arm). These shallow thermistor arrays consist of a wire rope with 5 temperature loggers spaced 0.5 m hanging from a surface buoy in the top two meters and inside of a PVC pipe with holes. Data from these loggers will complete our time series of water temperature of the sub-surface moorings (Fig. 6).Note the thermal stratification during each day in the upper 2 m.

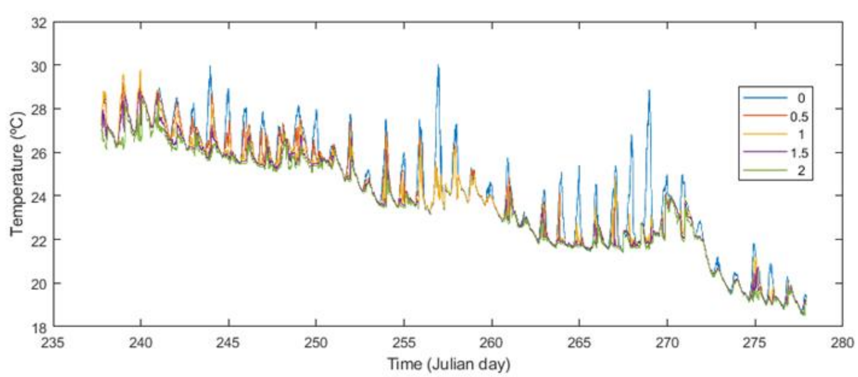

Fig. 6. Time series of water temperature in the upper 2 m at an offshore location in the Upper Arm

2.4. Lake Profiling

We also collect profiles of physico-biogeochemical properties of the lake water adjacent to the seven moorings every 6 weeks using a Seabird SBE-19 water quality profiler. This sensor measures conductivity, temperature, depth (CTD), chlorophyll, turbidity, and dissolved oxygen (Fig. 7). Temperature and dissolved oxygen time series from our mooring stations were intercalibrated against these profiles. This Seabird profiler has recently returned from a complete calibration of all sensors.

Measurements of photosynthetically active radiation (PAR) are made throughout the water column using a LiCOR L250 (Fig. 7). We also measured the Secchi depth at each site and sampling date using a Secchi disk. Thus, we used both light profiles and Secchi depths to compute the light attenuation coefficient in the water column, which has ranged between 0.6 and 1.2 m^{-1} during the studied period and at times varied substantially among stations within the lake.

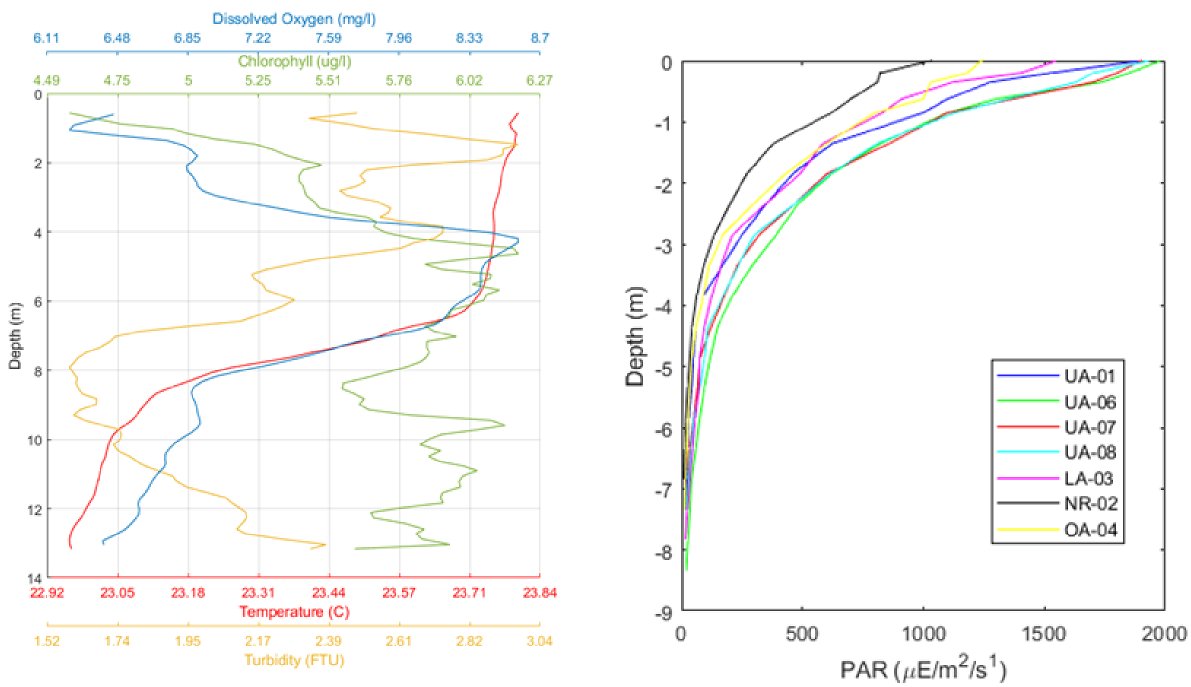

Fig. 7. (Left) Profiles of temperature, turbidity, chlorophyll and dissolved oxygen measured with our Seabird profiler in the Lower Arm in July 2019 in Clear Lake. (Right) Light profiles measured at the seven monitoring site in Clear Lake in July 2019

2.5. Lake Water Quality Sampling

Lake profiles next to our seven mooring stations every 6 weeks are paired with the collection of discrete water samples at 4 depths at each mooring station. Sampling depths are at 1 m, 2 m, and 4 m above the bottom and 0.5 m below the surface. We have completed 7 water quality sampling events since March 2019. The water samples are analyzed for the following nutrients and water quality constituents:

- Nitrogen forms: dissolved nitrite + nitrate (NO_2+NO_3), total dissolved nitrogen (TDN), particulate nitrogen (PN);

- Phosphorus forms: dissolved orthophosphate phosphorus (SRP), total dissolved phosphorus (TDP), particulate phosphorus (PP);
- Particulate carbon (PC), dissolved organic carbon (DOC);
- Chlorophyll-*a*, phytoplankton identification, and enumeration; and,
- Particle size distribution.

Results from the Lower Arm during the seven water quality sampling events show the significant temporal variability of the constituents in a hyper-eutrophic and polymictic system such as Clear Lake (Fig. 8). We have also captured the spatial variability of the different constituents (data not shown) as data was collected at each of the stations (recall Fig. 3).

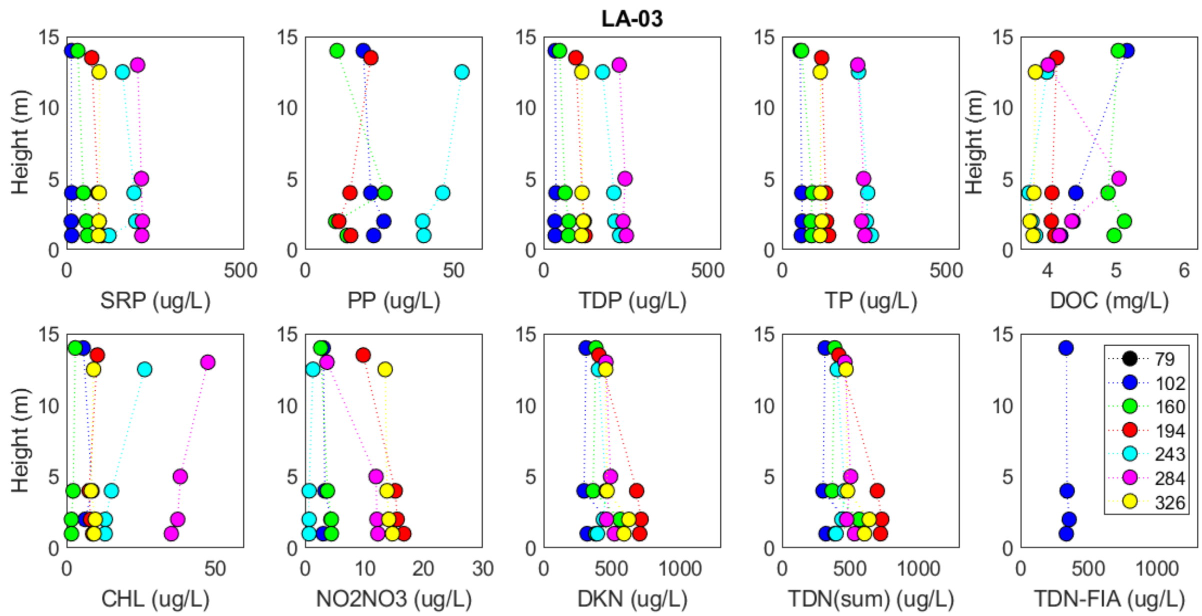

Fig. 8. Profiles of water quality constituents measured in Clear Lake in 2019 in the Lower Arm. Note that on the y-axis we show height above the bottom instead of depth

2.6. In-Lake ADCP Measurements

In order to aid in modeling currents and the distribution of dissolved oxygen and heat within the lake, we made direct measurements of water velocity. An Acoustic Doppler Current Profiler (ADCP) is a device used to measure water velocities throughout the water column at a high resolution (Fig. 9). An ADCP equipped with a single beam echosounder was deployed near the Lower Arm mooring from the start of August through September 2019. The recorded data reports the magnitude and direction of the water's movement which provides insight into the hydrodynamic processes occurring in the lake. Additionally, the echosounder produces data on the vertical distribution of fish in the water column (Fig. 10). Analysis of this dataset will allow us to find a correlation between the physical conditions in the water column and how they are impacting the vertical distribution of fish.

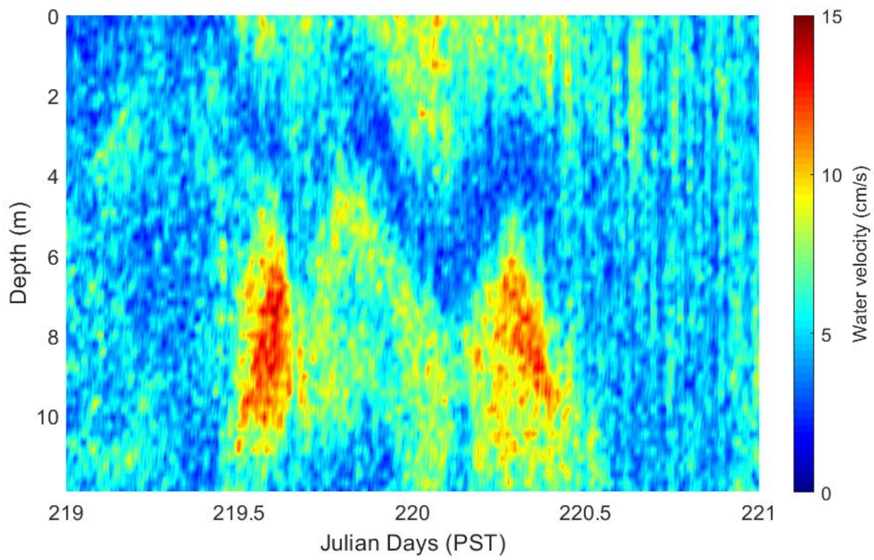

Fig. 9. Time series of water velocity magnitude (cm/s) (e.g. horizontal velocities) in the Lower Arm collected by the ADCP. We observed relatively high velocities (red and yellow) in both the upper and lower water column from day 219.5 to 220.5

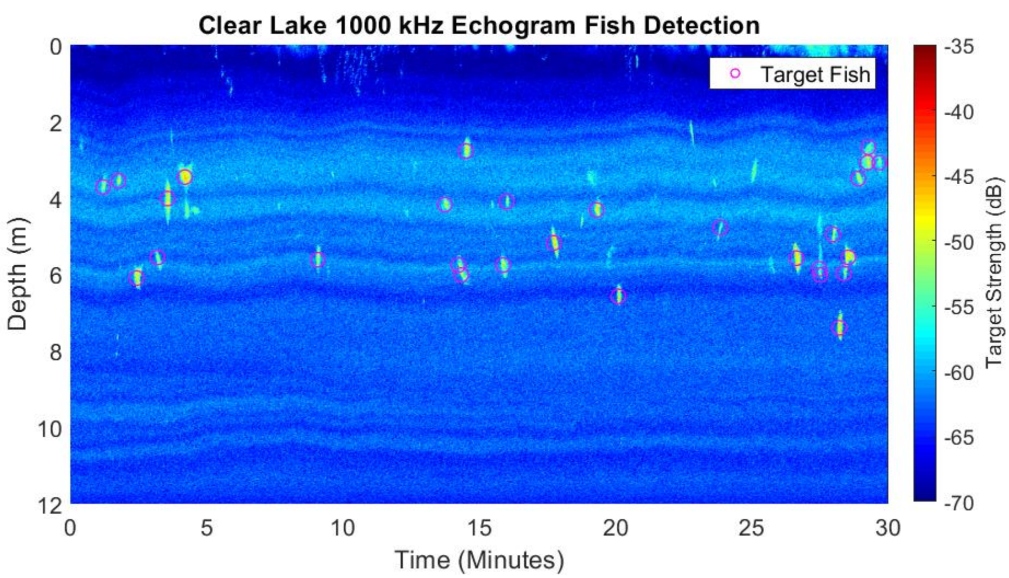

Fig. 10. Example of echogram recorded by the ADCP in the Lower Arm. The magenta circles indicate fish that are identified using an algorithm based on target strength

2.7. Benthic Sediment Incubations and Nutrient Flux Experiments

We have undertaken experiments examining the sediment-water interface. Sediment cores were collected and incubated in the laboratory under oxic and anoxic conditions to measure nutrient flux rates from six stations throughout the lake. Although mass balance estimates of phosphorus fluxes were historically computed, this is the first direct measurement of phosphorus flux made for Clear Lake. We collected 4 intact sediment cores at 6 different sites across the lake for a total of 24 cores. Two of the four cores from each site were subjected to an anoxic treatment by bubbling the overlying water with nitrogen gas. The two remaining cores from the same site were subjected to an oxic treatment by bubbling with air. We then measured ORP and pH of the overlying water in the cores as well as the concentrations of soluble reactive phosphorus (SRP), total dissolved phosphorus, nitrate, and ammonium every 3 days over a 30 day period. Fluxes of the chemical constituents were calculated at the end of the experiment and were calculated by performing a linear regression on the linear portion of each mass versus time curve. Nutrient flux rates from these incubations will be scaled up for each basin to estimate internal P and N loading rates for the entire lake for each season. This is a critical piece of information to understanding internal loading to the system.

Results indicate that SRP flux rates in Clear Lake show large spatial variation as some sites show nearly 3-fold differences in flux rates (Fig. 11) These rates are comparable to those found in other hyper-eutrophic lakes and are shown for each of the 6 sites as the average between duplicate cores in Table 1.

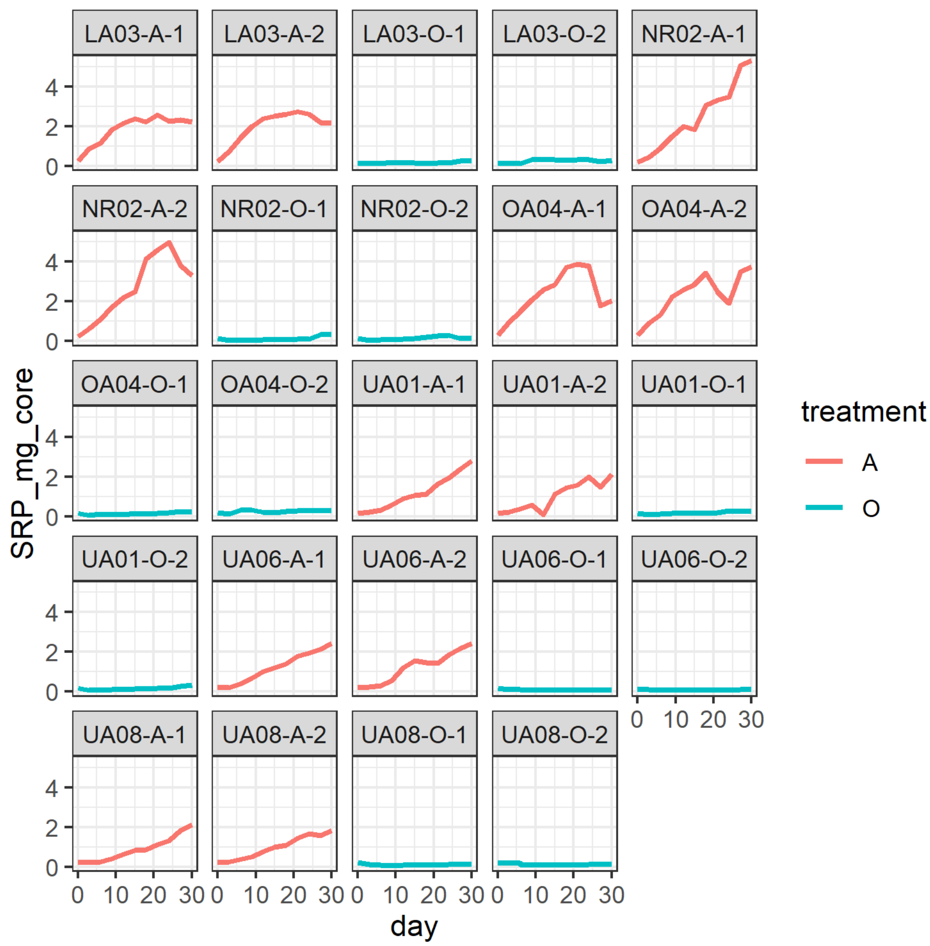

Fig. 11. Time series of soluble reactive phosphorus (SRP) mass (mg) contained in the overlying water of each core over 30-day incubation. The sample name is indicated at the top of each plot with the format “site-treatment-replicate” (“A” standing for anoxic and “O” for oxic treatments). The anoxic treatments (shown above in red) showed high rates of SRP flux while oxic treatments show very little change in SRP during the incubation

Table 1. Soluble reactive phosphorus (SRP) flux rates in the anoxic treatment from 6 sites across the lake (Fig. 3) and their variability between duplicate cores

Site	SRP Flux Rate (mg m^{-2} d^{-1})
UA-01	11.6 ± 0.94
UA-06	11 ± 0.14
UA-08	8.8 ± 0.09
NR-02	26.7 ± 3.86
OA-04	24.9 ± 0.86
LA-03	21.4 ± 1.61

2.8. Sediment Traps

We are periodically quantifying sedimentation rates in Clear Lake using sediment traps deployed at the deepest site of each basin (Fig. 3). Sediment traps consist of clear cylindrical tubes with no lid, located ~1 m off the lake bottom. Sediments caught in the traps are analyzed for particulate carbon, nitrogen, and phosphorus, particle size distribution, and total suspended solids. We have estimated mean sedimentation rates using the total suspended solids of order 0.4 cm yr^{-1}, with maximum values up to 1 cm yr^{-1}. In addition, sedimentation tended to be larger in the eastern basins of the lake (Oaks and Lower Arms).

3. Lake Modeling

We are conducting simulations using a three-dimensional (3-D) hydrodynamic and water quality model (Si3D). The model is based on the continuity equations for incompressible fluids, the Reynolds-averaged form of the Navier-Stokes equations for momentum, the transport equation for temperature, and an equation of state relating temperature to the fluid density. The governing equations are first posed in layer-averaged form by integrating over the height of a series of horizontal layers separated by level planes. The layer-averaged momentum equations are solved using a semi-implicit, three-level, iterative leapfrog-trapezoidal finite difference scheme on a staggered Cartesian grid. The semi-implicit approach is based on treating the gravity wave and vertical diffusion terms in the momentum equations implicitly, while all other terms are treated explicitly. Turbulent mixing is represented using diffusion-like terms. A water quality module is coupled to the hydrodynamic model in order to simulate the evolution of different constituents, such as dissolved oxygen, nitrogen species, phosphorus species, phytoplankton, and suspended solids.

The high computational cost of running a 3-D model in a large domain like Clear Lake has been reduced thanks to the use of High-Performance Computers (HPC). We have requested the use of the UC Davis College of Engineering High-Performance Computing Cluster (HPC1) for this project. The performance of this machine allows us running ~3-month simulation in about 8 hours.

We are completing the calibration of the hydrodynamic model using recently measured data from Clear Lake between March and June 2019. This entails adjusting the model parameters and forcing (meteorology and streams) within the margins of the uncertainty to reproduce the conditions that we measured in the lake during the spring. To do that, we have taken advantage of the measured spatial variability of the wind field across the lake. Our trial and error process is already producing promising results when we compare observed and model lake temperatures (Fig. 12). The computational domain has been discretized in cells which horizontal and vertical resolutions are 100 m and 0.5 m, respectively, and the simulation time step has been set to 20 s. Finer resolution is currently being explored.

The next step, model validation, entails running the calibrated model for a different period of time but without changing the calibrated parameters and assessing the quality of the fit to the data. In addition, we are setting up the water quality module of this 3D model in order to simulate the spatial distribution of dissolved oxygen, nitrogen and phosphorous species, phytoplankton, and suspended solids. We are also using a stand-alone Lagrangian particle-tracking model to visualize circulation patterns and simulate the transport of particulate matter.

Once the 3D numerical model reproduces previous lake conditions to within a satisfactory margin and the validation phase is completed, we will initially use the model to better understand the physical and biogeochemical processes occurring within Clear Lake. At a minimum, we would like to accurately reproduce the timing and intensity of the mixing and stratification events. This may result in changes in our monitoring, or possibly specific experiments to understand important phenomena better. Eventually, the model will be used to explore future scenarios and evaluate the effects of different restoration projects on the water quality challenges of Clear Lake.

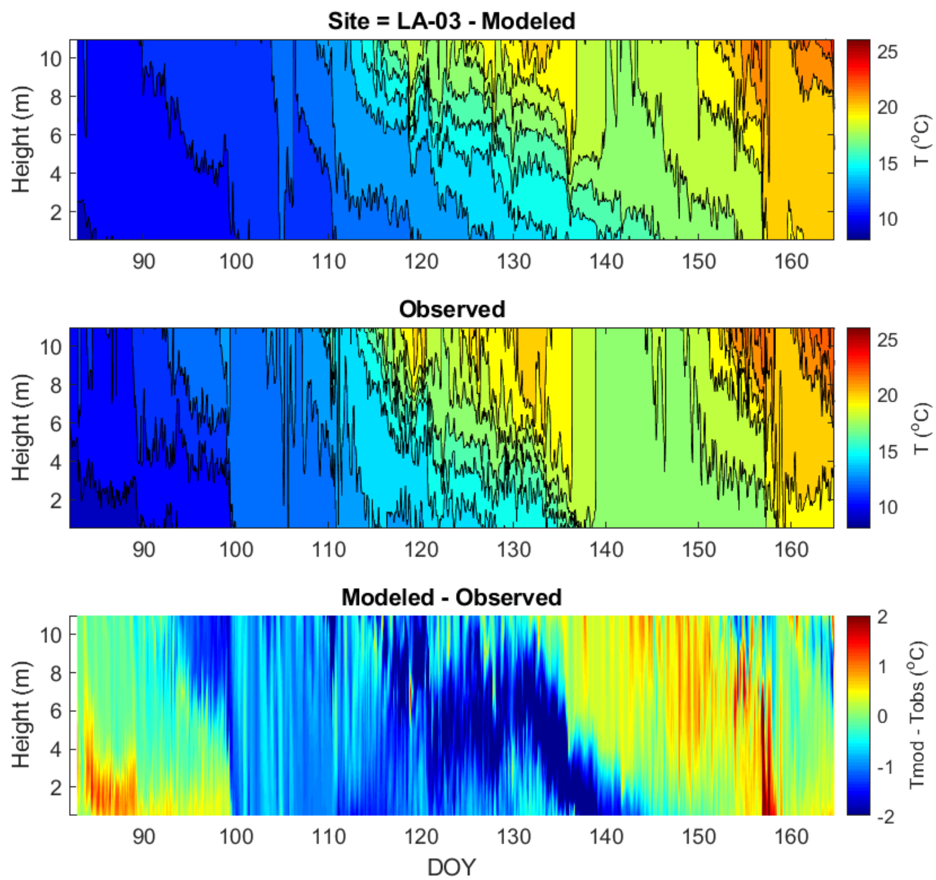

Fig. 12. Two hours averaged modeled temperature (top), observed temperature (middle), and the difference between them (bottom) time series at the deepest site of the lake (Lower Arm) between March and June 2019.

4. Remote Sensing Validation

Beyond the initial scope of the work, the team also initiated a study of cyanobacteria in Clear Lake looking at scales of spatial and temporal variability of harmful algal blooms using various sampling methods. The National Ocean and Atmospheric Administration (NOAA) developed a remote sensing algorithm to detect cyanobacteria using the satellites MERIS and Sentinel-3 in the Great Lakes. The San Francisco Estuary Institute (SFEI) and NOAA have applied this algorithm for lakes in California by developing a Harmful Algal Blooms (HAB) Analysis Tool. The HAB Tool calculates a cyanobacteria index from satellite reflectance data for water bodies in California. The collected data will be compared to a remote sensing model of harmful algal blooms in lakes in California to validate the model.

We have conducted a pilot project to compare the satellite-derived CI with in-situ cyanobacteria measurements collected using several methods at varying scales and resolutions. We completed three sampling events over the Summer 2019 in July, August, and October. The sampling methods employed include:

- Collection of discrete samples for laboratory analysis of chlorophyll-a, phycocyanin (a photosynthetic pigment specific to cyanobacteria), and algal species identification (completed in collaboration with the State Water Resources Control Board and the Big Valley Rancheria Tribe);
- Collection of radiometer measurements of the reflectance from the lake surface using a handheld hyperspectral instrument (completed in collaboration with the State Water Resources Control Board);
- Deployment of an unmanned aerial vehicle (drone) with a multispectral camera attached to collect large areal reflectance data; and,
- Deployment of an autonomous underwater vehicle (AUV) with optical sensors attached to collect high-resolution data for chlorophyll-a, CDOM, and turbidity.

These sampling methods (Fig. 13) are completed at varying scales and resolutions, which allow for a more complete understanding of the spatial variability of cyanobacteria blooms in Clear Lake. In addition, the Harmful Algal Bloom tool, once validated, will provide high temporal resolution data to understand the trends of cyanobacteria blooms in Clear Lake.

The collected data are currently being post-processed. Upon completion of post-processing, analysis and statistical comparison of the data will be completed and presented in 2020.

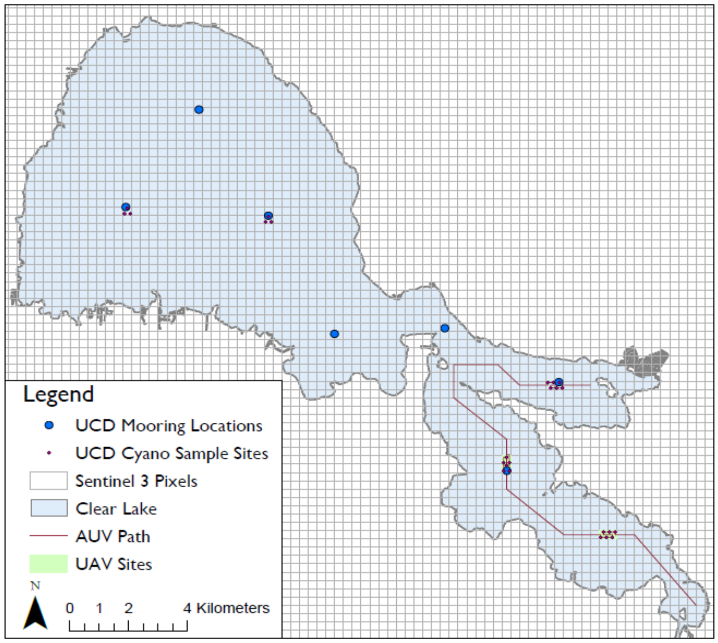

Fig. 13. Cyanobacteria sampling sites in Clear Lake

5. TERC Education and Public Outreach

5.1. Blue Ribbon Committee Meetings

In light of the environmental challenges that Clear Lake is facing, Assembly Bill (AB) 707 (Aguilar-Curry, 2017) was passed by the California Legislature to create a Blue Ribbon Committee (BRC) to develop strategies to rehabilitate the lake and its economy. UC Davis Tahoe Environmental Research Center has been an active member of this Committee and participated in all meetings in 2019. UC Davis group has provided the required background information and advice to satisfy the Committee needs during the decision-making process. A list of some of the meetings is the following:

- March 13, 2019: Protocols and information needs.
- June 5, 2019: Scope and outline of recommendations.
- September 26, 2019: Final recommendations draft.
- December 11, 2019: Recommendations approved for inclusion in the January 2020 report to the Governor and Legislature.

A total of seven more meetings have been held to discuss and plan technical aspects of the rehabilitation process.

TERC is also participating in the Technical Sub-Committee established by the BRC.

5.2. USGS Meetings

The USGS has also participated in the BRC conversations, and some of their current projects are also focused on Clear Lake. For example, the Sulphur Bank Mercury Mine (SBMM) is a Superfund Site by the EPA where further research is required to minimize the impact of the abandoned mine on the lake's water quality by reducing concentrations of mercury, sulfate and other contaminants of concern in the mine drainage. We have recently initiated discussions to (a) implement a mercury module in our current 3D hydrodynamic and water quality model, and (b) provide support to the USGS team for the installation of extra instrumentation on our moorings.

5.3. Senior Capstone Design Project

In 2019, as another form of education, we also participated in the Senior Capstone Design Project in Civil Engineering at UC Davis. The way that this class is structured is that several groups of students work on a single project for a real-world client. In this case, we gave them the task of designing an early warning system for algal blooms for Clear Lake. Five groups (4 students per group) worked on this project and attended a field site visit in addition to gathering data from stakeholders around the lake. In addition, some of the students came to attend the BRC meetings to see firsthand what the decision-making process was.

The final reports of these projects were then reviewed by some of the project personnel and elements have been incorporated into the project work plan. An example of this is that the collaboration working with the tool developed by SFEI was initiated by one of these project teams. This, in turn, led to the incorporation of both the AUV and drone use in the remote sensing validation that was run in August 2019. Their work was also showcased at the end of year presentations that they do on campus.

5.4. Student Conferences

The graduate students working on the Clear Lake project have participated in different conferences in 2019 to present the most updated results from our work:

- In October 2019, Micah Swann presented the results of the 2019 Clear Lake stream monitoring program at the California Lake Management Society (CALMs) Conference.
- In October 2019, Samantha Sharp presented on the cyanobacteria and remote sensing validation work at the 34th Annual California Lake Management Society (CALMS) Conference in San Diego, CA.
- In October 2019, Samantha Sharp gave a poster presentation on the cyanobacteria and remote sensing validation work at the 26th Annual California Aquatic Bioassessment Workgroup Meeting in Davis, CA.
- In November 2019, Samantha Sharp attended the Cyano Task Force meeting in North Lakeport, CA.
- In December 2019, Samantha Sharp gave a poster presentation on the cyanobacteria and remote sensing validation work at the American Geophysical Union Fall Meeting in San Francisco, CA.

5.5. Website

The data acquisition that we are conducting will form the basis of a long-term monitoring strategy to measure status and trends in the future (https://ucdclearlake.wixsite.com/cldashboard). Raw stream monitoring, meteorological and lake mooring data from 2019 are publicly available and available for download via this site.

6. TERC Personnel

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PART B: UC Davis Center for Regional Change (CRC)

1. Meetings & Communication

1.1. Blue Ribbon Committee Meeting Participation

Several UC Davis Center for Regional Change (CRC) faculty and staff attended the Blue Ribbon Committee Meetings held in September and December 2019. Jonathan London presented at the September meeting and identified the CRC's proposed research in three subject areas: Socio-Economic Analysis, Tribal Engagement Strategy, and Community Economic Development Strategy. Bernadette Austin presented at the December meeting, updating the BRC on research done to date and requesting feedback from the BRC by the March 2020 meeting.

The CRC has also continued to update the public UCD website, Rehabilitation of Clear Lake (AB 707).

2. Project Investigator Updates

1.2. Community & Tribal Engagement

Our team has successfully completed a scan of the publicly available data sources related to tribal lands. In July and August 2019, we met with tribal leaders of most tribal nations and convened a focus group with the Big Valley Band of Pomo Indians of the Big Valley Rancheria. We have undertaken outreach to tribal leaders from Robinson Rancheria, but have been unable to set up an introductory meeting.

We plan to work with the various tribes in the Clear Lake area individually to explore opportunities and coordinate ongoing efforts for socioeconomic development with activities and interests related to the Blue Ribbon Commission. We will hold at least one tribal convening in the Clear Lake region in the coming year and are researching the possibility of hosting a symposium at UCD this summer that would focus on current tribal research.

1.3. Socio-economic Analysis

In June 2019 our team presented preliminary results using a census block group representation of the community. The BRC expressed concerns regarding the validity of this representation. Specifically, the committee questioned the inclusion of areas that had low population sizes (e.g. in or near the Mendocino National Forest) and the accuracy of certain data values. In November 2019, Noli Brazil and Carlos Becerra presented a research brief describing the work done to address these concerns, concluding that they will use Census places within Lake County as the definition for the Clear Lake community due to lower levels of statistical uncertainty. Read the full report here.

Moving forward, we will focus our data analysis on indicators of socio-economic wellbeing, listed below. We plan to have preliminary results of our research by March 2020 and will report to the BRC in June 2020.

1. Demographic (e.g. age composition, residential mobility)
2. Economic (e.g. poverty rate, broadband access)
3. Employment (e.g. unemployment rate, commuting patterns)
4. Business (e.g. industry composition)
5. Housing (e.g. housing and rental cost burden)

6. Health
    a. This indicator was added after feedback from BRC during the Dec 2019 meeting. We are still exploring possible datasets at the proper geographic scale for this indicator.

1.4. Community Economic Development Strategy

Since June 2019, our team has conducted 13 interviews of stakeholders in the Clear Lake region, as well as field observation in the following sub-regions:

1. Clearlake and north lake shore;
2. Kelseyville and Rt. 20 corridor to south lake shore;
3. Middletown, south Lake County Hwy 175 corridor;
4. Lakeport; and,
5. Lucerne, Nice Upper Lake, and Hwy 20 corridor to Mendocino County

In our initial analysis of these interviews we have defined several economic opportunities in the region, including visitation/tourism, commercial agriculture, neighborhood-serving retail, manufacturing, small business development, education and housing. Challenges include competition with other similar destinations, rising housing costs for workers in the region, extreme weather impacts, pollution, disinvestment and poverty, and lack in infrastructure investment.

We will build upon these interviews by convening participatory strategy sessions early in 2020, which will help to inform a community economic development plan by June 2020.

3. Project Evaluation

We also plan to evaluate the participatory strategy sessions in order to report and improve on their efficacy throughout the coming FY.