Clear Lake Blue Ribbon Committee

LG Sonic Clear Lake Harmful Algal Bloom Monitoring, Prediction, and Control System

Project Title: Clear Lake Harmful Algal Bloom Monitoring, Prediction, and Control System

Project Description:

Summary of the project

Given Clear Lake's naturally eutrophic state, rising temperatures associated with climate change present managers with increasingly tight tolerances with respect to mitigating harmful algal blooms' (HABs) impacts on lake uses. HABs threats have an environmental justice valence, as key users include Tribal Nations, water treatment systems, and residents for recreational use. Also, these treatment plants usually cannot intercept cyanotoxins, placing households at risk for exposure. The CDC's One Health approach to HABs also makes it clear that events pose a unified threat to human health as a subset of environmental health.

This proposal is designed to pilot and show the effectiveness of LG Sonic's MPC-Buoy to control and mitigate HAB's in designated areas of Clear Lake. Remote sensing studies have indicated that HAB in Clear Lake originate from certain hotspot areas within the lake, from where they spread into the rest of the water surface. By preventing formation of algae in some of these hotspots, this project aims to reduce and mitigate the effect of HABs in Clear Lake. The algal blooms are targeted using specific ultrasonic frequencies that control algal growth effectively without negative side effects to the environment.

Background

The MPC-Buoy system was developed in 2012 by LG Sonic based in the Netherlands. LG Sonic US is based in Pennsylvania and supplies and services all North America. The MPC-Buoy has been deployed of 50+ countries and in 20+ US States. The first US install was in 2014 by American Water in New Jersey. Since that time, American Water has installed systems at 8 reservoirs in the US, in addition, over 50 additional systems have been installed in US lakes and reservoirs. These range from 16 ha [40 ac.] (1 buoy) to 120+ ha [300+ ac.] (12 buoys) around the US. Our largest international deployment was in the Dominican Republic in a lake/reservoir of 688 ha [1,700 ac.] (46 buoy system).

The MPC-Buoy is solar powered with no reliance on an outside power source. This not only creates an economical long-term algal control strategy but also flexibility for system modifications if or when conditions may change. Also, an integral part of the MPC-Buoy is its monitoring system. A critical part of the system is monitoring water quality and its system to optimize treatment based on current water conditions. As a secondary benefit, this data will allow local water professionals to track improvement

in water quality and algal concentrations. The MPC-Buoy can also be integrated with other water quality monitoring options such as real-time phosphorous monitoring, a vertical profiler, and weather stations. These ad-ons allow an even more powerful interpretation of the water conditions and better optimization of the ultrasonic treatment and are also incorporated in this proposed pilot.

When a waterbody suffers from algal blooms, managers often seek to reduce phosphate, which is the key nutrient that algae and cyanobacteria consume to grow. However, besides phosphate, light is also a critical resource for all phytoplankton. The MPC-Buoy uses ultrasonic waves to form a continuous pressure cycle around the algal cells. This affects their buoyancy regulation, which does not allow them to obtain sufficient buoyancy to remain the area where photosynthetically active radiation is high enough for them to bloom. This approach excels because it retains vibrant primary producer populations and allows lakes to reach stable chemical equilibria on their own without the shocks observed with external chemical treatments.

Through the implementation of algorithms, LG Sonic uses machine learning to predict environmental challenges such as algal blooms. LG Sonic developed and implemented these algorithms, and they function at the core of their technology. Users can visualize the data and models through an online platform, called the MPC-View. Finally, the systems installed by LG Sonic control algal bloom formation, which will be of key importance to safeguard water quality.

Integrated algorithms effectively adapt ultrasonic programs to the present algae type, while other algorithms provide prediction of algal blooms up to 10-days ahead. The algorithms are based on a Machine Learning (ML) model that applies deep learning technique known as N-BEATS. Using advanced tools for data analysis and artificial intelligence, we can model growth of trends in chlorophyll-a and phycocyanin up to 10 days ahead. In addition to using the data from our in-situ sensors, users can extrapolate data from remote sensing images to develop predictions over the entire surface of the waterbody.

The MPC-View software visualizes the water quality data. The software provides insight into the water quality, algae trends, and the progress of the ultrasonic treatment. Furthermore, the software displays technical parameters, such as the status of the ultrasonic transmitters, signal strength, and battery strength. Alarms can be set on the MPC-View for certain thresholds on parameters. These same alarms will also trigger automatic responses of the system, such as the changes of the ultrasonic treatment for algae control, alert an operator, or a prompt staff to collect a laboratory sample.

Project description

LG Sonic conducted a remote sensing analysis to determine the areas with the highest chlorophyll-a and phycocyanin concentrations within Clear Lake at different times in the year. We calculated the median chlorophyll-a (Figure 1) and phycocyanin (Figure 2) concentrations for the combined summers of 2021 and 2022, shown in the following images. We chose the median as a statistical measure, as it represents the most typical conditions on Clear Lake for the selected period. We identified six hotspot areas within the lake, labeled 1-6 in Figure 3. Figure 4 illustrates major water users' adjacency to these hotspots.

Treatment Area 6 with Vertical Profiling and Phosphate Monitoring

18 MPC-Buoys, additional – 2 MPC-Buoys with Vertical profilers, 2 buoys with phosphate sensors and consumables.

To really understand why certain problems such as algal blooms occur in lakes and reservoirs, it is beneficial to measure the water quality at different depths and in brief time intervals. Although staff manually sample at different depths in a water column, the limited interval of sampling (weeks or even months) makes it easy to miss peak events that are important for correct interpretation.

Our vertical profiler can be pre-set to take samples from a wide range of depths within a water body and measure key water parameters in real-time. The system transmits data through 4G, radio, or satellite to the MPC-View online software. The profiler measures up to a maximum depth of 100 m at 50 cm intervals. The vertical profiler monitors in-situ water quality parameters and wet-chemistry parameters. Expected outcomes include a better understanding of thermoclines, hypoxic/anoxic zones, and benthic bloom dynamics.

The unique wet chemistry sensor developed by LG Sonic, in collaboration with Dublin City University monitors physicochemical parameters in the water that staff conventionally only measured in the laboratory. The lab-on-chip technology truly functions as a floating, self-calibration, real-time laboratory that can monitor parameters at different depths. The orthophosphate as phosphorus sensor assesses the eutrophic status of the lake, identifies release of legacy nutrients from the sediment of the lake, and identifies discharge events at the surface of the lake.

Projected Budget	
Task	USD ($)
1: Education and Outreach	15,000
2: Planning and Permitting	20,000
3: MPC-Buoy purchase & Install	939,200
4: Monitoring & Maintenance	567,600
5: Final Reporting	25,000
Overall Budget Request	1,566,800

After 3 years, buoys are to be maintained by owners. Services supplied by LG Sonic US, as needed, or requested by the owner.

For budgeting purposes after year 3:

1) Annual calibration, IAC, and data managements costs - $32,800
2) 4 Service visits by LG Sonic US – If needed or requested - $48,000
3) Parts accrual - $30,000

MPC-Buoy Lifespan is estimated at 12-15 years.

Clear Lake managers, rightsholders, and stakeholders will determine project success. Nevertheless, quality-based limits could include chlorophyll-a of 60 µg/L, phycocyanin of 30 µg/L, and pH of 8.5.

It is important to note that eutrophic lakes may require multi-year treatment campaigns to attain stable and desirable parameter values. It may also be desirable to assess small water treatment system finished water's compliance with federal and state cyanotoxin exposure limits.

LG Sonic US and approved subcontractors will design and construct the MPC-Buoy system. Trusted third parties, including Tribal Nations, SWAMP, and academic partners should manage any required monitoring components. Project managers should also coordinate with CEDEN to coordinate data archive and access.

Project Timeline:

- **Month 1-3:** Planning and permitting, CEQA, and outreach
- **Month 4-6:** Outreach and engagement, project construction, and baseline monitoring
- **Month 7-8:** Buoy Installation and deployment
- **Month 9-12, year 2-3:** System run – treatment and monitoring
- **Year 4:** Final report preparation

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Additional Information:

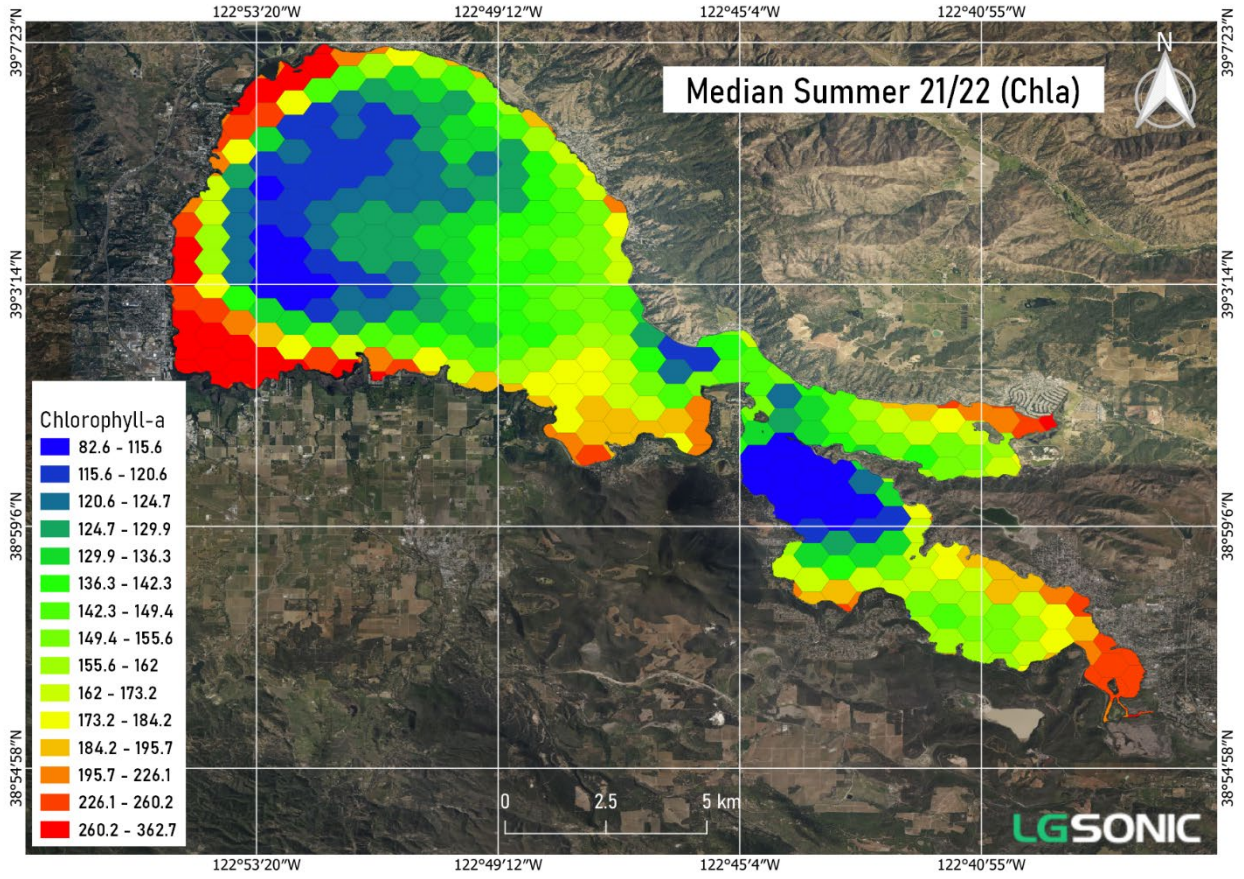

Figure 1 - Clear Lake - Chlorophyll-a (Median - Summer 2021/2022)

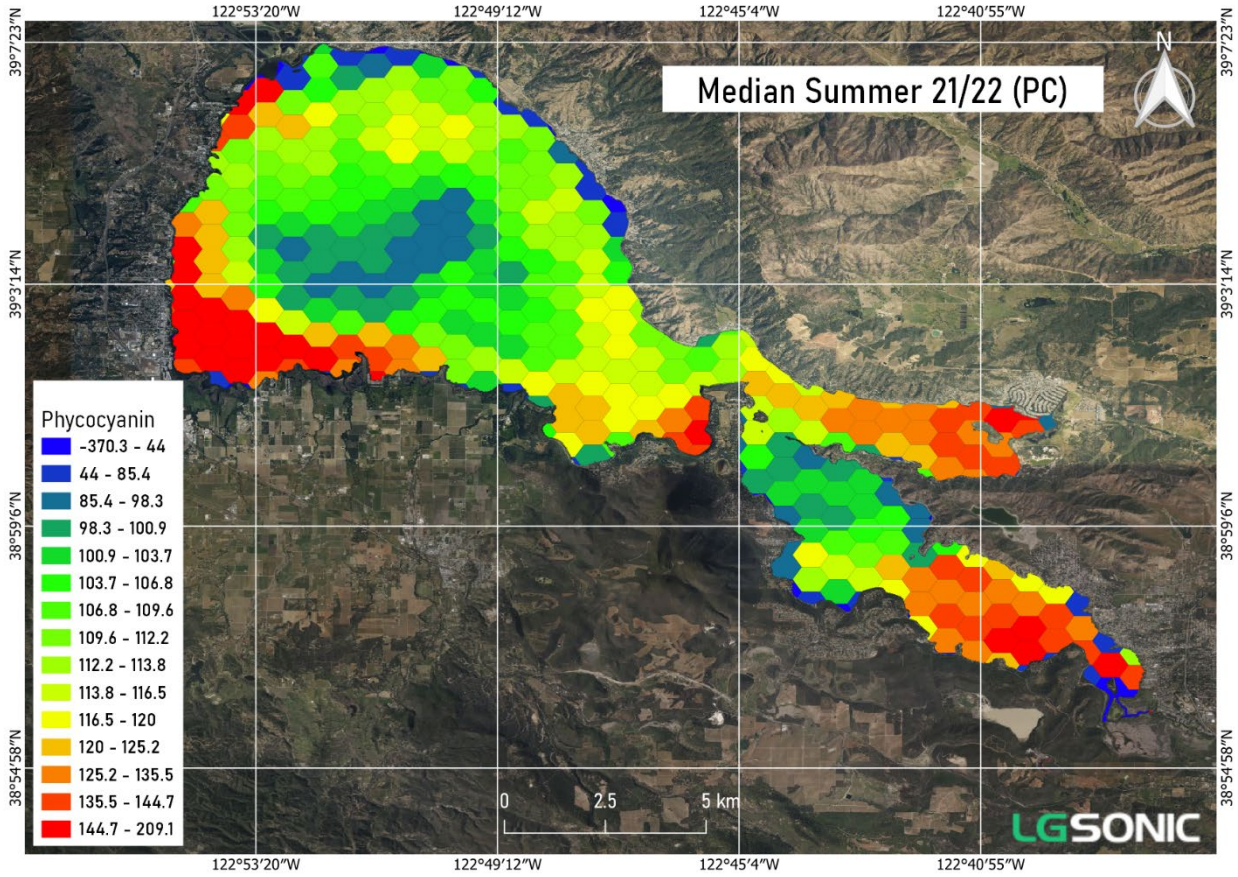

Figure 2- Clear Lake - Phycocyanin (Median - Summer 2021/2022)

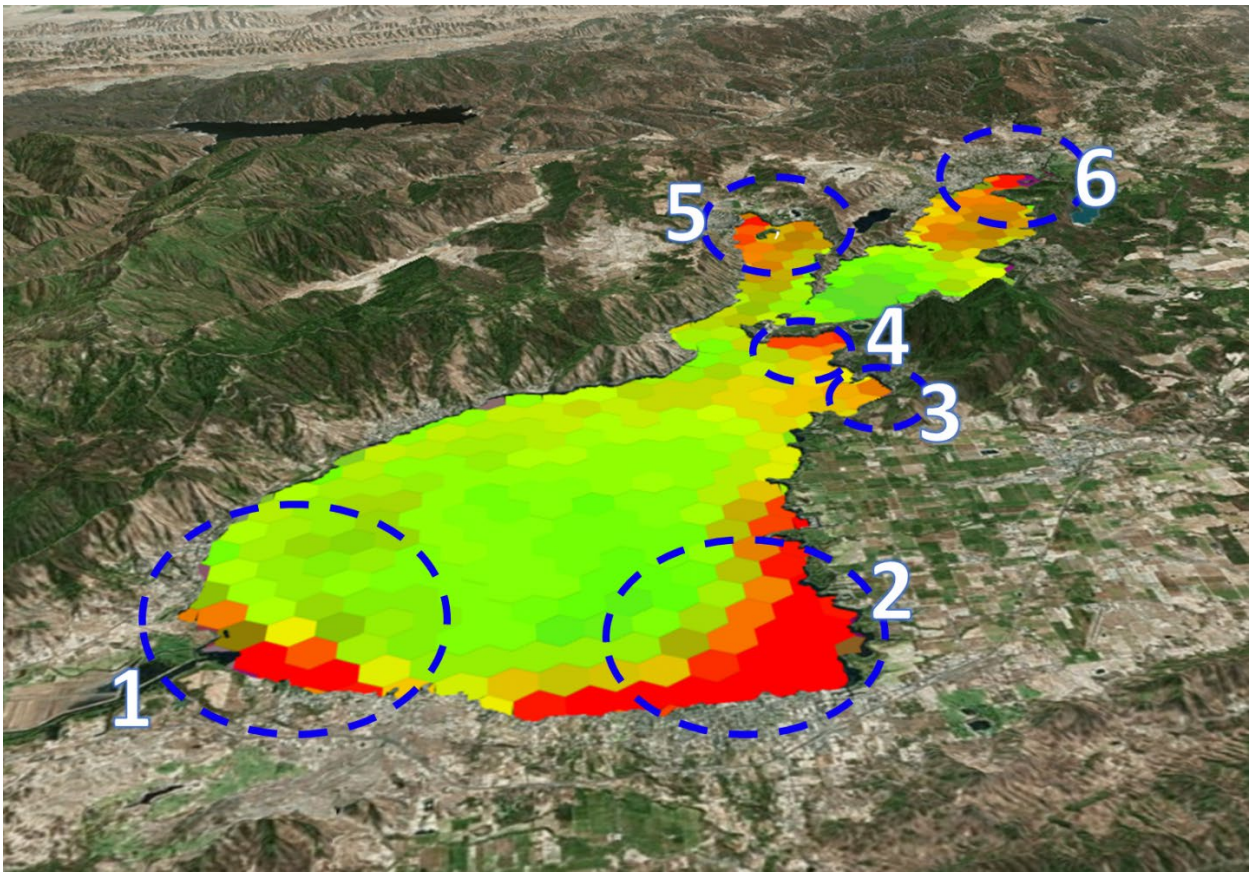

Figure 3 - Clear Lake Bloom Hotspots

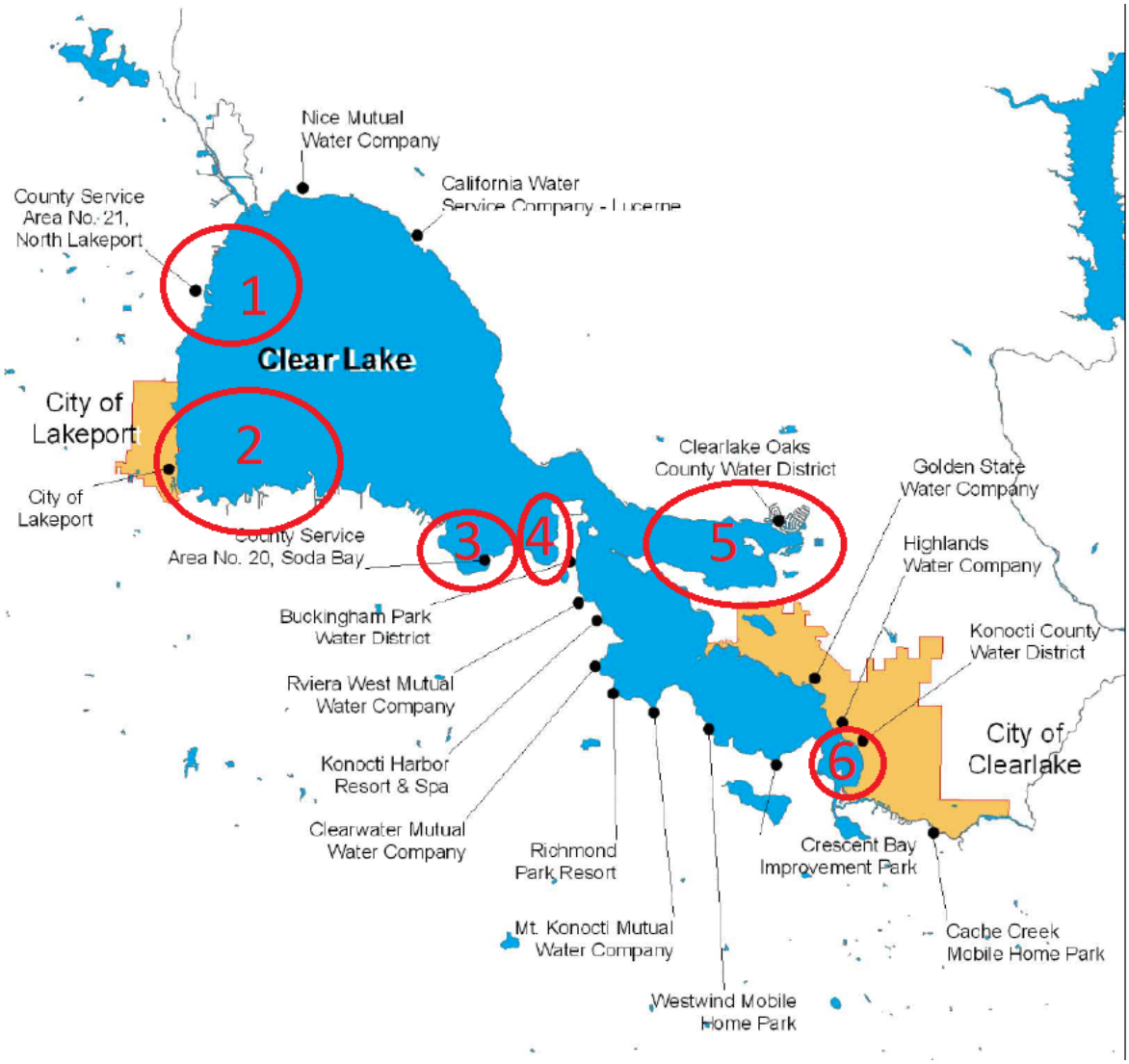

Figure 4 - Clear Lake Bloom Hotspots and Major Water Users