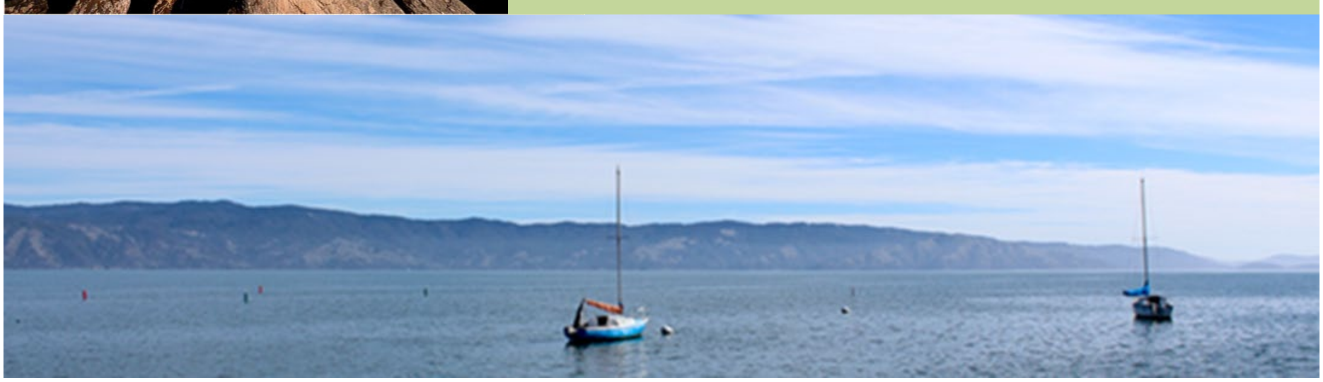
2020 Report to the Governor of California and California State Legislature

AB 707
Blue Ribbon Committee for the Rehabilitation of Clear Lake

January 6, 2020



Prepared for: The Governor of California, California State Legislature, California Natural Resources Agency, and the Blue Ribbon Committee for the Rehabilitation of Clear Lake

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Blue Ribbon Committee for the Rehabilitation of Clear Lake

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Section 1: Background

Clear Lake is one of the top two contributors to the local Lake County economy, according to the 2016 Lake County Comprehensive Economic Development Strategy, which cites the lake as "the cornerstone of the local visitor and recreation markets," mainly through boating and bass fishing tourism.[1] It is essential to the traditional cultural resources and economies of the seven federally recognized Tribes of the area; the condition of the lake affects the safety of traditional ceremonies, as well as fishing and consumption of fish and other aquatic species in accordance with Tribal customs.

Clear Lake is the oldest species-rich, warm water, natural lake in North America. It supports the surrounding ecosystems of native plants and animals, as well as species introduced by the Department of Fish and Wildlife. Clear Lake and the surrounding environment are also a home to endangered and rare animal species. However, the lake also experiences environmental challenges such as harmful algal blooms and mercury contamination from legacy mining issues.

In light of the environmental challenges facing Clear Lake and Lake County, Assembly Bill (AB) 707 (Aguiar-Curry, 2017) was passed by the California Legislature (Legislature) and signed by Governor Jerry Brown to create a Blue Ribbon Committee (Committee) to develop strategies to clean up Clear Lake and revitalize local economies dependent on the health of the Lake. AB 707 places the Committee under the management of the California Natural Resources Agency (Resources), with the Resource Secretary or designee serving as Committee Chair. Additionally, the Legislature appropriated $5 million in Proposition 68 funding for Clear Lake-specific capital improvement projects to improve conditions in the lake. The Committee will play a significant role in determining appropriate projects for funding.

This report represents the second annual report to Governor Gavin Newsom and appropriate committees of the Legislature as required by AB 707. AB 707 specifically requires annual reports to identify barriers to improved water quality in Clear Lake, the contributing factors causing poor water quality, and the threats to wildlife. The report must include recommendations on solutions to these issues, estimates of cost, and a plan for involving the local, state, and federal governments in funding for and implementation of lake restoration activities.

The Committee is a multi-year process; this report outlines implementation steps for the Committee's 2020 recommendations, which includes specific funding recommendations for the next budget cycle. These implementation steps are designed to address the challenges noted above, beginning with a robust data collection effort to ensure future environmental and socioeconomic recommendations are based on the most up-to-date analysis possible.

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1 https://www.lakecountyca.gov/Assets/Departments/Economic+Development/Docs/2016+CEDS+Report.pdf?method=1

Section 2: COVID-19 Response and Modifications to 2019 Recommendation Implementation

On March 19, 2020, Governor Gavin Newsom issued a statewide shelter-in-place order to combat the COVID-19 pandemic. The impacts of the pandemic are far-reaching and affect nearly every sector of government and the economy. The economic downturn associated with the pandemic drastically reduced available budget for all new projects and efforts requiring State general fund appropriations, including the Committee's recommendations.

In the spring of 2020, the Committee requested $6.8 million in general fund appropriations to implement its 2019 recommendations through the end of Fiscal Year (FY) 2022/2023. Due to budget shortfalls, the State of California was unable to provide funding. As a result, this report advocates for funding for these recommendations as part of the FY 21/22 budget cycle, in addition to providing specific implementation measures for each recommendation. Although the Committee continues to investigate alternative sources of funding, it expects that full allocation of funds may not be available until the FY 21/22 budget is approved.

A discussion of potential alternative funding sources and Committee recommendations for the utilization of bond funding is provided in **Section 6**. A detailed funding request breakdown is provided in **Appendix A.**

Section 3: Committee Process and Progress to Date

<u>Committee Deliberations</u>

This section provides a brief background on the Committee and its subcommittees, and summarizes their deliberations in 2020. Resources launched the Committee effort in June 2018 by requesting applications from local County and Tribal representatives in accordance with AB 707, including:

- A representative from the University of California (appointed by the Chancellor of the University)
- One member of the Board of Supervisors from Lake County or their designee
- Representatives from Tribes impacted by Clear Lake, appointed by their respective Tribal councils
- The Resources Secretary or their designee
- A representative of the Central Valley Regional Water Quality Control Board (Regional Water Board), appointed by its board
- An expert from each of the follow areas, appointed by the Lake County Board of Supervisors:
    - Local economic development
    - Agriculture
    - Environment
    - A public water supplier drawing its water supply from Clear Lake

A full list of the current membership of the Committee is available in Appendix E.

Committee Process to Date

The Committee met four times in 2020. The table below includes the meeting schedule and a brief summary statement of topics discussed at each session. Complete summaries, as well as video and/or audio recording of each meeting are available online at https://resources.ca.gov/Initiatives/Blue-Ribbon-Committee-for-the-Rehabilitation-of-Clear-Lake.

At each Committee meeting, members provided relevant local updates and UC Davis research teams provided research updates.

Meeting Date	**Summary**
March 11, 2020	Secretary Crowfoot and Assemblymember Aguiar-Curry commend the Committee on the 2019 Recommendations Report. Eric Sklar is introduced as Committee Chair. Resources staff confirms that the request for funding of all five recommendations has been submitted for inclusion in the State budget for FY 20/21. Committee approves letters of support for the Middle Creek Project and for Lake County Water Resources Department (WRD) Proposition 84 Storm Water Grant Program application. Committee reviews 2020 Work Plan.
June 18, 2020	Chair informs the Committee that 2019 recommendations were not included in the FY 20/21 budget due to reduced funding in response to the COVID-19 pandemic, but State funding may yet be available and alternative funding sources will be pursued. Committee receives updates on formation of Socioeconomic Subcommittee and the developing implementation plans for recommendations 1 (distributed watershed model) & 2 (comprehensive monitoring plan), and deferred 2019 recommendations in the 2020 Work Plan.
September 23, 2020	Committee confirms that without FY 20/21 State funding, the primary focus for the 2020 Report should be on securing funding for the 2019 Recommendations; with recommendations 1-3 as higher priority than 4 & 5 in the case of limited funding availability. Committee discusses potential projects to receive their allocated Proposition 68 funding and brainstorms alternative funding sources. Committee approves letters of support for UC Davis research gap funding and for continued California Department of Water Resources (DWR) Clear Lake water quality sampling.
December 9, 2020	Committee conditionally approved recommendations in the Report and unanimously approved funding two recommendations for funding with existing Proposition 68 funds.

Table 1: 2020 Committee Schedule and Outcomes

Technical Subcommittee Process to Date

The Technical Subcommittee is the primary venue for detailed discussions of lake science and the environmental factors impacting water quality in Clear Lake. Members include local stakeholders with a deep knowledge of lake conditions, Tribal water quality experts, researchers from UC Davis, and state and federal agency representatives. A complete roster of regular Technical Subcommittee attendees is included in Appendix E.

The Subcommittee met seven times in 2020. The table below includes a meeting schedule and brief summary of topics discussed during each session. Complete summaries and audio recordings of each meeting are available online at https://resources.ca.gov/Initiatives/Blue-Ribbon-Committee-for-the-Rehabilitation-of-Clear-Lake/clearlake-meeting-materials. The annual process of engagement between the Committee and the subcommittees is outlined in Appendix B.

Meeting Date	**Summary**
February 20, 2020	USGS presents on the Spatially Referenced Regression on Watershed attributes (SPARROW) model. Subcommittee continues to develop a basin-wide monitoring plan.
March 26, 2020	USGS presents on modeling and monitoring needs in the Clear Lake basin, presentation developed in collaboration with the UC Davis Tahoe Environmental Research Center (TERC) and Lake County Water Resources Department (WRD), Subcommittee provides input to inform implementation plans for Recommendations 1 & 2. Subcommittee continues to develop a basin-wide monitoring plan.
April 24, 2020	Lake County WRD presents on data management options. Commonwealth Scientific and Industrial Research Organisation (CSIRO) presents on optical technologies for observations of water quality and algal blooms, to inform deferred recommendations from 2019 regarding data management and remote telemetry. Subcommittee provides final comments regarding development of a basin-wide monitoring plan.
July 23, 2020	Subcommittee members provide updates on constituent activities. Subcommittee confirms that 2019 Recommendations should still be priority Recommendations for 2020. Subcommittee discusses progress that can be made without State funding.
August 27, 2020	Lake County WRD presents on the Middle Creek Restoration Project. Subcommittee continues discussion on prioritizing recommendations for 2020 and brainstorm of alternative funding sources. Subcommittee brainstorms projects eligible for Committee's Proposition 68 funding.
September 24, 2020	Subcommittee discusses alternative funding sources with input from UC Davis Foundation Engagement office and Office of Research Funding Opportunities.
October 22, 2020	SePRO Corporation presents on their product Phoslock, intended to minimize hazardous algal blooms. Committee discusses criteria for projects applying for the Committee's Proposition 68 funds and proposed projects, including fish ladders and hitch habitat restoration on Clover and Kelsey Creeks. Big Valley Rancheria consultant FlowWest presents on Kelsey Creek fish ladder project. Subcommittee continues discussion of alternative funding sources and alternative means of implementing recommendations.

Socioeconomic Subcommittee Process to Date

In the summer of 2020, the Committee formally launched its Socioeconomic Subcommittee. Similar to the Technical Subcommittee, this group is comprised of local stakeholders with a deep understanding of socioeconomic opportunities and challenges facing Clear Lake communities. Its primary purpose is twofold: developing specific measures for Committee consideration to alleviate socioeconomic challenges, and ensuring recommendations from other subcommittees do not adversely affect the Clear Lake economy whenever possible. A complete roster of regular Socioeconomic Subcommittee attendees is included in Appendix E.

This subcommittee met twice in 2020. The table below includes a meeting schedule and brief summary of topics discussed during each session. Complete summaries and audio recordings of each meeting are available online at https://resources.ca.gov/Initiatives/Blue-Ribbon-Committee-for-the-Rehabilitation-of-Clear-Lake.

Meeting Date	**Summary**
August 6, 2020	Subcommittee convenes, learns about the charges of the Committee and subcommittees, and 2019 Recommendations. UC Davis Center for Regional Change (CRC) presents research and opportunities for the Subcommittee to engage with their work. Subcommittee discusses possibilities for collaboration and networking regarding socioeconomics.
October 29, 2020	Subcommittee brainstorms alternative funding sources and participates in a focus group conducted by UC Davis CRC.

Cultural and Traditional Ecological Knowledge (TEK) Subcommittee

In 2019, the Committee approved the formation of a Cultural and TEK Subcommittee. While the seven representatives from the local Tribes ensure that Tribal interests are represented in the Committee's decision-making, this subcommittee will include members knowledgeable about specific heritage sites and traditional uses of the lake, for Tribes as well as other cultural groups. Like the other subcommittees, this group will ensure recommendations do not adversely affect these cultural resources, and that the Committee's decisions are informed by the TEK of the ancestral stewards of the Clear Lake basin.

Due to the increased demand on Tribal representatives during the COVID-19 pandemic in 2020, formation of this Subcommittee is deferred to 2021. The 2019 and 2020 recommendations all focus on information gathering and are unlikely to affect cultural resources, but input from this group will be essential to inform recommendations for future on-the-ground projects.

Committee Support and Parallel Research Efforts

Resources contracted with the Sacramento State University College of Continuing Education Consensus and Collaboration Program (CCP) in August of 2018 to provide neutral facilitation and process management services for the Committee. CCP works closely with Resources and Committee membership to design agendas, facilitate all Committee and subcommittee meetings, carry out routine negotiations between members over recommendations, and ensure all outreach meets the requirements of the Bagley Keene Open Meetings Act.

The UC Davis Tahoe Environmental Research Center (TERC) was selected to lead a research effort on the health of the lake, factors contributing to environmental challenges, and develop a 3-dimensional hydrodynamic model of Clear Lake. UC Davis's Center for Regional Change (CRC) was selected to lead a socioeconomic research effort. These efforts run in parallel to, but are separate from, the Committee effort. Research from both entities will inform the Committee's work in the future. Additional information on both research projects is described below.

An organization chart showing the interrelation between these efforts and the Committee, as well as the annual process for Recommendation development, is provided in **Appendix B**. As the TERC and CRC research efforts are funded through June 30, 2021, it is expected their research outcomes will provide foundational information for future Committee projects and actions.

TERC Information

UC Davis TERC conducted significant research activities in 2020 as part of its ongoing effort to develop a thorough understanding of in-lake processes driving many of the conditions outlined in Section 3 above. A summary of TERC's research and outcomes to date is provided in **Appendix C.**

CRC Information

The UC Davis CRC conducted ongoing research to develop an economic development strategy for Clear Lake communities in 2020. A summary of CRC's progress to date and next steps is included in **Appendix D**.

Clear Lake Ongoing Cyanotoxin Monitoring Information

The Big Valley Band of Pomo Indians and Elem Indian Colony conducted cyanotoxin monitoring on Clear Lake in 2020 (and ongoing since 2014) to determine whether toxin levels reached thresholds for safety and signage. Their sampling event results/sampling maps are available in **Appendix E.**

Section 4: Barriers to Improving Water Quality and Threats to Wildlife

For 2020, the Committee and Technical Subcommittee opted to focus on the causes of HABs from cyanobacteria, as well as elevated methylmercury levels as prominent water quality issues in Clear Lake. This section lays out key water quality issues, barriers to improving the physical condition of Clear Lake, and threats to wildlife caused by these issues and identified by Committee, Technical Subcommittee, and the parallel efforts at UC Davis.

Recommendations to further understand these challenges are presented in Section 5 below, and are expected to result in a suite of management activities after 2021.

Barriers to Improving Water Quality at Clear Lake

While lists of water quality challenges can be readily compiled, the greatest barrier to improvement is the absence of quantitative data on the response of the system to investments in specific restoration projects. Acquiring quantitative data requires completing four fundamental tasks:

1) Quantifying the processes that contribute to poor water quality, i.e. data collection;
2) Accurately predicting the lake response to environmental forces, including the extent of the current water quality challenges, i.e. model development;
3) Quantitatively evaluating the impacts, the costs, and unintended consequences of implementing particular projects and strategies, i.e. scenario development; and,
4) Quantitatively evaluating the consequences and costs of the "no action" alternative, with the inclusion of the likely impacts of climate change, i.e. future forecasting.

Past research, together with the experiences of residents and stakeholders at Clear Lake, has made it possible to identify many of the challenges facing the lake that these four tasks will address. These include:

- *Lake water temperatures* are increasing globally, and is likely the case at Clear Lake too. Aside from the direct effect of higher temperatures on metabolic and reaction rates, the most important consequence of this is expected to be an increase in the duration of periods of thermal stratification. Mixing or turnover events may be less effective and frequent. This trend cannot be prevented by local action as it is happening on a regional scale, but all planning needs to explicitly take this into account.
- Episodic *low dissolved oxygen* (DO) events in the deep water are known to occur, producing fish kills, release of nutrients through a phenomenon known as "internal loading", release of heavy metals including mercury to the food web, and the formation of noxious odors. With climate warming, there are likely to be more extended periods of low DO, with a corresponding increase in water quality degradation. There are engineering solutions to addressing low DO, but the extent of the problem needs to be quantified in order to make these solutions feasible and cost-effective.
- Identifying the relative contribution of *nutrient inputs* (both phosphorus and nitrogen, P and N) through both external and internal loading. External loading can be amplified by agricultural fertilizer addition, grazing, erosion due to poor land management or wildfire, increases in impervious land cover due to population growth, destruction of wetlands, etc. Internal loading is caused by low DO in the lake. Quantifying the sources of nutrients, their seasonal variability, and partitioning the loading rates (both internal and external) are key to selecting the most appropriate solutions to Clear Lake's eutrophication problem.
- Increasing frequency, biomass, duration and distribution of both algal blooms and *cyanobacteria* blooms. Cyanobacteria blooms and their toxins create risks to human and animal health, increase the costs for water treatment, contribute to a negative perception of the region leading to losses in tourism, property values, and business. Factors that may favor the cyanobacterial dominance include:
  - Episodic low DO events in the deep waters, leading to nutrient release and alterations in the food web;
  - Increased nutrient inputs from the watershed; and,

  - Rising water temperatures.

  The first two factors lend themselves to a number of restoration projects. Warming temperatures need to be accounted for in the design of these projects.
- *High methylmercury levels* in fish due to both the watershed inputs, the existing sediment load, and potentially ongoing supply input from the Sulphur Bank mercury mine. Understanding the mercury cycle in the lake is currently an active area of research at Clear Lake by the USGS. There are a range of engineering options for controlling mercury release to the water and the food web.
- Shift between a *clear state with macrophyte dominance* and *turbid phytoplankton-dominated state*. Native macrophytes stabilize clear-water conditions by reducing resuspension, increasing sedimentation, providing habitat for fish, and suppressing phytoplankton growth (nutrient competition). When the nutrient concentrations in the water are very high, the submerged and emergent native vegetation can be lost and the turbidity of the water increases. As a result, the buffering capacity of the ecosystem to external stressors is reduced. The current state of Clear Lake waters based on the limnological parameters is being assessed.

Threats to the Wildlife at Clear Lake

The threats to wildlife are intimately linked to the water quality condition of the lake. While some of the threats may be independent of the eutrophic status of the lake, a better understanding of the relations between watershed and lake processes will be essential when addressing these and other threats. Some of the threats include:

- Fish loss due to herbicide use;
- Episodic low DO, pH, and NH_3-NH_4, which may cause fish kills;
- Extensive periods of "fish habitat compression", occurring when low DO deep waters and high surface temperatures reduce the fish habitat;
- The dominance of non-native fish and other aquatic invasive species, which may modify nutrient cycling, cause habitat loss and be more dominant in the food chain as compared to non-native species;
- Native fish such as Clear Lake hitch (*Lavinia exilicuada chi*) loss due to multiple stressors, including loss of spawning habitat, water diversions, predation by non native fish, and barriers to passage; and,
- The introduction of new aquatic invasive species such as Quagga mussels. While Quagga mussels are not currently in the lake, and all efforts are being taken to prevent their establishment in the lake, the change in a broad suite of factors tends to increasingly disadvantage native species while at the same time creating niches for species that may previously not have survived in Clear Lake.

Section 5: 2020 Committee Recommendations and Implementation Steps

This section includes a summary of the Committee's 2020 recommendations. It also includes available implementation details for the recommendations, specific information on the suite of models recommended by the Technical Subcommittee, and the proposed monitoring plan designed by the Technical Subcommittee for Recommendation 2.

As noted in Section 2, fiscal shortfalls caused by the COVID-19 pandemic limited available funding for the implementation of 2019 Committee recommendations in 2020. **The Committee requests funding based on the table provided in Appendix A as its primary recommendation this year**. Additionally, in 2020 the Committee recommends financial support to continue existing critical water monitoring and research programs that the COVID-19 funding shortage impacted.

2019 Recommendations for Funding in 2021

1. Develop a distributed model of the upper watershed
2. Implement a comprehensive basin-wide monitoring strategy
3. Conduct a bathymetric survey of Clear Lake
4. Review the implementation of existing Tribal, local, State, and Federal programs, Best Management Practices (BMPs), and other management requirements to limit sedimentation/nutrient loading in the Clear Lake Basin
5. Assess the public's perceptions, attitudes, and knowledge gaps towards water quality in order to improve education and ultimately human impacts on Clear Lake
6. Continuation of Clear Lake Limnological Sampling for 2021
7. Bridge Funding for UC Davis research efforts

Each recommendation is discussed in detail below; where available, a detailed workplan is provided in the appendices.

Recommendation 1: Develop a Distributed Model of the Upper Watershed

US Geological Survey (USGS) Cost Estimate: $1,617,799 over three years*. See **Appendix G** for a complete work plan and budget information.

Models are a mathematical approximation of physical hydrologic and hydrodynamic processes. These models are highly organized and synthesize multiple related activities and hydrologic processes such as rainfall, sheet flows/runoff, surface water flows, and sediment discharges. In the case of Clear Lake, an upper watershed model can be developed to show where flows lead to significant sediment discharge, and how management activities can alter sediment or nutrient sources entering the lake.

The 2001 TERC Lake Tahoe model is an example of testing assumptions against observed and modeled sedimentation sources and that resulted in shifting management activities from forested to urban areas. This has resulted in a significant net water quality improvement and reversed a decades-long trend of worsening clarity in the lake. It should be noted that to properly calibrate this type of model, a unified monitoring strategy is required to ground truth all modeling runs with actual observed data. For the purposes of this recommendation, "upper watershed" is defined as areas upstream of Clear Lake, generally represented by the tributaries and drainages of major creeks and streams draining into the lake such as (but not limited to) Middle, Kelsey, Scotts, and Adobe Creeks.

Through discussions with the Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee) and its Technical Subcommittee, members have opted to use the US Geological Survey (USGS) Spatially Referenced Regression On Watershed Attributes, or (SPARROW) model. SPARROW is a watershed modeling technique developed by the USGS used for relating water-quality measurements made at a network of monitoring stations to attributes of the upstream watersheds, such as contaminant sources and environmental factors that affect rates of delivery to streams and in-stream processing.

The output is linked to a geographic information system (GIS) which can be display how the constituents move to downstream areas and what factors influence the movement. Additional elements included in this proposal and the cost estimate above include:

- SPARROW Decision Support Tool: a web-based mapper or decision support system to display how water quality would change under different management options.
- Hydrological Simulation Program (HSPF): HSPF is the only comprehensive model of watershed hydrology and water quality that allows the integrated simulation of land and soil contaminant runoff processes with in-stream hydraulic and sediment-chemical interactions. HSPF was applied to the lower Cache Creek watershed and successfully demonstrated post-fire effects (from the Jerusalem and Rocky fires in 2015) on sediment and mercury transport (Stern et al., in review).
- Sediment Fingerprinting: The sediment fingerprinting a procedure that establishes a minimal set of physical and/ (or) chemical properties (tracers) based on samples collected in upland or channel locations identified as potential sources of sediment. This allows land managers to accurately determine where problem constituents originate, and take reasonable actions to limit their entry into Clear Lake.

<u>Recommendation 2: Comprehensive Clear Lake Watershed Monitoring</u>

USGS Cost Estimate: $1,937,251 over three years. See **Appendix H** for a complete breakdown of cost estimates and proposed monitoring sites.

Consistent monitoring and sampling of stream flows, turbidity, sediment, and other constituents of concern is important for understanding nutrient, sediment, and other pollutant sources. Although a number of weather stations and stream gauges are used throughout the Clear Lake basin and some targeted monitoring is conducted by the Tribes, USGS, EPA, and for permit compliance , a lack of monitoring and sampling results for key areas in the Clear Lake basin results in data gaps around Clear Lake and in the upper watershed, particularly at stream confluences.

More robust monitoring and sampling will help ground truth remote sensing technology and calibrate the distributed upper watershed model (Recommendation 1). These two recommendations by the Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee) are essentially linked: for the model to be successfully calibrated, comprehensive monitoring of the upper watershed is essential. Physical management actions implemented at a later date as a result of modeling results will also require monitoring data to determine their efficacy.

For the purposes of this recommendation, “monitoring” includes weather stations, nutrient and chemical sampling, flow stage and sediment gauges, and biological monitoring (i.e., species health surveys, stream temperature measurements, etc.) similar to the State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Freshwater Harmful Algal Bloom (HAB) assessment.

Recommendation 3: Bathymetric Survey of Clear Lake

UC Davis TERC Cost Estimate: 1 time cost of $400,000

In the same way that topographic maps represent the three-dimensional features (or relief) of overland terrain, bathymetric maps illustrate the land that lies underwater. Variations in the lake bottom may be depicted by color and contour lines called depth contours. Bathymetry is the foundation of the science of hydrography and is critical information for the development of hydrographic models for a range of purposes including water quality management issues.

Conducting a bathymetric survey of Clear Lake is essential for understanding myriad lake processes and is not included in the current UC Davis Tahoe Environmental Research Center (TERC) Clear Lake research contract. UC Davis researchers note that monitoring for nutrients and oxygen at locations throughout the lake can be off by 10-20% absent up-to-date bathymetric data. USGS is commencing a study on volcanic eruption potential in the region, and US EPA is interested in bathymetric data near the Sulphur Bank Mine Superfund site, creating a shared need for bathymetric data.

Funding or Partnership Recommendation: Cost sharing with Federal partner agencies, such as US EPA and USGS, may provide attractive funding opportunities.

Recommendation 4: Regulatory and Best Management Practice Review

Big Valley Band of Pomo Indians Cost Estimate: One time cost of $60,000

Management of sediment and nutrient loading areas throughout the Clear Lake basin is varied, with Federal, State, County, and Tribal authority over land use planning and decisions. Small amounts of environmental monitoring occur to determine the success of the policies and best management practices (BMPs), but there is a need to coordinate the monitoring that exists and create an effective feedback loop in which the results drive improvements in the management policies to better control sediment and nutrient pollution loading in the watershed.

This review will create a useful tool for determining whether and where additional regulatory measures may be beneficial, and whether existing programs are effective in improving water quality. In cases in which programs are ineffective, the Committee may seek to provide resources to bolster existing programs. Additionally, it will help eliminate overlap between existing programs and Committee recommendations, increase coordination between different jurisdictions, and assist with planning cost effective, implementable actions in the future.

The Central Valley Regional Water Quality Control Board (Regional Water Board) has started a review of the Nutrient Total Maximum Daily Load (TMDL), and the Robinson Rancheria is conducting a review of current environmental ordinances, but given the multi-jurisdictional nature of water management activities in Clear Lake, the Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee) recommends a more comprehensive review of various jurisdictions' ordinances impacting water quality to date. The Regional Water Board will be actively engaged as a partner in this effort. Lake County and Tribal representatives on the Committee have expressed a willingness to support this effort financially.

Recommendation 5: Water Quality Public Perception Survey

Lake County Cost Estimate: One time cost of $120,000

The assessment seeks to identify what barriers to water quality exist from the public's perspective, or how the public's attitudes and perceptions may be driving behaviors that can both negatively and or positively impact water quality. The results of this assessment would allow managers, researchers, and policy makers to understand how to clearly communicate complex scientific information about water quality to the public. Additionally, decision makers can form better policies driven by community involvement, which determine the available resources for managing water resources, such as funding for basin scale non-point source pollution control. Furthermore, an accurate understanding of public behaviors will allow agencies and organizations to provide up to date, targeted educational materials and outreach opportunities.

The first activity implementation stage of this recommendation would be to survey the public and provide educational outreach on topics such as: causes and impacts of cyanobacteria, stormwater, current threats to Clear Lake water quality, current land use practice impacts on water quality, impacts of historical and present mining activities, wetland and flood infrastructure, current management or monitoring, non-point and point sources of pollution, and/or recognition of current outreach campaigns or messages.

After the survey data is gathered and analyzed, that information will allow land managers to implement specific, targeted, and data-driven outreach campaigns to improve overall water quality via behavioral/attitude shifts in the Clear Lake community. Specific tailored messages addressing identified knowledge gaps can provide maximum effect on the public's reception and acceptance of management implications and policies geared towards water quality, which has previously been a challenge in the Clear Lake basin. The data from the assessment survey may inform future annual recommendations from the Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee). After this targeted outreach, a similar survey can be administered to measure the efficacy of the targeted campaigns and drive future public engagement, as needed.

Committee members acknowledge it may be difficult to engage desired populations whose behaviors may impact water quality the most. Examples include individuals removing native vegetation to access Clear Lake, off highway vehicle users out of compliance with use restrictions, or property owners with outdated septic systems. Assessment surveys must be carefully designed to engage target populations without alienating residents; assessment results can be used to tailor educational materials to engage underserved communities.

2020 Recommendations for Funding in 2021

Due to funding shortages, two critical existing programs in Clear Lake monitoring and management are scheduled to be discontinued in 2021. Continued funding for both programs constitute the Committee's additional 2020 Recommendations. These items are:

Recommendation 6: Long-term Clear Lake limnological sampling

Committee Cost Estimate: $100,000 for one year of sample collection and analysis

Since 1968, the California Department of Water Resources (DWR) has conducted ambient water quality monitoring and sampling of Clear Lake in 3 locations: the Upper, Lower and Oaks arms of the lake. Data derived from this sampling allows the State, County, Tribes, and other impacted local organizations to identify and track key nutrients and potential contaminants. This publicly available water quality information is essential for making water quality management decisions for Clear Lake and dependent downstream areas, including the Cache Creek Watershed and ultimately, the California Delta. It is also supportive of California's effort to increase monitoring on streams as part of SB 19 (2019). Due to funding shortages in 2020, DWR will end the sampling and analysis program at the end of 2020.

A relatively small investment in a consistent water quality monitoring program has significant management and research implications. Without the consistent efforts and expertise of DWR, it is unlikely sampling will occur on a regular basis for the foreseeable future. This will likely impact not just County water quality management efforts, but also the 17 Public Water Systems and an unknown number of small and private drinking water supply operations around Clear Lake, downstream water users, and the environment.

Furthermore, ongoing research to create a full understanding of environmental challenges facing Clear Lake is structured to heavily rely on this ambient monitoring to create accurate models. In conjunction with the efforts of the Committee, these models are expected to provide a first ever scientific understanding of in-lake and watershed processes. This monitoring is also needed to assess post management action success, an essential tool to evaluate and maximize Committee-developed and other water quality improvement efforts.

The Committee supports a reinstatement of funding for a continuation of monitoring and sampling in Clear Lake and believes DWR's expertise and history of implementing the effort is invaluable. The information stemming from this sampling effort will assist in creating a more sustainable water supply for County residents and create opportunities for the restoration and enhancement of one of California's most unique water bodies in the face of ever-increasing environmental pressures.

Recommendation 7: Clear Lake in-lake modeling and research by UC Davis

Committee Cost Estimate: $100,000 for a short-term continuation of TERC and CRC research

Since 2017, TERC and CRC have engaged in long-term research efforts to better understand in-lake processes driving environmental challenges in Clear Lake, as well as socioeconomic pressures impacting Clear Lake communities.

TERC is in the process of developing a dynamic hydrologic model of lake processes for the largest natural lake in California. This model will provide a first of its kind look at the key drivers of environmental challenges such as cyanobacteria and cyanotoxin production in the Lake. As a key partner in the Committee process, TERC is designing its model to integrate with a broader watershed-wide model recommended by the Committee in its 2019 Annual Report. Combined, these models are expected to provide essential information for the development of specific management actions and projects to improve environmental conditions in and around the Lake. If funding is unavailable, research activities will cease in Spring 2021. Future funding to reinstate the research program will necessarily be increased due to new startup costs.

Similarly, CRC is engaged in socioeconomic research to identify the conditions driving poor economic growth opportunities in Lake County. The communities adjacent to Clear Lake have been hard hit by natural disasters, notably by significant wildfires in four of the last five years. Moreover, some residents of neighboring communities that have been displaced from their homes have turned to Clear Lake communities for temporary and permanent housing. These disasters highlight how important and urgent the need for data-driven decision-making by local jurisdictions and state agencies. This research can inform important state priorities, including affordable housing, economic development, and assisting vulnerable communities such as youth and Tribal communities. Similar to TERC, if funding is prematurely halted and reinstated in the future, significant startup costs can be expected, resulting in a more costly research effort.

The Committee supports a continuation of funding for the TERC and CRC research efforts. The information stemming from this research will assist in creating more sustainable physical as well as economic environments for Clear Lake and its surrounding communities. This funding will be used for a continuation of research activities through the summer of 2021, though additional long-term funding from a general fund appropriation or other source is required beyond fall 2021.

<u>Recommendation 8: Ongoing support for the Middle Creek Restoration Project</u>

The Middle Creek Restoration Project, a collaborative effort between Lake County, Tribes, and state and federal agencies, is expected to provide significant benefits to water quality improvement and flood risk reduction efforts for Clear Lake. Project partners are currently in the process of acquiring all impacted properties in the project footprint. Although state and federal funding is available for this acquisition, the project is still in the design phase. The Committee fully supports this ongoing effort and encourages the State of California to continue its commitment to the project.

The Committee unanimously approved letters of support for Recommendations 6-8 at its September 23, 2020 quarterly meeting. Additionally, the Committee approve a letter of support for the Middle Creek Restoration Project on March 10, 2020. Full text of each letter appears in **Appendix I.** These letters of support were also provided to the California State Assembly and Resources individually.

Recommendation Review

Several of the Committee's recommendations are interconnected. The distributed watershed model (item 1) is informed by basin-wide monitoring and bathymetric data (items 2 and 3), all of which are expected to inform and integrate with the existing hydrodynamic lake model under development by TERC (item 7). The lake model will identify specific internal sources of nutrient and mercury discharge; once the model is complete, a series of physical actions and capital projects can be designed to address specific pollution sources. The watershed model would provide a picture of external loads to Clear Lake, and in tandem with the internal loading information provided by the internal lake model, would create a full picture of nutrient and mercury loading to the lake. The bathymetric survey is an essential component to assure the accuracy of the hydrodynamic lake model.

Recommendations 4 and 5 include activities to address institutional barriers to water quality improvement and expedite planned restoration projects.

At the September 23, 2020 meeting, Committee members unanimously approved proceeding with the existing suite of recommendations. In the case of limited FY 21/22 funding opportunities, the Committee recommends immediate funding of Recommendations 1 and 2 using existing funding allocated to the Committee from Proposition 68. This is discussed in more detail in Section 6 below.

Section 6: Proposed 2021 Workplan and Funding Recommendations

Securing funding for the existing set of 2019 recommendations is the highest priority for the Committee's work in 2021. As discussed above, the Committee and its associated subcommittees have developed detailed implementation steps to institute Recommendations 1-3 as soon as funding becomes available. It is expected that upon appropriation of funds, the Committee will work closely with Resources to develop contracting mechanisms to carry out all work. Absent state funding, Committee facilitation staff are pursuing several funding options with assistance from Committee members and UC Davis, including:

- Local Tribal funding
- Federal grants through the National Science Foundation
- State grants through the Wildlife Conservation Board
- Private foundation opportunities

Allocation of Proposition 68 Funding

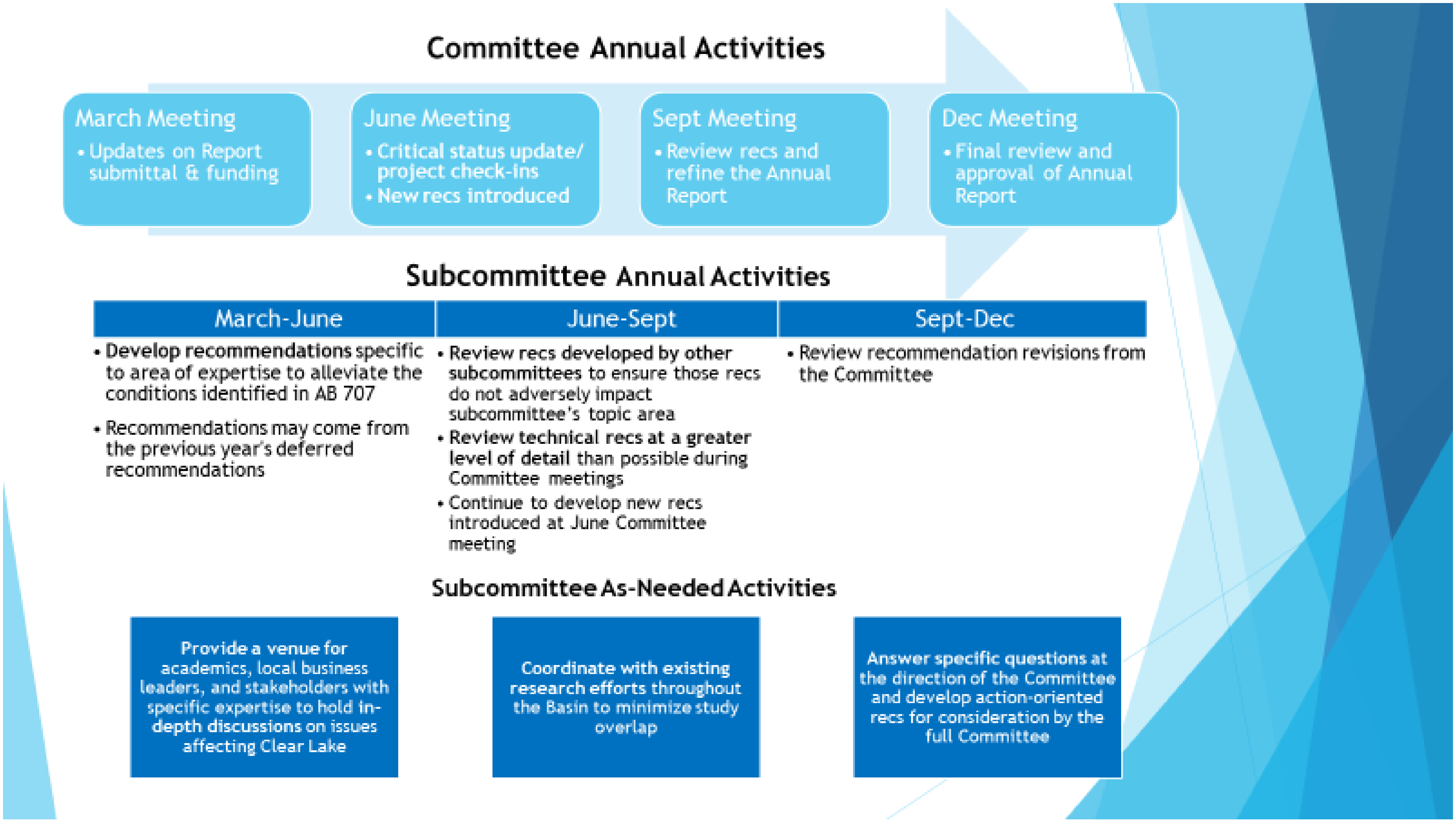
Additionally, AB 707 authorized the Committee to allocate $5 million in Proposition 68 funding for specific, on-the-ground projects. Although Proposition 68 generally has a 10% cap on the amount available for planning and study projects, this requirement is waived for disadvantaged communities with the approval of the Resources Secretary. Per the requirements of Proposition 68, all funding must be encumbered by May of 2023 and fully liquidated by May of 2025.

In the interest of preserving the Committee's momentum and beginning work on the highest priority items listed in Section 5, the Committee recommended fully funding Recommendations 1 and 2 at its final quarterly meeting on December 9, 2020. The remaining funding allocated from Proposition 68 will be set aside for the funding of specific capital improvement projects and research in 2021 such as fish ladder improvements, recreation enhancements, and a further continuation of UC Davis research efforts if alternative funding sources are not identified.

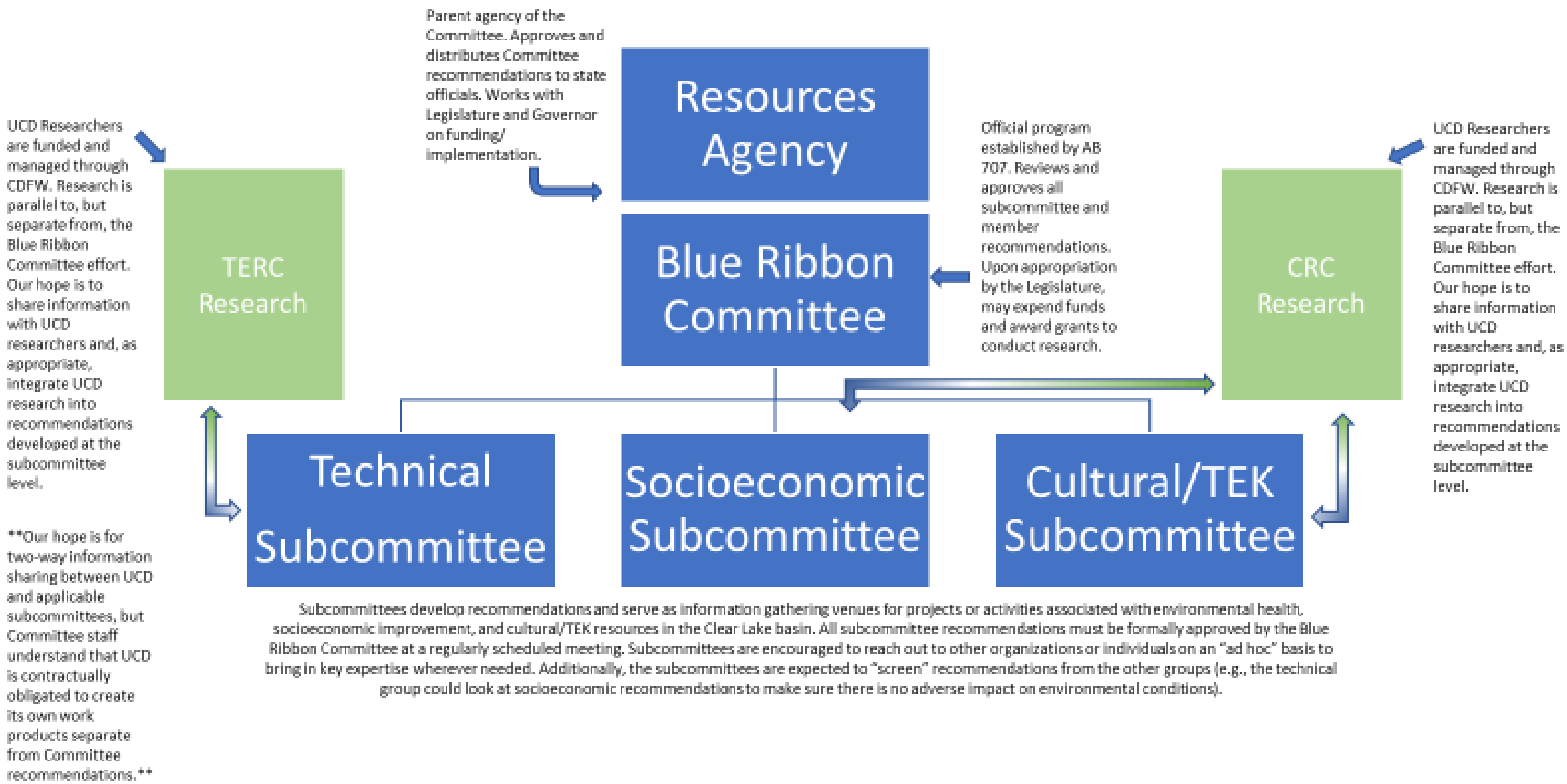
Appendix A: 2021 Funding Request and Associated Recommendations

2020 Recommendations and Projected Funding Request							
Item	Description	Total Cost Estimate Per Item	2021 Projection	2022	2023	Funded?	Proposed Source
Distributed Watershed Model	Comprehensive watershed model of Clear Lake basin to understand upland/upper watershed sediment and nutrient transport to inform state and local decision making for restoration/remediation activities. Estimate based on USGS proposal; requires discussion. One time investment to fund three years of model development and calibration.	$1,617,799	$536,605	$503,379	$577,815	Yes	Proposition 68
Basin-wide Monitoring	Monitoring for model calibration. Includes equipment outlay, O&M, and analysis. Includes nutrients, sediment, and cyanotoxin. Initial investment to fund three years of monitoring activities.	$1,937,251	$730,218	$588,144	$618,889	Yes	Proposition 68
Bathymetric Survey	Add-on bathymetric survey to refine TERC in-lake model under development. One time investment.	$400,000				No	
Review Existing BMPs	Survey and review of existing BMPs to meet current regulatory requirements. One time investment	$60,000				No	
Public Assessment	Public perception survey to better understand residents' attitudes and behaviors impacting lake health. One time investment.	$120,000				No	
Limonological Sampling	In lake monitoring to provide crucial water quality data for local government, Tribes, and down-stream water managers. Initial, one year investment. Additional funding will be required for a continuation of in-lake sampling.	$100,000				No	
UC Davis Bridge funding	Short-term funding to provide a continuation of reseach activities for TERC and CRC. One time cost.	$100,000				No	
Ongoing TERC Research	Long-term, full funding for a completion of TERC's in lake modeling and research activities. One time investment.	$1,850,000				No	
Ongoing CRC Research	Long-term, full funding for a completion of CRC's economic development strategy and associated research activities. One time investment.	$600,000				No	
Total:							$6,785,050
Recommended funding through Proposition 68:							$3,555,050
Total 2021 Funding Request:							**$3,230,000**

Appendix B: Committee Annual Process Organization Chart



Committee Organizational Chart



Appendix C: 2020 UC Davis Tahoe Environmental Research Center Outcomes and Next Steps

Scientific Studies Toward the Restoration of Clear Lake:

2020 Annual Report of the UC Davis Tahoe Environmental Research Center

Geoffrey Schladow, Alexander Forrest, Steven Sadro, Alicia Cortes, Micah Swann and Ruth Thirkill

November, 2020

1. Barriers to Improving Water Quality at Clear Lake

While lists of water quality challenges can be readily compiled, the greatest barrier to improvement is the absence of quantitative data on the response of the system to investments in specific restoration projects. Acquiring quantitative data requires completing four fundamental tasks:

5) Quantifying the processes that contribute to poor water quality, i.e. data collection;
6) Accurately predicting the lake response to environmental forcings, including the extent of the current water quality challenges, i.e. model development;
7) Quantitatively evaluating the impacts, the costs, and unintended consequences of implementing particular projects and strategies, i.e. scenario development; and,
8) Quantitatively evaluating the consequences and costs of the "no action" alternative, with the inclusion of the likely impacts of climate change, i.e. future forecasting.

Past research, together with the experiences of residents and stakeholders at Clear Lake, has made it possible to identify many of the challenges facing the lake that these four tasks will address. These include:

- *Lake water temperatures* are increasing globally, and is likely the case at Clear Lake too. Aside from the direct effect of higher temperatures on metabolic and reaction rates, the most important consequence of this is expected to be an increase in the duration of periods of thermal stratification. Mixing or turnover events may be less effective and frequent. This trend cannot be prevented by local action as it is happening on a regional scale, but all planning needs to explicitly take this into account.
- Episodic *low dissolved oxygen* (DO) events in the deep water are known to occur, producing fish kills, release of nutrients through a phenomenon known as "internal loading", release of heavy metals including mercury to the food web, and the formation of noxious odors. With climate warming, there are likely to be more extended periods of low DO, with a corresponding increase in water quality degradation. There are engineering solutions to addressing low DO, but the extent of the problem needs to be quantified in order to make these solutions feasible and cost-effective.
- Identifying the relative contribution of *nutrient inputs* (both phosphorus and nitrogen, P and N) through both external and internal loading. External loading can be increased by agricultural fertilizer addition, grazing, erosion due to poor land management or wildfire, increases in impervious land cover due to population growth, destruction of wetlands, etc. Internal loading is caused by low DO in the lake. Quantifying the sources of nutrients, their seasonal variability, and partitioning the loading rates (both internal and external) are key to selecting the most appropriate solutions to Clear Lake's eutrophication problem.
- Increasing frequency, biomass, duration and distribution of both algal blooms and *cyanobacterial* blooms. Cyanobacterial blooms create risks to human and animal health, increase the costs for water treatment, contribute to a negative perception of the region leading

to losses in tourism, property values, and business. Factors that may favor the cyanobacterial dominance include:

  - Episodic low DO events in the deep waters, leading to nutrient release and alterations in the food web;
  - Increased nutrient inputs from the watershed; and,
  - Rising water temperatures.

  The first two factors lend themselves to a number of restoration projects. Warming temperatures need to be accounted for in the design of these projects.

- *High mercury levels* due to both the watershed inputs, the existing sediment load, and potentially ongoing supply input from the Sulphur Bank mercury mine. Understanding the mercury cycle in the lake is currently an active area of research at Clear Lake by the USGS. There are a range of engineering options for controlling mercury release to the water and the food web.
- Shift between a *clear state with macrophyte dominance* and *turbid phytoplankton-dominated state*. Native macrophytes stabilize clear-water conditions by reducing resuspension, increasing sedimentation, providing habitat for fish, and suppressing phytoplankton growth (nutrient competition). When the nutrient concentrations in the water are very high, the submerged and emergent native vegetation can be lost and the turbidity of the water increases. As a result, the buffering capacity of the ecosystem to external stressors is reduced. The current state of Clear Lake waters based on the limnological parameters is being assessed.

2. Threats to the Wildlife at Clear Lake

The threats to wildlife are intimately linked to the water quality condition of the lake. While some of the threats may be independent of the eutrophic status of the lake, a better understanding of the relations between watershed and lake processes will be essential when addressing these and other threats. Some of the threats include:

- Tule perch loss due to herbicide use;
- Episodic low DO, pH, and NH_3-NH_4, which may cause fish kills;
- Extensive periods of "fish habitat compression", occurring when low DO deep waters and high surface temperatures reduce the fish habitat;
- The dominance of non-native fish and other aquatic invasive species, which may modify nutrient cycling, cause habitat loss and be more dominant in the food chain as compared to non-native species;
- Native fish such as Clear Lake hitch (*Lavinia exilicuada*) loss due to multiple stressors, including loss of spawning habitat, water diversions, and barriers to passage; and,
- The introduction of new aquatic invasive species such as Quagga mussels. While Quagga mussels are not currently in the lake, and all efforts are being taken to prevent their establishment in the lake, the change in a broad suite of factors tends to increasingly

disadvantage native species while at the same time creating niches for species that may previously not have survived in Clear Lake.

3. UC Davis TERC Accomplishments in 2020

3.1. Prediction of low levels of dissolved oxygen (hypoxia) at Clear Lake

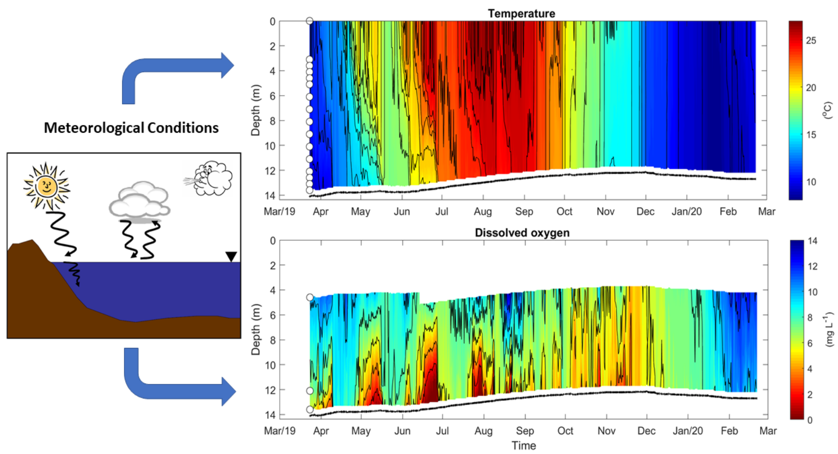


Figure 1. Cartoon summarizing our method to predict hypoxia in Clear Lake

Dissolved oxygen (DO) is essential for maintaining healthy aquatic ecosystems. DO is consumed by multiple biogeochemical processes both in the water column and by the sediments. However, when the water column develops temperature gradients in depth (i.e. becomes *thermally stratified*), DO levels next to the sediments are potentially depleted to the point of hypoxia. Using the in-lake surface temperature and DO data we have collected in all three basins, together with simple meteorological data, we have developed a new, simplified tool for predicting hypoxia (Figure 1). This tool can be a cost-effective decision-making tool for management actions when hypoxia is a concern. We have submitted a manuscript describing this method to the peer-reviewed journal *Water Resources Research*.

This tool has widespread application beyond Clear Lake. The results were presented at the 2020 California Lake Management Society Conference in October 2020, and we are now working with the Santa Ana Regional Water Quality Control Board on adapting it for use in Southern California.

3.2. First measurements of nutrient fluxes from the sediments

Under low DO levels, nutrients accumulated in the sediments (particularly phosphorus in the form of orthophosphate) can be released and returned to the water column, representing a threat for the lake water quality through internal loading. We conducted a laboratory experiment using lake sediment cores during fall 2019/winter 2020 to quantify the rate of phosphorus release from the sediments under low DO levels (Figure 2). In September 2020 we conducted a second set of laboratory experiments to measure the rate of phosphorus release from the sediments under low dissolved oxygen levels and elevated temperatures, more typical of those encountered at Clear Lake during summer periods.

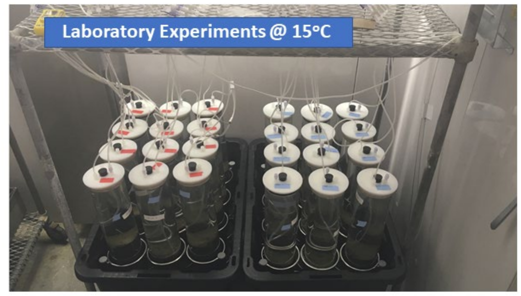


Figure 2. Nutrient release from the sediment laboratory experiment in fall 2019/winter 2020

Results from these experiments have provided the first direct estimates of the annual internal load of phosphorous in Clear Lake. We estimated that phosphorous release from the sediments represents ~40-60% of the total phosphorus annual load in Clear Lake assuming cold lake temperatures. We estimate that warm temperatures could increase the nutrient release rates up to ~60% of the total phosphorus annual load in Clear Lake. Preliminary analysis of data from the incubation experiment we carried out during Summer 2020 show lower phosphorus flux rates from sediments than we predicted; however, interpretation of these results are complicated by antecedent periods of anoxia in Clear Lake and sediment P-fluxes that occurred during the summer that reduced pools of available P in sediments at the time of our incubations (Figure 3). We plan to quantify sediment concentrations of P from our summer incubations to confirm this hypothesis. These results demonstrate that internal loading events earlier in the summer may have the greatest contributions of phosphorus to the lake since they occur before available phosphorus is depleted in sediments.

We also conducted a pilot study to evaluate the effectiveness of Lanthanum-modified bentonite (www.sepro.com) to reduce the anoxic release of phosphorus accumulated in the sediments, and subsequent eutrophication in Clear Lake. Results have proved this substance completely blocks the release of orthophosphate from the sediments under anoxic conditions.

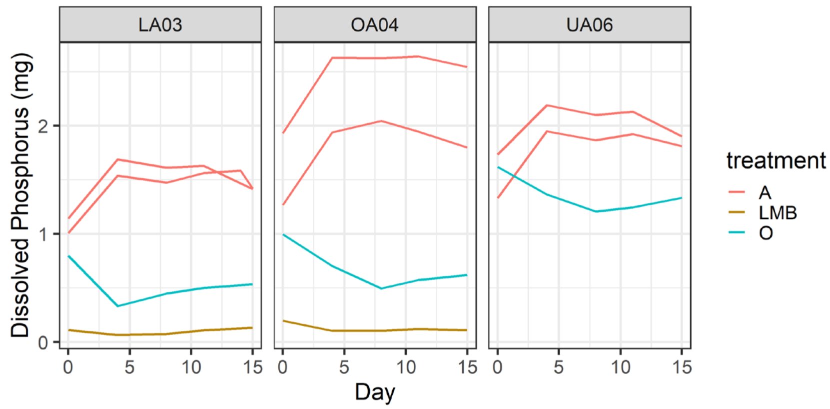


Figure 3. Observed phosphorus flux from sediments in cores incubated over 15 days during September 2020. Anoxic cores (red lines) showed highest flux rates and cores with lanthanum-modified bentonite (LMB) showed the lowest phosphorus flux.

3.3. Validating a remote sensing tool for monitoring cyanobacteria in Clear Lake

DO is also relevant for cyanobacterial growth. In collaboration with the California State Water Resources Control Board we have used different sampling techniques to quantify the spatial variability of cyanobacterial blooms in Clear Lake at finer spatial scales than available remote sensing tools (https://fhab.sfei.org/).

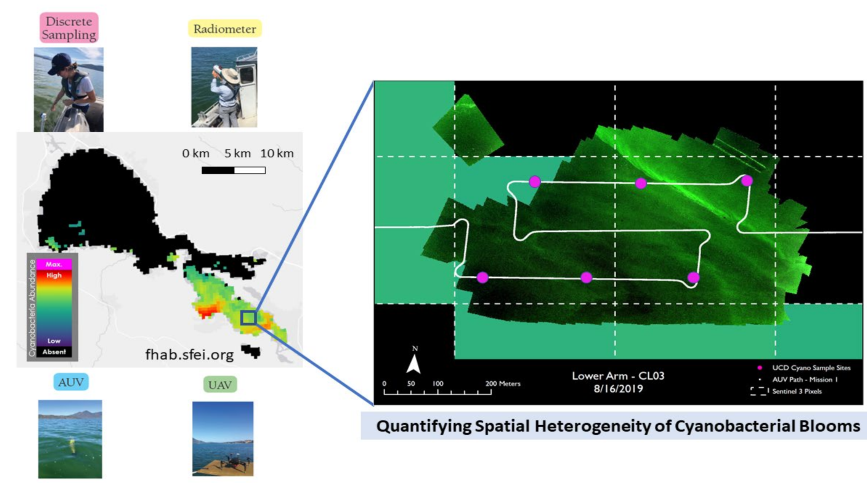


Figure 4. Diagram showing the different instrumentation used in TERC cyanobacterial studies to explore the variability of cyanobacterial blooms and validate remote sensing algorithms available at Clear Lake

In summer/fall 2019 we deployed an autonomous underwater vehicle (AUV), a drone, a radiometer, and completed intensive, coordinated sampling and multiple locations around Clear Lake (Figure 4) on three different dates. In 2020 we have been comparing the results to a satellite algorithm aimed at detecting cyanobacteria blooms. The acquired data are being used to quantify critical scales of variability of cyanobacterial blooms and ground-truth satellite data. This work was sent for publication to the peer-reviewed journal *Remote Sensing, Special Issue Remote Sensing of Coastal and Inland Waters* in fall 2020.

We are also collaborating with the Big Valley Band of Pomo Indians and their scientific team to better understand the relationships between hypoxia, cyanobacterial blooms and fish kills.

3.4. NASA Fellowship for the detection of cyanobacteria in Clear Lake

One of our Graduate Students, Samantha Sharp, has received a 3-year NASA Fellowship for her HAB research at Clear Lake. There are only 25 of these awarded annually in the entire country. The monetary value is approximately $270,000, representing a significant cost match to State funding. This Fellowship will aid in the effort of validation of the remote sensing tools for the detection of cyanobacteria in Clear Lake, and other lakes in California.

3.5. Impact of hypoxia on fish habitat in Clear Lake

DO is also essential for fish health. Graduate student Drew Stang has used echo-sounding in combination with the data that TERC's monitoring buoys have been collecting, to quantify fish biomass underwater and under different conditions as part of his MS Thesis. He found that during low DO (or stratified periods), fish migrated vertically upwards to shallower depths. Thus, fish are changing their vertical distribution under hypoxic conditions (Figure 5). If hypoxia becomes more intense in the future, this could stress and eventually threaten fish species (native and non-native) further.

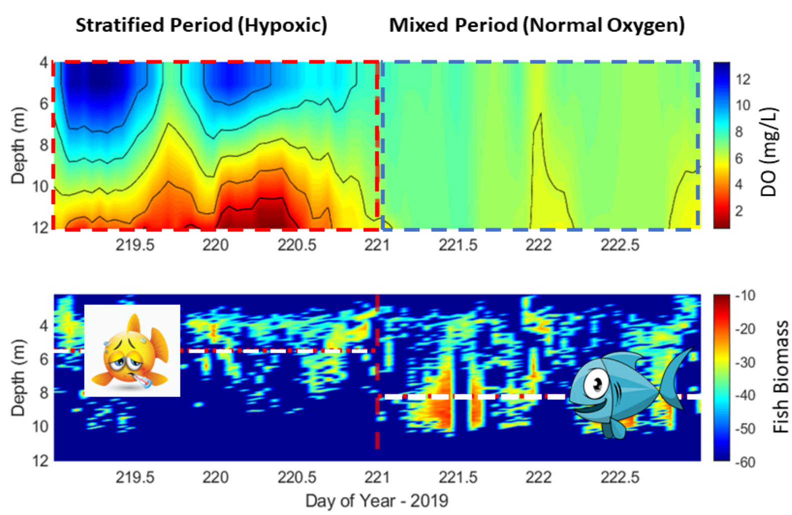


Figure 5. Time series of lake dissolved oxygen concentrations and fish biomass during three days in summer 2019 at Clear Lake. The white-red dashed line in the bottom panel shows the average depth where fish are located under hypoxic and normal-oxygen conditions

3.6. High-resolution data for streams, meteorology, and lake

During 2020, despite the limitations imposed by COVID-19 on our ability to safely conduct fieldwork and laboratory analysis, we continued the high-resolution data acquisition for (1) stream properties at three locations (Middle, Scotts, and Kelsey Creeks), (2) meteorological data at seven locations around the perimeter of the lake, and (3) lake temperature and dissolved oxygen at multiple depths and locations across the lake (seven permanent water quality stations). The field effort was led by graduate students Micah Swann, Ruth Thirkill, Nick Framsted and Drew Stang, together with assistance from other graduate and undergraduate students. All of these data are critical for the ongoing development of the numerical models of physical transport in the lake and in better understanding the range of solutions that may be applied in the future.

3.7. USGS collaboration to find a surrogate for mercury for water quality monitoring

Mercury contamination is a long-standing issue in Clear Lake, particularly in the Oaks Arm. Traditionally, we have to conduct intensive sampling campaigns and time-consuming laboratory analysis to quantify the amount of mercury in the water. As a result, we are collaborating with the US Geological Survey to find a surrogate for mercury, which we can more easily monitor continuously using high-resolution sensors. We deployed two YSI-EXO probes (https://www.ysi.com/EXO2?EXO2-Water-Quality-Sonde-90) in our permanent water quality station in the Oaks Arm in spring 2020 to develop regressions between time series of chromophoric dissolved organic matter (CDOM) and mercury.

3.8. Lake bio-geochemistry

We evaluated the impact of nutrient loads on the lake water quality by measuring multiple constituents throughout the water column and across the lake 5-6 times during the year. We collected water samples to quantify dissolved and particulate forms of nitrogen, phosphorus, and carbon, chlorophyll, and particle size distribution. For example, our long-term records show a direct relationship between soluble reactive phosphorous (SRP) and chlorophyll-a at the end of the summer, when creeks are barely running into the lake and the lake bottom was hypoxic. This observation suggested hypoxia is likely to increase the internal SRP loading from the sediments. The laboratory filtering and chemical analysis was led by Anne Liston, Steven Sesma, Lindsay Vaughn and Tina Hammel, with assistance from graduate and undergraduate students.

3.9. Public data portal

TERC has made our data publicly available via the following website: https://terc-clearlake.wixsite.com/cldashboard. This website also includes a brief description of our field monitoring plan, displays data interactively, shows field observation animations, stores photos and publications, and posts updates on a blog. We have also been collaborating with the County of Lake to provide content for their community Facebook posts.

3.10. Numerical Modeling – Calibration and simulation of particle transport in the lake

The field and laboratory measurements are essential to build, calibrate, and validate a three dimensional (3-D) numerical lake model. A numerical lake model is a computer model that uses sets of mathematical equations to reproduce the different processes which are occurring in the lake (warming, mixing, stratification, inter-basin transport). The model is 3-D because it takes into account changes both in the horizontal and vertical directions. The processes the model simulates are organized into two groups: those that characterize how the water moves (i.e. *hydrodynamic*) and those that modify nutrients and algae in the lake (i.e. *water quality*). We are currently working on the calibration/validation of the hydrodynamic model. The *calibration* process is a trial and error process in which we adjust parameters of the mathematical equations to reduce the error between field observations and lake model results. During the *validation*, we use a different set of field data without changing any parameters, and we expect a good agreement between observations and model results. Once the validation is completed, we are expecting to use the model to explore different questions regarding lake water quality (e.g. dissolved oxygen enhancement techniques, the fate of streams, and culvert loads).

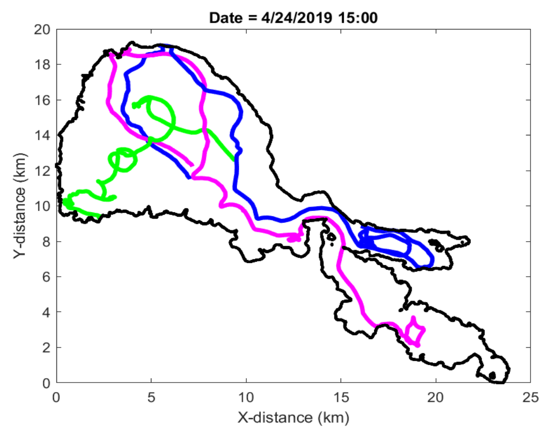


Figure 6. Three-dimensional lake model results of possible pathways for particles. We used a different color to trace the path of each particle

This lake model can also help us to better understand the transport of particles and dissolved constituents in the lake. The particles could be algae, phosphorus-rich sediment, or particulate mercury). Figure 6 shows the lake model results of the paths of three particles released in the Upper Arm. Each particle followed a completely different pathway, which highlights the complexity of the hydrodynamics or water movement in this system. Our field sampling plan is focused on improving our understanding of what are the factors affecting the different pathways.

4. UC Davis (TERC) Next Steps

The activities listed below are contingent on the extension of funding as recommended by the Blue Ribbon Committee. In some cases additional funding from other sources, as indicated, will be utilized to greatly enhance these activities.

4.1. Continue Cyanobacterial studies

We are continuing our collaboration with the California State Water Resources Control Board for the validation of satellite imagery detection algorithms of HABs in California. This validation exercise will allow us to focus on specific areas of research, such as (1) species-specific relationships with remote sensing outputs, (2) effects of spatial variability of the bloom within a pixel, and (3) the impact of atmospheric conditions on the detection algorithms. We have also broadened this collaboration by engaging with scientists at NASA through the NASA Fellowship (see above). Funding from the NASA Fellowship ($270,000) will greatly enhance what can be achieved with the requested level of State funding.

4.2. WQ Modeling and scenario development

A water quality module is coupled to the hydrodynamic model to simulate the evolution of different constituents, such as dissolved oxygen, nitrogen species, phosphorus species, phytoplankton, and suspended solids. This module needs the same type of calibration/validation described for the hydrodynamic module. We are planning to complete this task in 2021.

Once the 3-D numerical model reproduces previous lake conditions, we will use it to better understand the physical and biogeochemical processes occurring within Clear Lake. This may result in changes to our monitoring, or possibly specific experiments to understand important phenomena better. Eventually, the model will be used to explore future management scenarios and to evaluate the effects of different restoration projects on the water quality challenges of Clear Lake. These could include:

- Model exploration of DO enhancement techniques
- Model exploration of the fate of stream and culvert loads
- Model controls on cyanobacteria
- Model climate change impacts
- Model sediment capping

4.3. Adapt 3-D model to provide daily hazard assessment and lake conditions

Models are typically used to provide predictions of future conditions to enable assessments of management actions months, years or even decades into the future. However, it is a relatively straightforward step to adapt the model to provide daily assessments of hazards and lake conditions for the public, lake managers and a broad range of stakeholders. Examples of how such a tool could be used include:

- Daily forecast of lake temperatures, dissolved oxygen, and currents
- Daily forecast of HAB hotspots across the lake to provide warnings to water companies and the recreational public
- Forecast of areas with high fish-kill potential

- Assisting law enforcement in the location and recovery of drowning victims whose bodies may be carried by the lake's complex currents
- Providing data on the spread, concentration and breakdown of accidental toxic releases to the lake

4.4. Link 3-D model to mercury model (USGS) – subject to availability of federal funding

We have been in discussions with the USGS to collaborate on the implementation of a mercury module in the 3-D lake model. Such an addition will provide projections of mercury levels throughout the lake and would be the basis of developing a complete food web model for predicting mercury levels (and other contaminants) in fish.

4.5. Wildfire Smoke Impacts on Clear Lake

TERC was recently (November 2020) awarded an NSF RAPID grant to measure the impacts of wildfire smoke and particulates on the productivity of lakes in the western US. Due to the existing mooring stations we have in Clear Lake we were able to include Clear Lake in this study. This will allow for the deployment of an autonomous underwater Slocum glider in Clear Lake to gather lake data continuously for up to three weeks. It will provide additional resources for the analysis of data that have already been collected. This serves as an important example of how the establishment of the research program at Clear Lake has the potential to leverage additional resources beyond those being invested by the State.

4.6. Keck Pre-proposal

The project team has submitted a pre-proposal to establish a Keck Foundation Center focused on the study of improved detection of HABs. Although at an early stage, if successful this will provide $1M of additional funding that will build on our efforts at Clear Lake. The degree of focus of the Center on Clear Lake will be contingent on the continuation of the monitoring program.

4.7. Measurement of Greenhouse Gases (Methane and Carbon Dioxide)

Through a new study in partnership with Valley Water (Santa Clara county), the UC Davis team is launching a new program for monitoring Greenhouse Gases (GHG) (e.g. methane and carbon dioxide) for 2021/ 2022. As part of this program, the team is purchasing a new GHG field analyzer. Once this equipment is acquired, the team will initiate some pilot studies at Clear Lake in 2021 to understand what the current baseline conditions are. This is extremely important in order to understand longer term contributions of the lake to climate change, and to be able to use carbon sequestration potential as one of the criteria in evaluating lake remediation strategies.

4.8. Decommissioning of Lake Moorings, Meteorological Stations, Stream Sampling stations and ending of water quality monitoring

UC Davis funding currently extends through June 2021. Without an extension of funds, we will be forced to commence removing our installations in Spring 2021. This is typically a critical time at Clear Lake, as it is when thermal stratification becomes established and the water quality issues become greatly enhanced.

4.9. Bathymetric Survey

Subject to funding as per the Blue Ribbon Committee request, the bathymetric survey of Clear Lake will commence in winter 2021. The boat and necessary equipment are currently reserved for this effort. We have been negotiating with various sections of the USGS to provide additional funding for this effort, to increase the scope of the survey data. These additional funds will enable the seismic and volcanic assessments for Clear Lake to be determined. Clear Lake is extremely seismically and geothermally active and such an assessment will complement the work that is being undertaken.

Appendix D: UC Davis CRC 2020 Research Outcomes

UC DAVIS
Center for Regional Change

TO:	Sam Magill, Senior Facilitator Consensus and Collaboration Program California State University, Sacramento
FROM:	Bernadette Austin, Acting Director UC Davis Center for Regional Change
RE:	2020 Clear Lake Annual Report: Draft
DATE:	October 13, 2020

Clear Lake 2020 Annual Progress Summary Report

Under the program established for the Blue Ribbon Committee for the Rehabilitation of Clear Lake (AB 707), researchers from UC Davis Center for Regional Change (CRC) have been tasked with providing research to guide the Blue Ribbon Committee in improving outcomes for the communities surrounding Clear Lake in Lake County. This year has been unprecedented in many ways. On a global scale, COVID-19 has not only severely impacted the ability for ongoing research, but will have lasting health, economic, and social consequences for communities around the world. Regionally, these consequences have been exacerbated in the Clear Lake region as Northern California experiences an historical and devastating wildfire season. As the communities in the Clear Lake region strive to recover and meet the challenges of our current circumstances, the CRC's work around strategies to improve community vitality is more important than ever.

California's Clear Lake Region – A Socioeconomic Profile

Dr. Noli Brazil, PI, Assistant Professor in the Department of Human Ecology at UC Davis
Carlos Becerra, doctoral candidate in the Geography Graduate Group at UC Davis
Dr. Asiya Natekal, Data and Informatics Coordinator at the UC Davis Center for Regional Change

During 2020, the CRC socioeconomics assessment team investigated barriers to socioeconomic improvement in Lake County. Dr. Noli Brazil, with support from Carlos Becerra and Dr. Asiya Natekal, successfully collected secondary data from various sources, based on the established analytic framework for assessing the Clear Lake Region. They then conducted a comprehensive analysis of the data using the established framework across five main domains – demographic, economic, housing, workforce, and industry – for the Clear Lake region. The CRC team conducted monthly internal meetings to provide an update, discuss progress, and to receive feedback. Dr. Brazil, with support from Dr. Natekal, then prepared a draft report entitled "California's Clear Lake Region – A Socioeconomic Profile," (see Appendix A for an executive summary). The objective of the socioeconomic analysis is to provide an in-depth statistical portrait of the Clear Lake region. A quantitative assessment of the region's socioeconomic indicators can be used to identify current strengths, weaknesses, opportunities, and threats. The data provided in this document can also establish a baseline against which to measure future socioeconomic change.

Dr. Brazil presented the findings of the research during the Blue Ribbon Committee meeting on June 18, 2020, and the CRC team also shared the draft report with the Socioeconomic Subcommittee of the Clear Lake region. The Socioeconomic Subcommittee team provided positive and valuable feedback on the draft report, and the CRC socioeconomics assessment team is currently addressing these comments.

Next Steps

In 2021, Dr. Brazil, with support from Dr. Natekal, will provide an updated report and plan to include other potential digital media for presenting the findings, (ArcGIS StoryMap/ Microsoft PowerPoint presentation).

Lake County Economic Development

Dr. Clare Cannon, Assistant Professor of Community and Regional Development at UC Davis
Carolyn Abrams, Research Data Analyst at the UC Davis Center for Regional Change
Alex Volzer, Student Researcher, Community and Regional Development at UC Davis

The CRC's qualitative data collection team, (led by Dr. Clare Cannon with support from Research Data Analyst Carolyn Abrams and Student Researcher Alex Volzer), conducted a total of 13 formal interviews and two informal interviews to date. The formal interviews consisted of eight female informants and five male informants, with geographic representation from both incorporated and unincorporated communities in Lake County. Interviewees answered questions about their economic development vision for the region, with particular attention paid to major drivers of economic change and whether change is welcome or needed. Three infographics were produced to represent the demographics of those interviewed and summarize the interview findings about amenity development, (see Appendix B).

The objective of the economic development interviews is to provide insight from stakeholders and ground-truth promising practices for holistic community economic development. The data provided through these interviews will help situate the conversation around amenity development and tie together the economic development implications from the socioeconomic profile produced by Dr. Brazil and Dr. Natekal and the assets identified for Tribal engagement, (see Appendix C, Figure 1, for the asset map).

Next Steps

Upcoming work includes developing a user-friendly literature review of promising practices in holistic community economic development. The research team will also connect with Dr. Robert Eyler to address aspects of economic development not captured in his 2018 report, "Lake County Economic Development Strategy," and the team will conduct a focus group with the socioeconomic subcommittee to identify a meaningful deliverable that can support this work beyond the CRC's involvement in Lake County.

Clear Lake Tribal Engagement Team

Dr. M. Anne Visser, PI, Associate Professor of Community and Regional Development at UC Davis

Dr. Clare Cannon, Co-PI, Assistant Professor of Community and Regional Development at UC Davis

Over the past year, the Tribal Engagement Research Team has been actively working to engage with Tribal communities in and around the Clear Lake Area. Dr. Visser and Dr. Cannon met with leadership from four of the six Tribal communities in the Clear Lake Region – Big Valley Band of Pomo Indians, Elem Indian Colony, Habematolel Pomo of Upper Lake, and Middletown Rancheria of Pomo Indians. They attempted, through phone calls and emails, to reach out to the other two Tribal communities – Robinson Rancheria of Pomo Indians and Koi Nation – but were unable to set up a meeting. They also met with representatives of the Lake County Tribal Health Consortium. These meetings were listening sessions, in which researchers sought to understand the needs, challenges, and opportunities of Tribal communities in the Clear Lake Region to gain insights that can inform the Blue Ribbon Committee's (BRC) work to rehabilitate and revitalize the area. See Appendix C for an overview of these sessions.

Next Steps

Due to the disruptions of COVID-19, wildfires, and wildfire smoke, the team has had to postpone in-person community engaged activities with Tribal partners on this research. These disruptions, in turn, have informed next steps accordingly. Taking together the findings from the interviews and in working on the two postponed convenings, Dr. Visser and Dr. Cannon are now working to develop a compendium of promising practices for Tribal communities for economic recovery to disasters and create an interactive resource list of UCD resources based on this work and feedback from the BRC subcommittees that will exist online at the CRC repository and available as a toolkit for Clear Lake Tribal communities.

Appendix A

California's Clear Lake Region: A Socioeconomic Profile
Executive Summary

The objective of the socioeconomic analysis is to provide an in-depth statistical portrait of the Clear Lake region. A quantitative assessment of the region's socioeconomic indicators can be used to identify current strengths, weaknesses, opportunities, and threats. The data provided in this document can also establish a baseline against which to measure future socioeconomic change.

In this profile, we examined the Clear Lake region across multiple geographic scales. At the lowest scale, we examined all Census incorporated and designated places within Lake County. The Census defines a place as a concentration of population; a place either is legally incorporated under the laws of its respective State, or a statistical equivalent that the Census Bureau treats as a census designated place (CDP). There are two incorporated places in Lake County: Clearlake and Lakeport. There are 13 CDPs: Clearlake Oaks, Clearlake Riviera, Cobb, Hidden Valley Lake, Kelseyville, Lower Lake, Lucerne, Middletown, Nice, North Lakeport, Soda Bay, Spring Valley, and Upper Lake. The following methodological features form the foundation of our analytic framework.

1. **Comparison of the Clear Lake area to the broader regions:** A comparison to the regions that an area borders or is nested within provides important context to its demographic and socioeconomic profile. We compared Lake County Places (LCP) to three larger regions: Lake county (LC), the counties adjacent to the Northern border of Lake County (NBC; Colusa, Glenn, and Mendocino), and the counties adjacent to the Southern border of Lake County (SBC; Napa, Sonoma, and Yolo).
2. **Examination of the Clear Lake area over time:** We examine characteristics at three time points: 2000, 2010, and 2017. The year 2017 represents the most recent year in which Census data were available at the time of the analysis.
3. **Examination of the Clear Lake area across several important socioeconomic domains:** No one metric is an adequate reflection of the socioeconomic and demographic status of an area, so multiple measures are used in the analysis. The measures are organized under five domains, depicted in Figure 1.

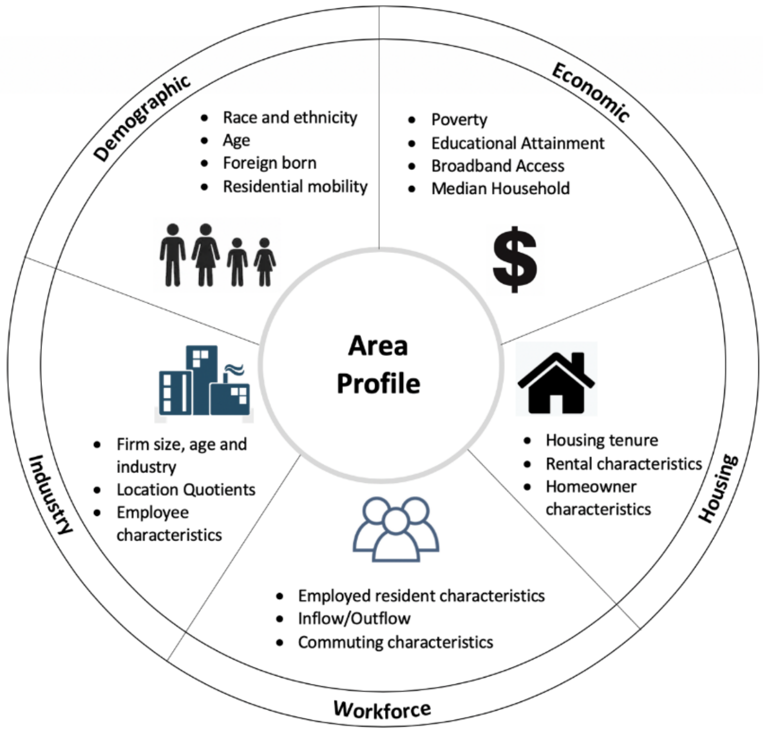


Figure 1. Five domains of an area profile.

Key Takeaways

Our focus was on a comparative analysis of five socioeconomic domains of community opportunity across multiple geographic scales over a 17-year time-period. In this report, we highlight seven key takeaways, with implications for regional development.

First, the resident population in Lake County Places is older compared to the populations living in bordering counties and has become increasingly older since 2010. The implication is that there should be an increase in the provision of health care and social services for these older age groups, including adequate access to health care, housing, and transportation services. Another implication of an aging resident population is an aging workforce. The findings suggest the need to retain and create the types of jobs with competitive wages that are suitable for older employees.

Second, although the Clear Lake area is predominantly white compared to the larger region, it has experienced a significant decrease in percent white and a near identical increase in percent Hispanic since 2000. The foreign-born population has also increased, and the area's overall racial/ethnic diversity, although lower relative to bordering areas, has increased since 2000. The implication is that future policies and programs must address the needs of the changing racial and ethnic makeup of their communities.

Third, Lake County Places have a similar or more advantaged economic profile compared to Lake County as a whole. However, they are more disadvantaged compared to bordering counties, with the gap increasing since 2010. For example, Lake county places compared to the north and the south bordering counties have higher poverty rates, lower median household incomes, and smaller increases in percent college graduates. The implication is that the area is losing ground economically relative to the broader region, potentially due to a slower recovery from the Great Recession, with the recent wildfires a likely factor. Not all indicators of socio-economic circumstances are negative in the region, however. The housing cost burden has decreased, residents without a high school degree has decreased since 2010, and the population size has increased.

Fourth, Lake County Places have greater renter challenges compared to the broader region. In particular, the share of renters burdened with housing costs is noticeably higher than the share in the north and the south bordering counties and has grown significantly since 2000. A likely influencing factor is the recent wildfires, which forced residents who lost their homes to rent. The area also has higher vacancy rates, indicating an underutilization of local housing units despite increasing demand, and higher residential mobility rates, indicating high turnover and an unstable resident population.

Fifth, although the share of Lake County Places workers and employed residents earning $3,300 or more per month has increased since 2002, the share of Lake County Places workers and employed residents making $3,300 or more per month is relatively lower than the share of these workers in the north and south bordering counties. On similar lines, as of 2017, the share of Lake County Places workers and employed residents earning $1,250 or less is relatively higher than the share of these employed residents in the south bordering counties. Within Lake County Places, as of 2017, the share of Lake County Places residents with external jobs and earning $3,300 per month is noticeably higher than the share of outside workers working in Lake County Places and earning $3,300 per month or more. Although the share of residents with higher earnings per month has increased since 2002, their commuting distances have increased. Since 2002, the share of Lake County Places residents commuting beyond 50 miles for work has grown. These findings emphasize the need to create more jobs with competitive wages in Lake County Places.

Sixth, Lake County Places has a substantial presence of the Health Care and Social Assistance sector-related jobs. Although this sector contributes to the largest share of employment in all regions, the share of Health Care and Social Assistance sector-related jobs in Lake County Places is noticeably higher than the share of these jobs in the other areas. Since this sector accounts for a large share of jobs, it is essential to provide a mechanism to provide resources and training for workers needed in this field. Additionally, an aging population in Lake County Places calls for more services in this sector to cater to their needs.

Seventh, Lake County Places experienced an increase in the presence of younger and smaller firms. In Lake County Places, as of 2017, small firms have the highest share of jobs. Jobs generated by smaller firms have increased in all regions since 2011. However, as of 2017, the share of jobs created by smaller firms in Lake County Places is relatively higher than the share of jobs generated by these firms in the north and south bordering counties. Similar to small firms, the share of jobs generated by younger firms has noticeably increased in Lake County Places since 2011. The increase in the share of younger firms (startups) points to the need for resources for startups' growth and longevity to promote economic growth. Local governments need to examine how they can support startups and small businesses. Focus on both financial and regulatory mechanisms is necessary to encourage the growth of startups and small businesses. These mechanisms may take the form of providing small business loans, simplifying tax codes and payment systems, streamlining zoning approvals, and others.

Authors and Contributors

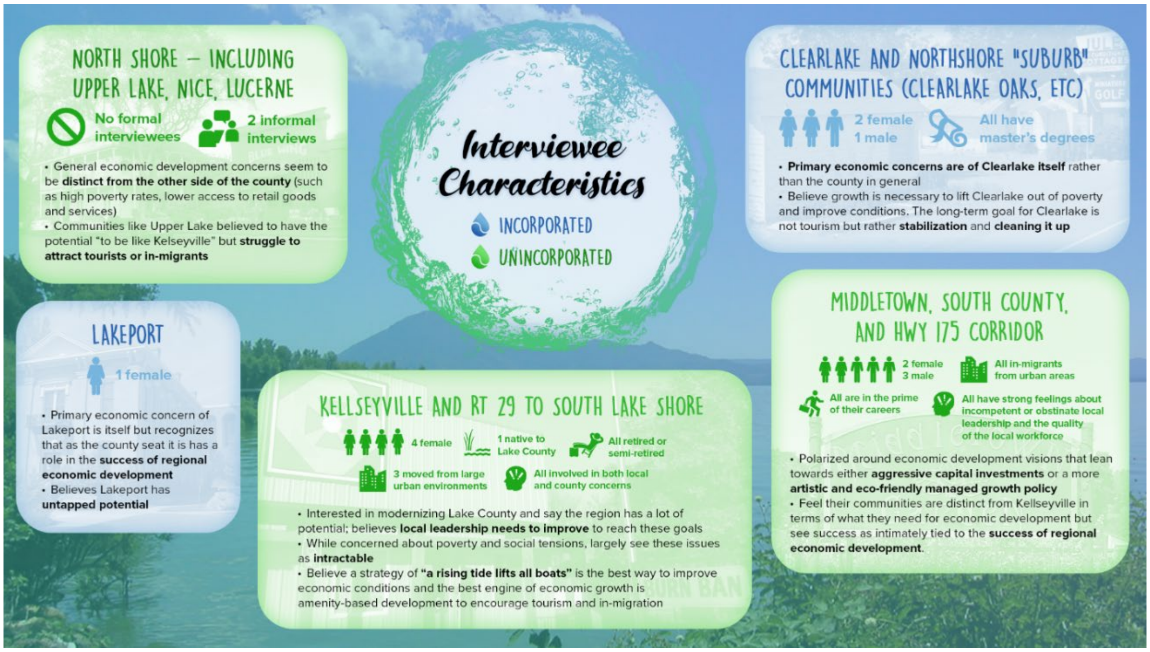
Under the program established for the Blue Ribbon Committee for the Rehabilitation of Clear Lake (AB707), researchers from UC Davis Center for Regional Change (CRC) and UC Davis Tahoe Environmental Research Center (TERC) propose to conduct applied research to guide the Committee in improving the environmental quality and economic outcomes for the communities surrounding Clear Lake in Lake County, California. This is a multi-year project (2018-2020) funded by the California Department of Fish & Wildlife.
This report was prepared by Noli Brazil with support from Carlos Becerra and Asiya Natekal. Dr. Brazil is an Assistant Professor in the Department of Human Ecology. He holds a Ph.D. in Demography from UC Berkeley. Mr. Becerra is a doctoral candidate in the Geography Graduate Group at UC Davis. Dr. Natekal is the Data and Informatics Coordinator at the UC Davis Center for Regional Change. She is a postdoctoral scholar with a Ph.D. in Planning, Policy, and Design from UC Irvine.

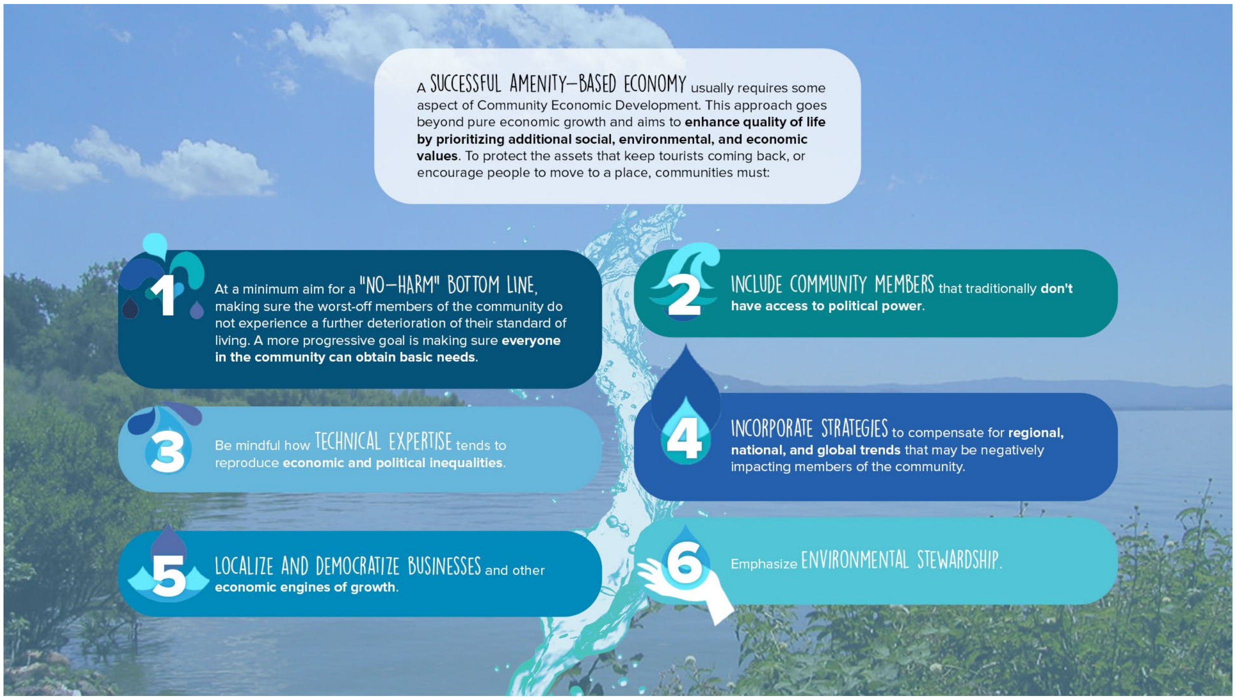
Preferred Citation

Brazil, N., A. Natekal, C. Becerra. 2020. California's Clear Lake Region: A Socioeconomic Profile. Center for Regional Change, University of California, Davis.

Appendix B

Infographics created from the findings of the CRC's qualitative data collection team, concerning Lake County economic development. Content: Alex Volzer, UC Davis graduate researcher; Illustration: Chelsea Jimenez, UC Davis undergraduate.




A SUCCESSFUL AMENITY-BASED ECONOMY usually requires some aspect of Community Economic Development. This approach goes beyond pure economic growth and aims to enhance quality of life by prioritizing additional social, environmental, and economic values. To protect the assets that keep tourists coming back, or encourage people to move to a place, communities must:
1 At a minimum aim for a "NO-HARM" BOTTOM LINE, making sure the worst-off members of the community do not experience a further deterioration of their standard of living. A more progressive goal is making sure everyone in the community can obtain basic needs.
2 INCLUDE COMMUNITY MEMBERS that traditionally don't have access to political power.
3 Be mindful how TECHNICAL EXPERTISE tends to reproduce economic and political inequalities.
4 INCORPORATE STRATEGIES to compensate for regional, national, and global trends that may be negatively impacting members of the community.
5 LOCALIZE AND DEMOCRATIZE BUSINESSES and other economic engines of growth.
6 Emphasize ENVIRONMENTAL STEWARDSHIP.

Appendix C

This research brief provides an overview of the Clear Lake Tribal Engagement Team activities in 2020, including a description of COVID-19 related impacts; a description of research activities; and, findings from research activities for the current time-period.

COVID-19 related disruptions

The ongoing global pandemic, COVID-19, has greatly impacted research in this area. It prevented our planned convening in the Clear Lake area for Tribal members to discuss how to communicate their insights to the BRC in the rehabilitation and revitalization of the area for April of 2020 when the pandemic forced a statewide lockdown. Due to the uptick in cases in the summer along with historic wildfires and wildfire smoke, we were forced again to postpone our convening. Similarly, based on our research with Tribal communities, we were planning a convening at UC Davis for the Fall of 2020 to connect Tribal communities to resources at UC Davis such as the beer, wine, and forestry programs and include a campus tour for students and their families. In preparation for this convening, we met with the director of the UC Davis Native American Academic Success Center (The Nest) to best leverage the extensive expertise of those at the Nest working to inform students of admissions and student experiences at UCD. This convening has also been indefinitely postponed due to the ongoing public health and climate change-related emergencies.

Research Activities and Findings

The research team undertook in-depth informal meetings and interviews with Tribal leadership of four of the six Tribal communities over the time span of June 2019-December 2019. Two of the four interviews were done in person, and two were conducted over the phone at the request of Tribes. We also undertook an in-person informal interview with a representative with the Lake County Tribal Health Consortium. The interviews focused on four areas: economic and community development interests of the Tribes, challenges facing the Tribal communities in Lake County, environmental concerns, and opportunities or resources available through the research team/UC Davis that they felt would be beneficial. From this research we developed an asset map (Figure 1). Our findings are summarized in topical areas below.

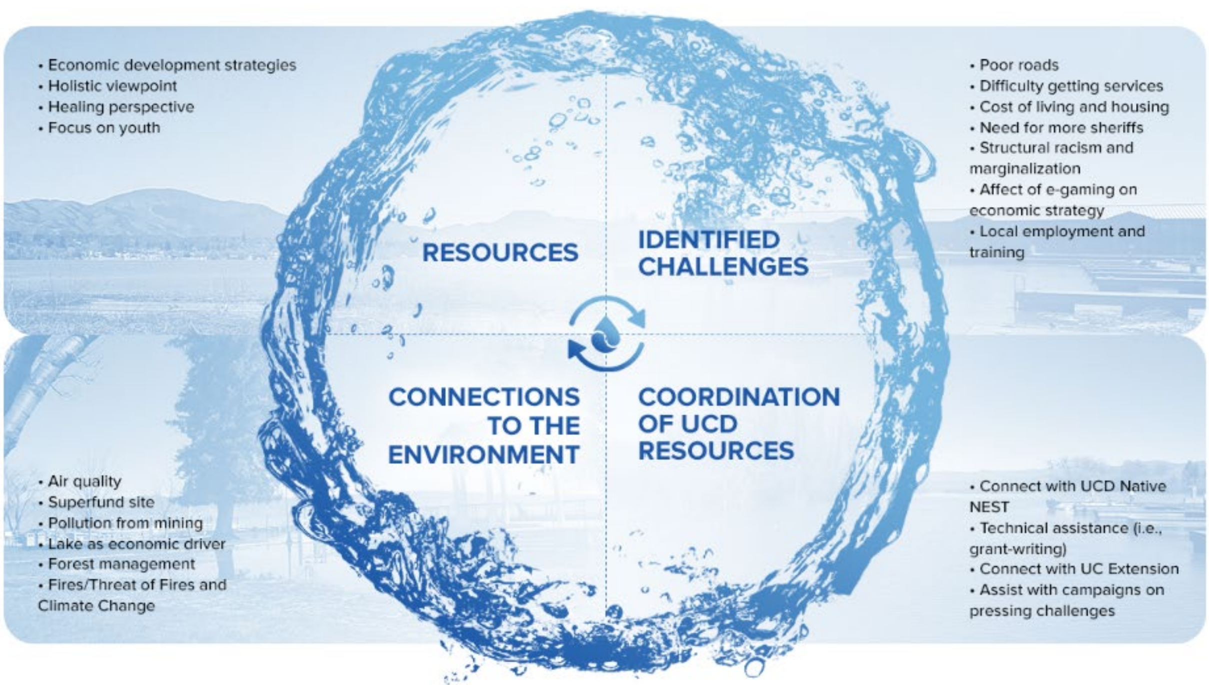


Figure 1. Tribal Engagement Asset Map

Economic & Community Development: Tribal community members noted that they would like to see an emphasis on economic development in the Blue Ribbon Committee. Individual Tribes had a variety of economic development strategies they are currently utilizing including gaming, online enterprises, call centers, and small business development. Representatives indicated that Tribal approaches to economic development were holistic and healing in perspective with each Tribal community placing youth as a center point in many of its developmental goals and missions. Representatives indicated the importance of a diversified economic development strategy.

Challenges: Themes surrounding challenges faced by Tribal communities in Clear Lake include poor infrastructure such as roads and lack of transportation which amplify the already existing challenges to receiving county and state services in the area. Economic factors such as the rising cost of housing in Lake County, the influence of e-gaming as well as emerging consequences to the U.S. Supreme Court's 2018 decision to open the door to legalized commercial sports betting (Murphy v. National Collegiate Athletic Association) on economic development strategies of Tribal communities. A tight local labor market were also cited as areas of concern for Tribal communities. In addition, the Tribal representatives noted there was need for a more coordinated outreach with the Lake County Sheriff's office and that ongoing racism was a significant challenge in the region.

Environmental Concerns: Given the Blue Ribbon Committee's emphasis on the revitalization of Clear Lake, all of the Tribal representatives indicated they were interested in prioritizing the rehabilitation the Lake. Tribal representatives viewed Clear Lake as a driver for economic development and shared concerns over a number of environmental conditions including high levels of mercury on Tribal lands in the area, high levels of pollution in the lake, and the declining air quality in the region (particularly during wildfires). In addition, Tribes indicated an interest in forest management activities given the increasing amount of wildfires over the last four years.

Potential Opportunities and Collaboration with Blue Ribbon Committee Activities: The Tribal engagement research team is focused on collaboration and cooperation with the activities of the Blue Ribbon Committee and aims to, where possible, assist Tribes with requests for resource and capacity development. Tribal representatives indicated interest in being connected to the UC Davis Native American Academic Student Success Network (NEST), UC Agriculture and Natural Resources (ANR) and cooperative extension. In addition, Tribes expressed interest in technical assistance such as with grant writing as well as assistance on campaigns and initiatives and trainings.

2020 Clear Lake Cyanotoxin Sampling Signage Recommendations

SITE ID	ARM	6/8 F	6/23 F	7/7 F	7/21 F	8/4 F	8/18 F	9/2 F	9/16 F	10/6 Final	10/20 Final	11/3 FINAL	11/23 FINAL
AP01	L	DANGER	DANGER	CAUTION	WARNING	CAUTION	DANGER	WARNING	DANGER	DANGER	WARNING	WARNING	DANGER
BP	L	N/A	DANGER	CAUTION	CAUTION	NONE	CAUTION	NONE	CAUTION	WARNING	CAUTION	CAUTION	NONE
BVCL6	U	N/A	NONE	NONE	NONE	NONE	NONE	NONE	UTION (AN	CAUTION	CAUTION	CAUTION	CAUTION
CL-1	U	N/A	NONE	N/A	N/A	NONE	N/A	N/A	NONE	N/A	N/A	CAUTION	N/A
CL-3	O	N/A	NONE	N/A	N/A	CAUTION	N/A	N/A	NONE	N/A	N/A	WARNING	N/A
CL-4	O	N/A	CAUTION	N/A	N/A	CAUTION	N/A	N/A	CAUTION	N/A	N/A	WARNING	N/A
CL-5	U	N/A	NONE	N/A	N/A	NONE	N/A	N/A	N/A	N/A	N/A	NONE	N/A
CLOAKS01	O	NONE	NONE	NONE	DANGER	CAUTION	CAUTION	NONE	WARNING	DANGER	WARNING	WARNING	WARNING
CLV7	L	NONE	NONE	NONE	NONE	NONE	NONE	CAUTION	CAUTION	CAUTION	CAUTION	CAUTION	CAUTION
CP	U	NONE	NONE	NONE	NONE	NONE	CAUTION	NONE	CAUTION	CAUTION	CAUTION	CAUTION	CAUTION
ELEM01	O	NONE	CAUTION	CAUTION	DANGER	CAUTION	NONE	NONE	DANGER	CAUTION	WARNING	CAUTION	CAUTION
GH	O	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	DANGER	WARNING	CAUTION	CAUTION
HB	U	N/A	NONE	NONE	NONE	NONE	NONE	NONE	CAUTION	CAUTION	CAUTION	CAUTION	CAUTION
JB	L	DANGER	DANGER	CAUTION	WARNING	CAUTION	CAUTION	CAUTION	DANGER	DANGER	WARNING	CAUTION	CAUTION
KEYS03	O	NONE	NONE	NONE	CAUTION	WARNING	DANGER	DANGER	DANGER	CAUTION	DANGER	DANGER	WARNING
KP01	U	NONE	NONE	NONE	NONE	NONE	NONE	NONE	DANGER	DANGER	CAUTION	WARNING	CAUTION
LC01	L	NONE	WARNING	CAUTION	DANGER	CAUTION	NONE	CAUTION	DANGER	DANGER	WARNING	CAUTION	CAUTION
LPTNT	U	NONE	NONE	NONE	NONE	NONE	WARNING	CAUTION	WARNING	WARNING	CAUTION	CAUTION	CAUTION
LS2	U	NONE	NONE	NONE	NONE	NONE	WARNING	WARNING	DANGER	N/A	WARNING	CAUTION	CAUTION
LUC01	U	NONE	CAUTION	CAUTION	NONE	NONE	NONE	CAUTION	DANGER	WARNING	CAUTION	CAUTION	NONE
RED01	L	NONE	NONE	WARNING	WARNING	CAUTION	CAUTION	WARNING	DANGER	DANGER	WARNING	WARNING	DANGER
RODS	U	NONE	NONE	NONE	CAUTION	NONE	CAUTION	NONE	NONE	NONE	NONE	NONE	CAUTION
SBMMEL01	O	NONE	DANGER	WARNING	WARNING	CAUTION	NONE	CAUTION	DANGER	DANGER	CAUTION	WARNING	CAUTION
SHADY01	L	NONE	NONE	WARNING	WARNING	CAUTION	CAUTION	NONE	WARNING	WARNING	WARNING	WARNING	WARNING

All cyanotoxin monitoring conducted by Big Valley Band of Pomo Indians and Elem Indian Colony. Signage Recommendations are based on lab results of microcystin toxin values at the site. https://mywaterquality.ca.gov/habs/resources/habs_response.html#advisory_signs_guidance

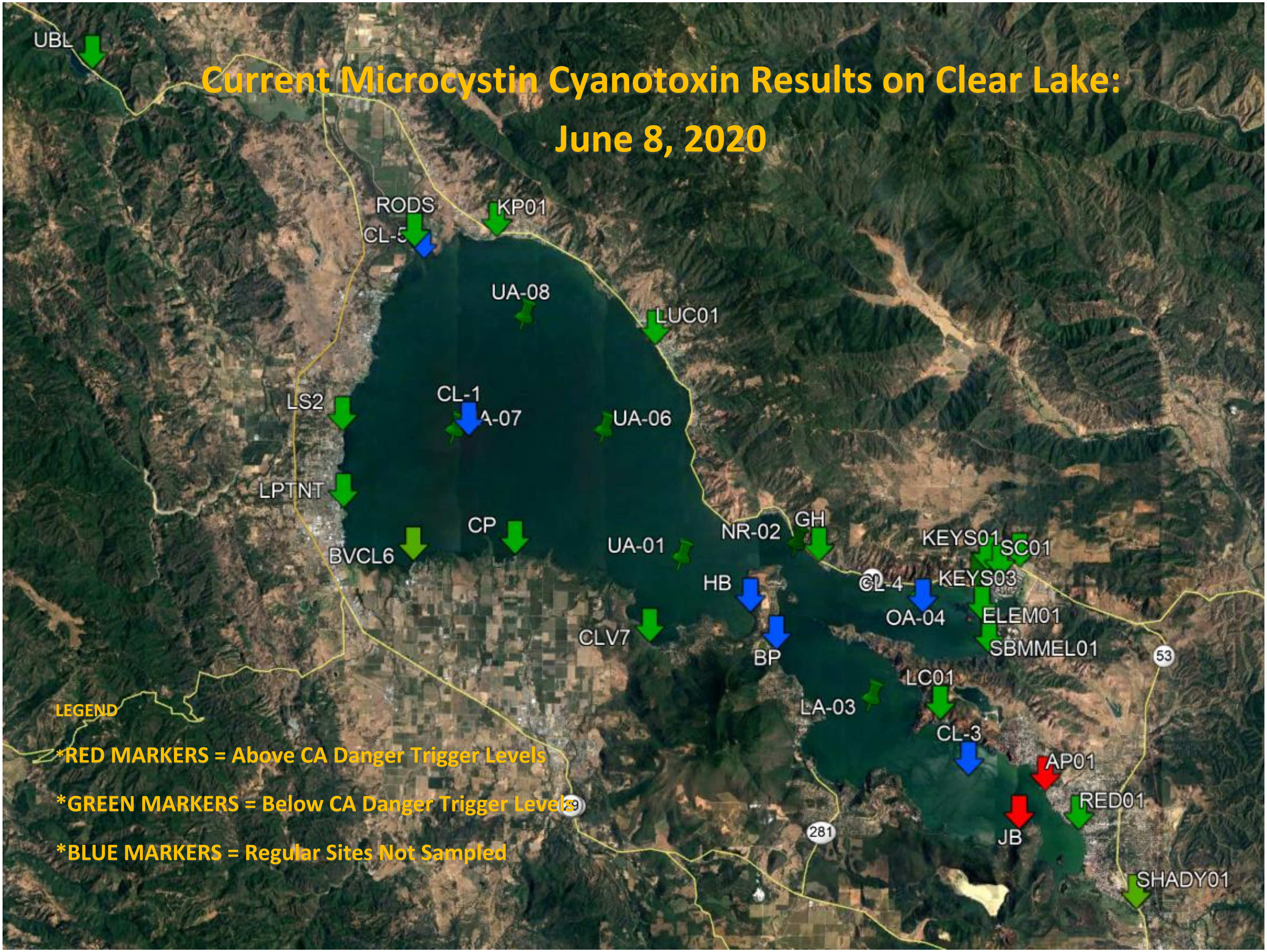
Caution – 0.8 µ/L - < 6.0 µ/L   Warning – 6.0 µ/L - <20 µ/L   Danger - > 20 µ/L

Microcystin Cyanotoxin Lab Results, Clear Lake 2020

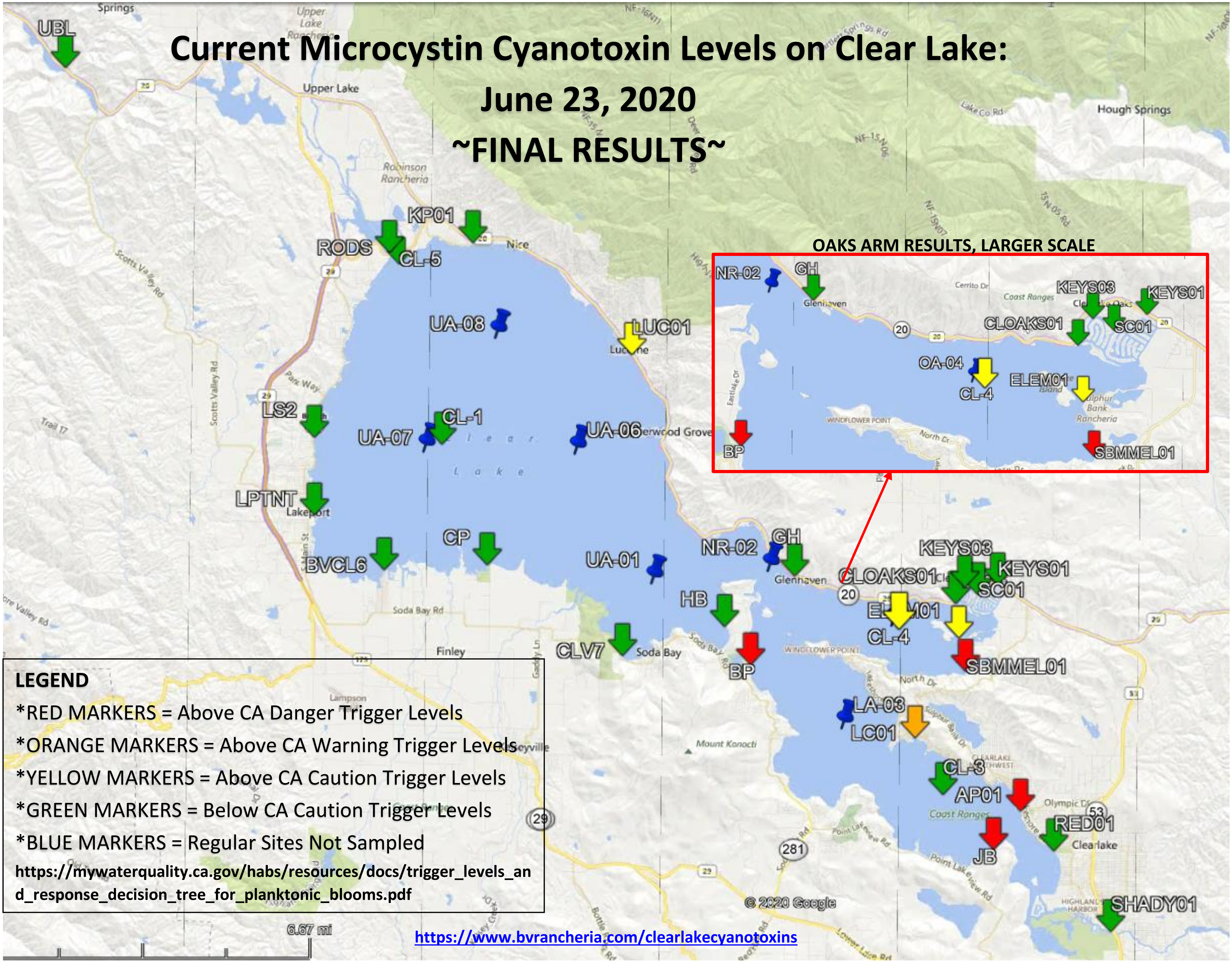
SITE ID	6/8/2020	6/23/2020	7/7/2020	7/21/2020	8/4/2020	8/18/2020	9/2/2020	9/15/2020	10/6/2020	10/20/2020	11/3/2020	11/23/2020
AP01	25.3	44.7	5.17	14.40	0.95	28.75	19.16	901.90	48.88	15.18	8.83	606.80
BP		45	2.64	1.73	0.67		0.57	1.83	13.57	1.17	3.81	
BVCL6						0.12	0.24	/Ana 0.34	3.03	1.70	2.11	0.91
CL-1								0.52			1.83 ^	
CL-3					0.85						7.35 ^	
CL-4					2.52			3.17			15.2 ^	
CL-5												
CLOAKS01				78.84	2.48	1.52	0.55	10.14	22.94	18.08	18.70	7.13
CLV7		0.26		ND	0.35	0.34		3.12	1.99	3.74	1.56	0.90
CP							0.33	2.90	3.25	2.95	0.95	0.81
ELEM01		4.86	2.79	21.47	0.85	0.18	0.74	71.93	5.78	12.78	4.40	4.67
GH									20.83	7.61	2.14	3.05
HB					0.25			4.97		5.54	2.09	1.70
JB	53.2	76.8	5.42	13.85	2.17	1.60	3.15	692.50	25.73	7.06	2.22	4.93
KEYS03				3.56	10.19	27.62	22.22	41.19/ Ana 14.11	0.93/ Ana 1.85	30.37	21.56	7.06
KP01		0.41				0.78		33.27	20.42	5.33	12.40	0.94
LC01		9.79	2.31	54.68	1.06	0.32	1.69	85.40	416.60	10.95	5.08	1.83
LPTNT					0.44	7.28	2.57	8.14	17.58	4.52	1.36	3.29
LS2						10.94	9.22	28.08		6.83	1.78	2.71
LUC01			0.75				4.19	1145.80	8.84	1.19	1.39	0.74
RED01			9.06	17.57	1.21	3.24	6.23	46.64	113.10	17.93	14.75	35.00
RODS				1.89	0.14		0.22					0.86
SBMMEL01		23.2	8.33	6.73	2.55	0.28	1.71	21.24	38.08	4.34	9.37	4.55
SHADY01			13.4	10.24	4.49	1.50	0.75	18.23	13.03	10.46	9.49	7.36

All cyanotoxin monitoring conducted by Big Valley Band of Pomo Indians and Elem Indian Colony. All results in µ/L. Results with "Ana" are Anatoxin lab results in µ/L.

^ - results shown on 11/23 map


Current Microcystin Cyanotoxin Results on Clear Lake:
June 8, 2020
UBL
RODS
KP01
CL-5
UA-08
LUC01
LS2
CL-1
A-07
UA-06
LPTNT
CP
BVCL6
UA-01
NR-02
GH
KEYS01
SC01
KEYS03
CL-4
HB
OA-04
ELEM01
CLV7
BP
SBMMEL01
53
LC01
LA-03
CL-3
AP01
RED01
JB
281
SHADY01
LEGEND
*RED MARKERS = Above CA Danger Trigger Levels
*GREEN MARKERS = Below CA Danger Trigger Levels
*BLUE MARKERS = Regular Sites Not Sampled

Current Microcystin Cyanotoxin Levels on Clear Lake:
June 23, 2020
~FINAL RESULTS~



LEGEND

*RED MARKERS = Above CA Danger Trigger Levels

*ORANGE MARKERS = Above CA Warning Trigger Levels

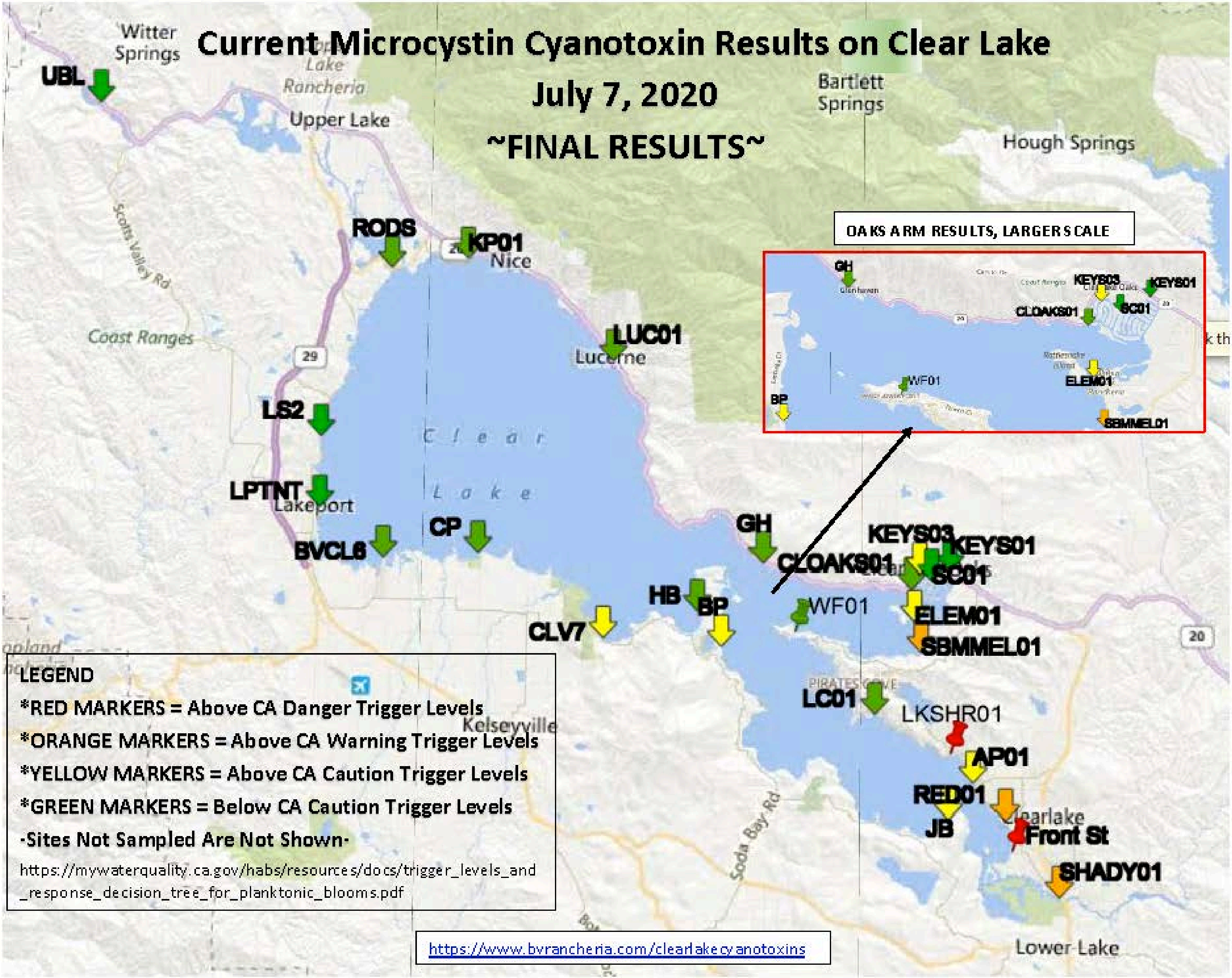
*YELLOW MARKERS = Above CA Caution Trigger Levels

*GREEN MARKERS = Below CA Caution Trigger Levels

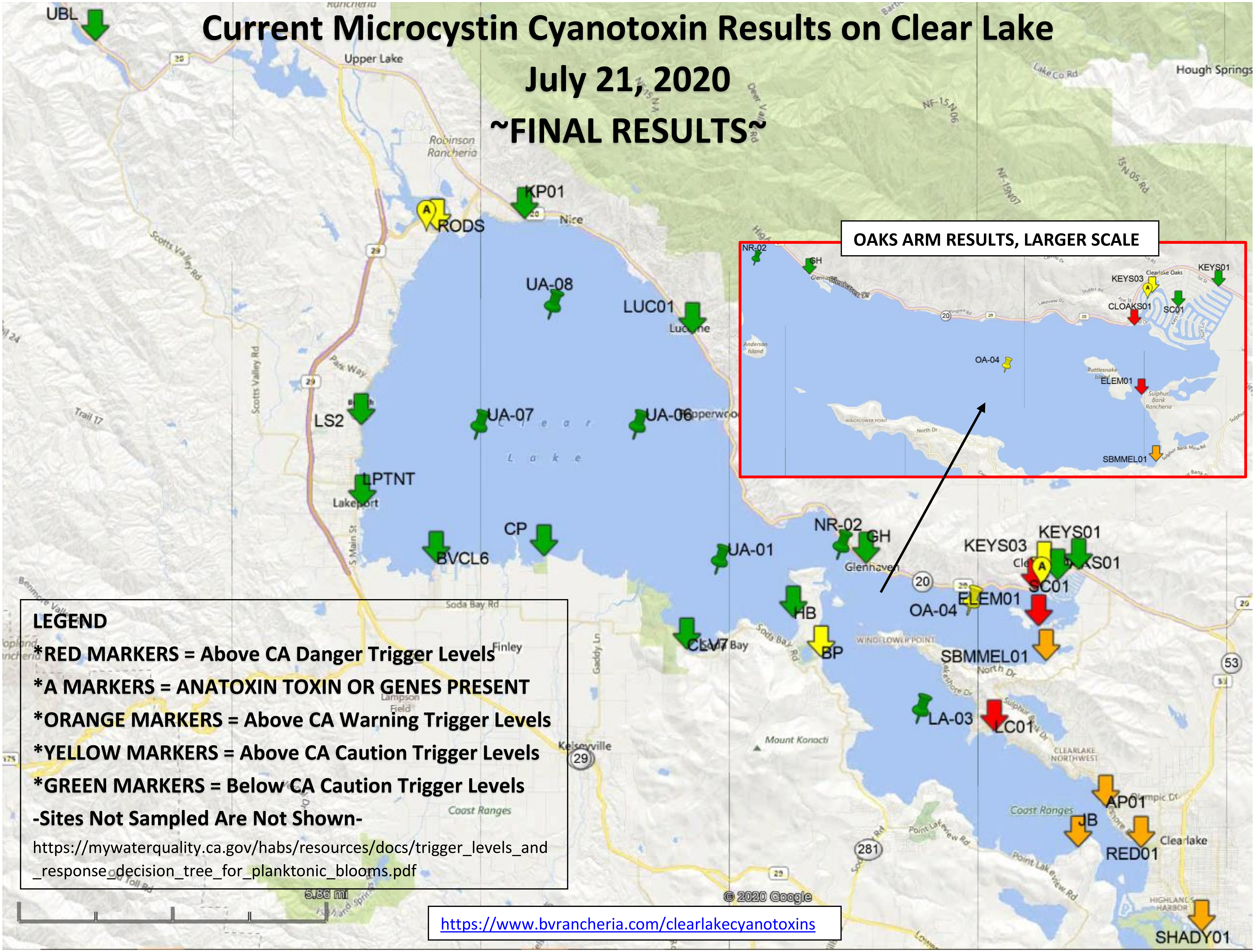
*BLUE MARKERS = Regular Sites Not Sampled

https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf

https://www.bvrancheria.com/clearlakecyanotoxins


Current Microcystin Cyanotoxin Results on Clear Lake
July 7, 2020
~FINAL RESULTS~
UBL
Witter Springs
Upper Lake
Bartlett Springs
Hough Springs
RODS
KP01
Nice
LUC01
Lucerne
Coast Ranges
LS2
LPTNT
Lakeport
BVCL6
CP
Clear Lake
GH
CLOAKS01
KEYS03
KEYS01
SC01
HB
BP
WF01
CLV7
ELEM01
SBMMEL01
OAKS ARM RESULTS, LARGER SCALE
LC01
LKSHR01
AP01
RED01
JB
Clearlake
Front St
SHADY01
Kelseyville
Soda Bay Rd
Lower Lake
LEGEND
*RED MARKERS = Above CA Danger Trigger Levels
*ORANGE MARKERS = Above CA Warning Trigger Levels
*YELLOW MARKERS = Above CA Caution Trigger Levels
*GREEN MARKERS = Below CA Caution Trigger Levels
-Sites Not Sampled Are Not Shown-
https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf
https://www.bvrancheria.com/clearlakecyanotoxins

Current Microcystin Cyanotoxin Results on Clear Lake
July 21, 2020
~FINAL RESULTS~



LEGEND

*RED MARKERS = Above CA Danger Trigger Levels

*A MARKERS = ANATOXIN TOXIN OR GENES PRESENT

*ORANGE MARKERS = Above CA Warning Trigger Levels

*YELLOW MARKERS = Above CA Caution Trigger Levels

*GREEN MARKERS = Below CA Caution Trigger Levels

-Sites Not Sampled Are Not Shown-

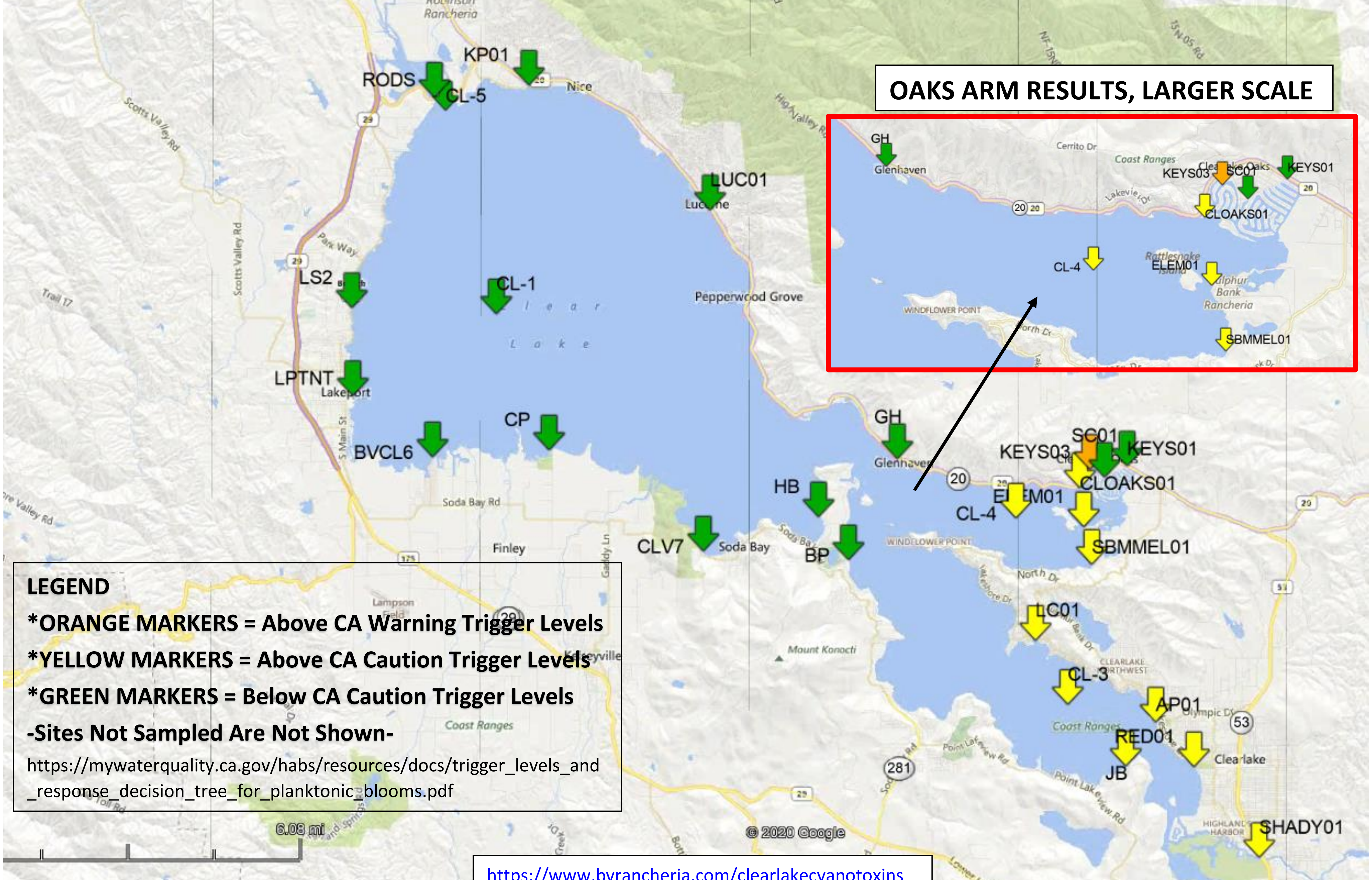
https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf

https://www.bvrancheria.com/clearlakecyanotoxins

Current Microcystin Cyanotoxin Results on Clear Lake

August 4, 2020

~FINAL RESULTS~



LEGEND

***ORANGE MARKERS = Above CA Warning Trigger Levels**

***YELLOW MARKERS = Above CA Caution Trigger Levels**

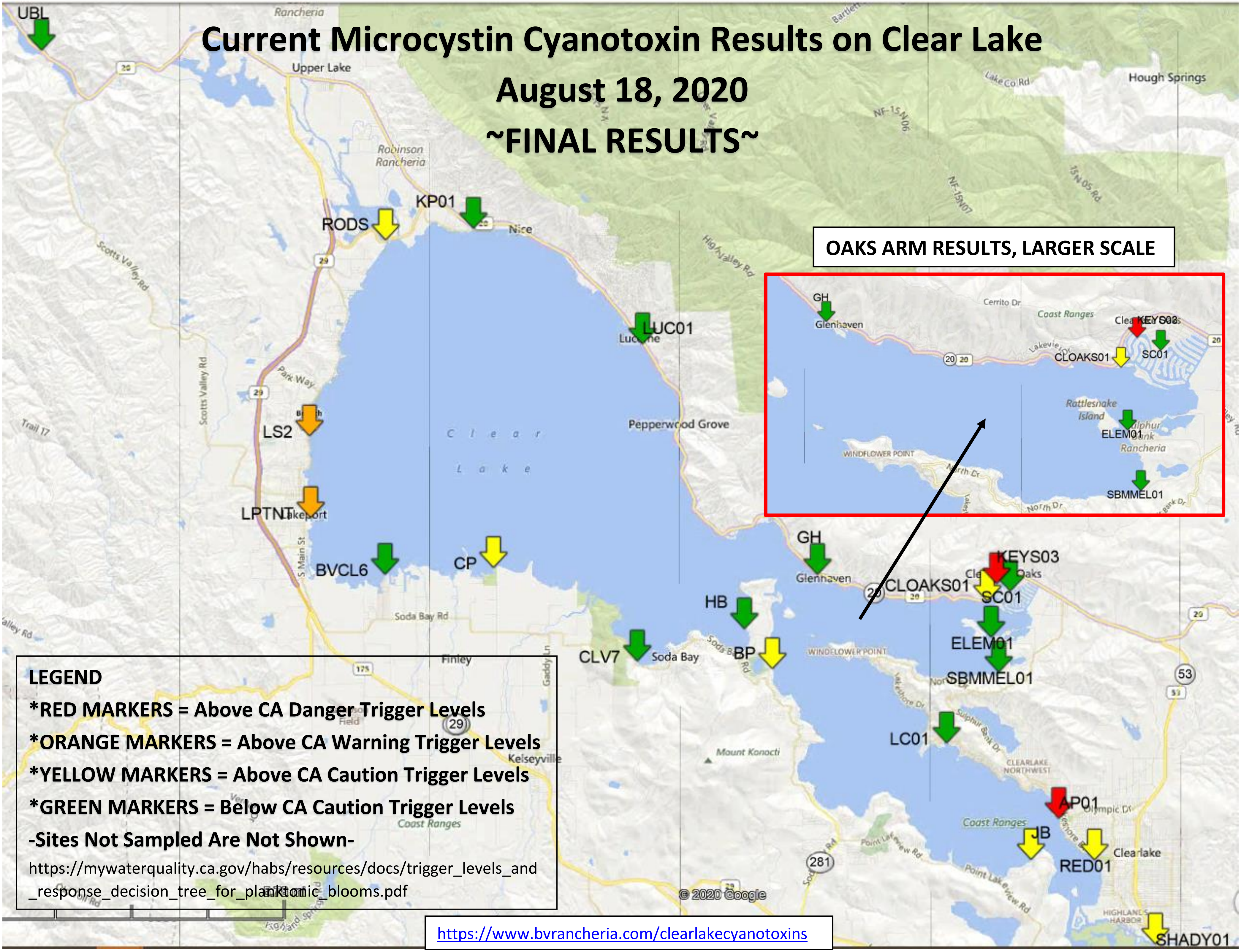
***GREEN MARKERS = Below CA Caution Trigger Levels**

-Sites Not Sampled Are Not Shown-

https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf

https://www.bvrancheria.com/clearlakecyanotoxins

Current Microcystin Cyanotoxin Results on Clear Lake
August 18, 2020
~FINAL RESULTS~



LEGEND

***RED MARKERS = Above CA Danger Trigger Levels**

***ORANGE MARKERS = Above CA Warning Trigger Levels**

***YELLOW MARKERS = Above CA Caution Trigger Levels**

***GREEN MARKERS = Below CA Caution Trigger Levels**

-Sites Not Sampled Are Not Shown-

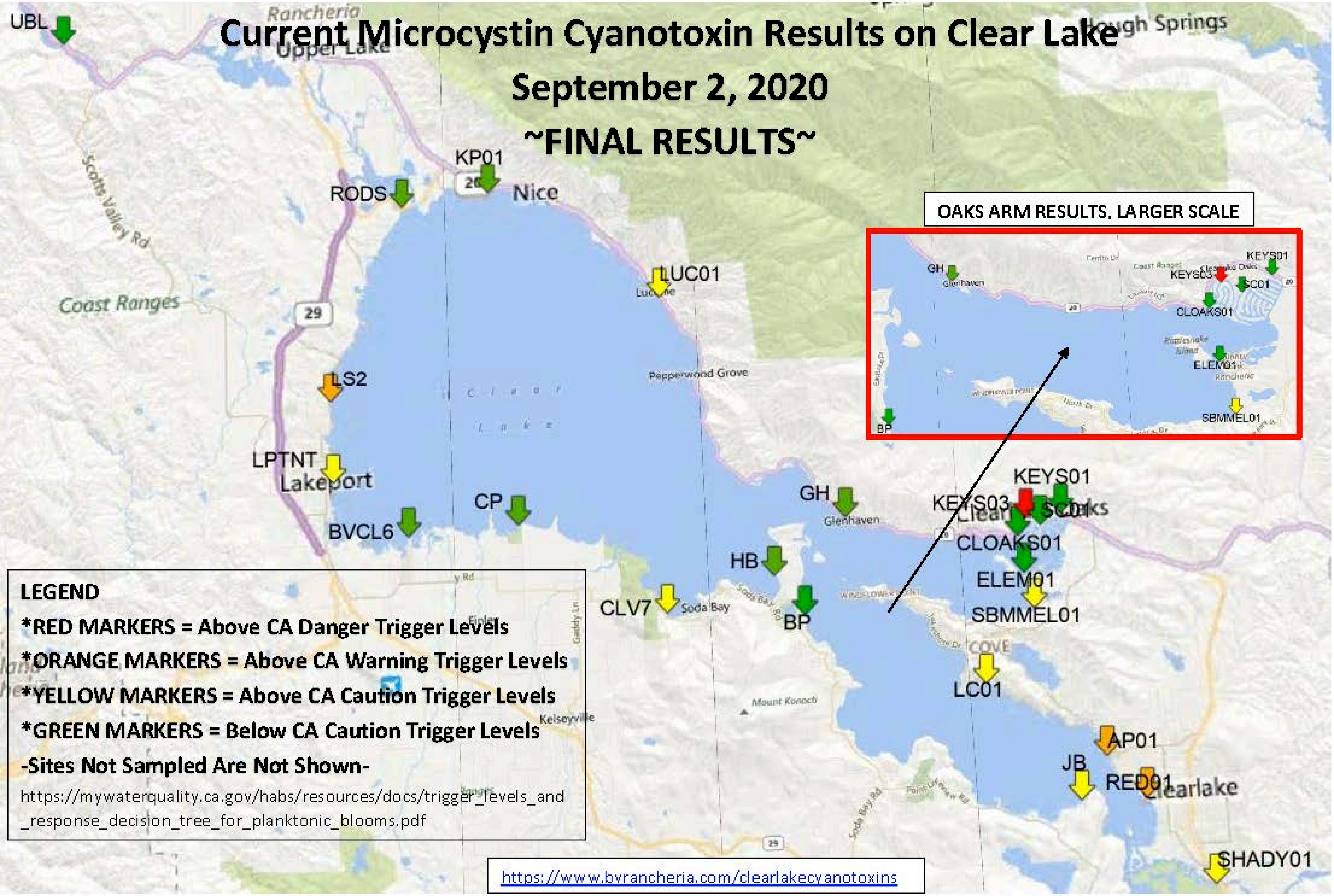
https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf

https://www.bvrancheria.com/clearlakecyanotoxins

Current Microcystin Cyanotoxin Results on Clear Lake

September 2, 2020

~FINAL RESULTS~



LEGEND

***RED MARKERS = Above CA Danger Trigger Levels**

***ORANGE MARKERS = Above CA Warning Trigger Levels**

***YELLOW MARKERS = Above CA Caution Trigger Levels**

***GREEN MARKERS = Below CA Caution Trigger Levels**

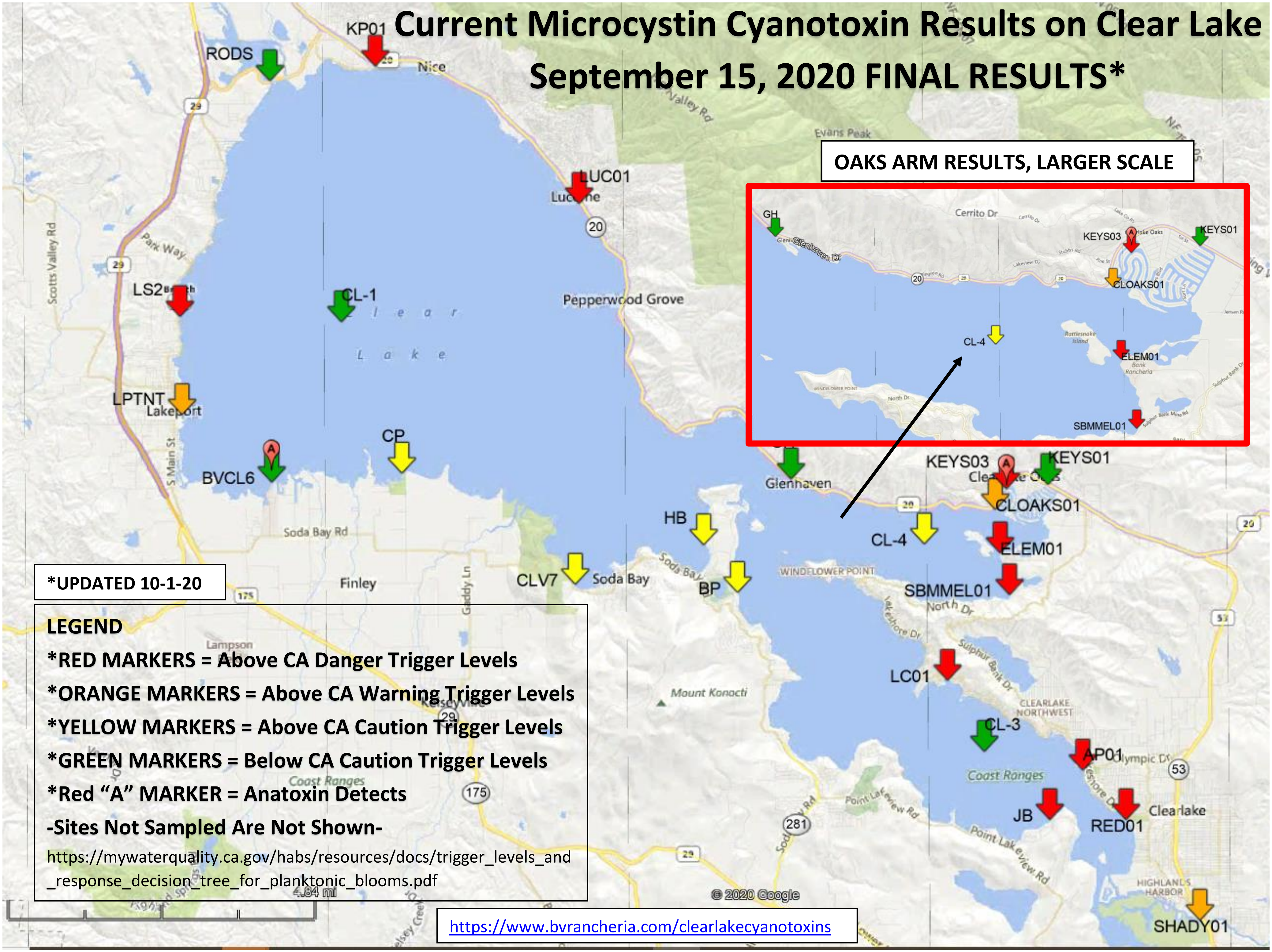
-Sites Not Sampled Are Not Shown-

https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf

https://www.bvrancheria.com/clearlakecyanotoxins

Current Microcystin Cyanotoxin Results on Clear Lake

September 15, 2020 FINAL RESULTS*



*UPDATED 10-1-20

LEGEND

*RED MARKERS = Above CA Danger Trigger Levels

*ORANGE MARKERS = Above CA Warning Trigger Levels

*YELLOW MARKERS = Above CA Caution Trigger Levels

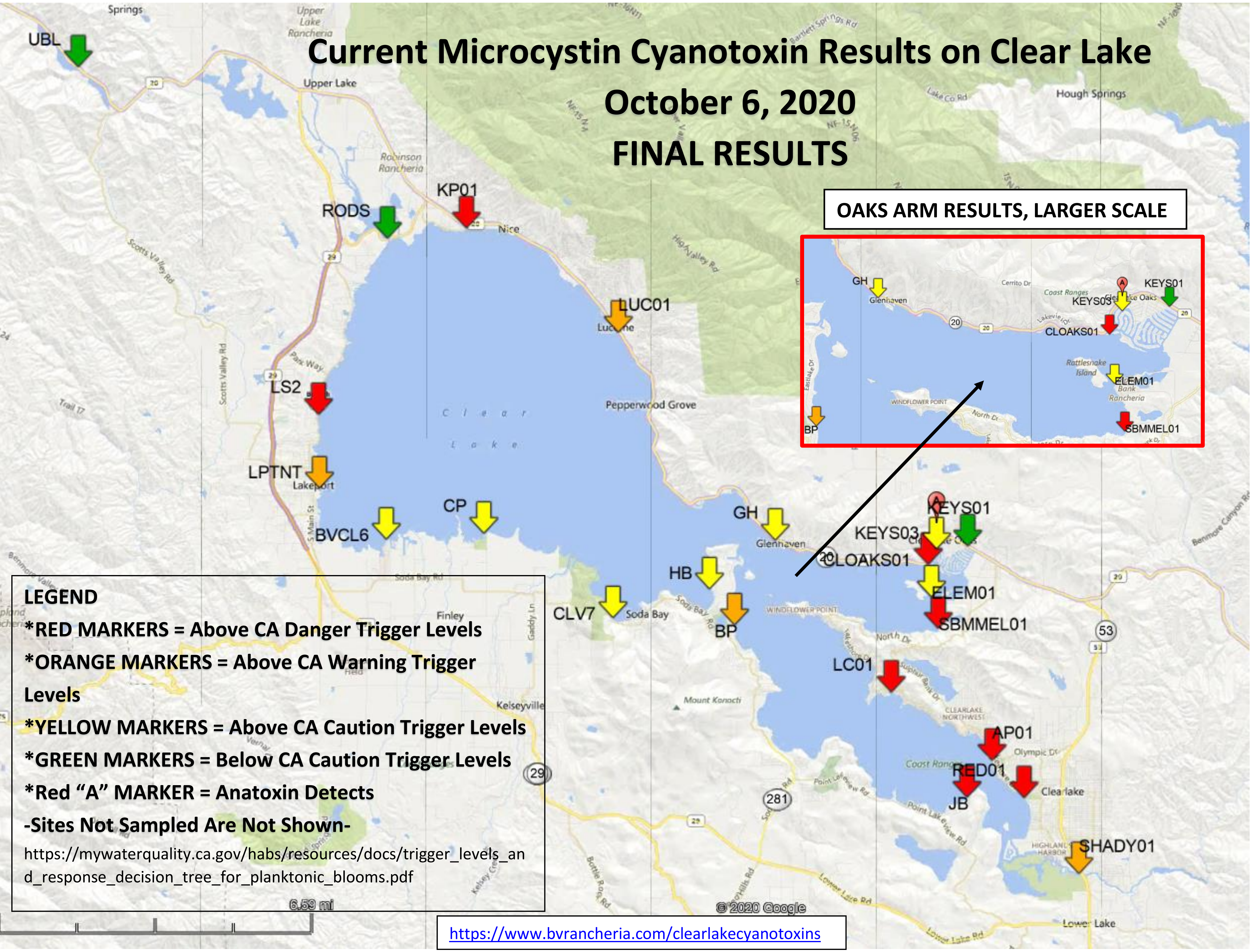
*GREEN MARKERS = Below CA Caution Trigger Levels

*Red "A" MARKER = Anatoxin Detects

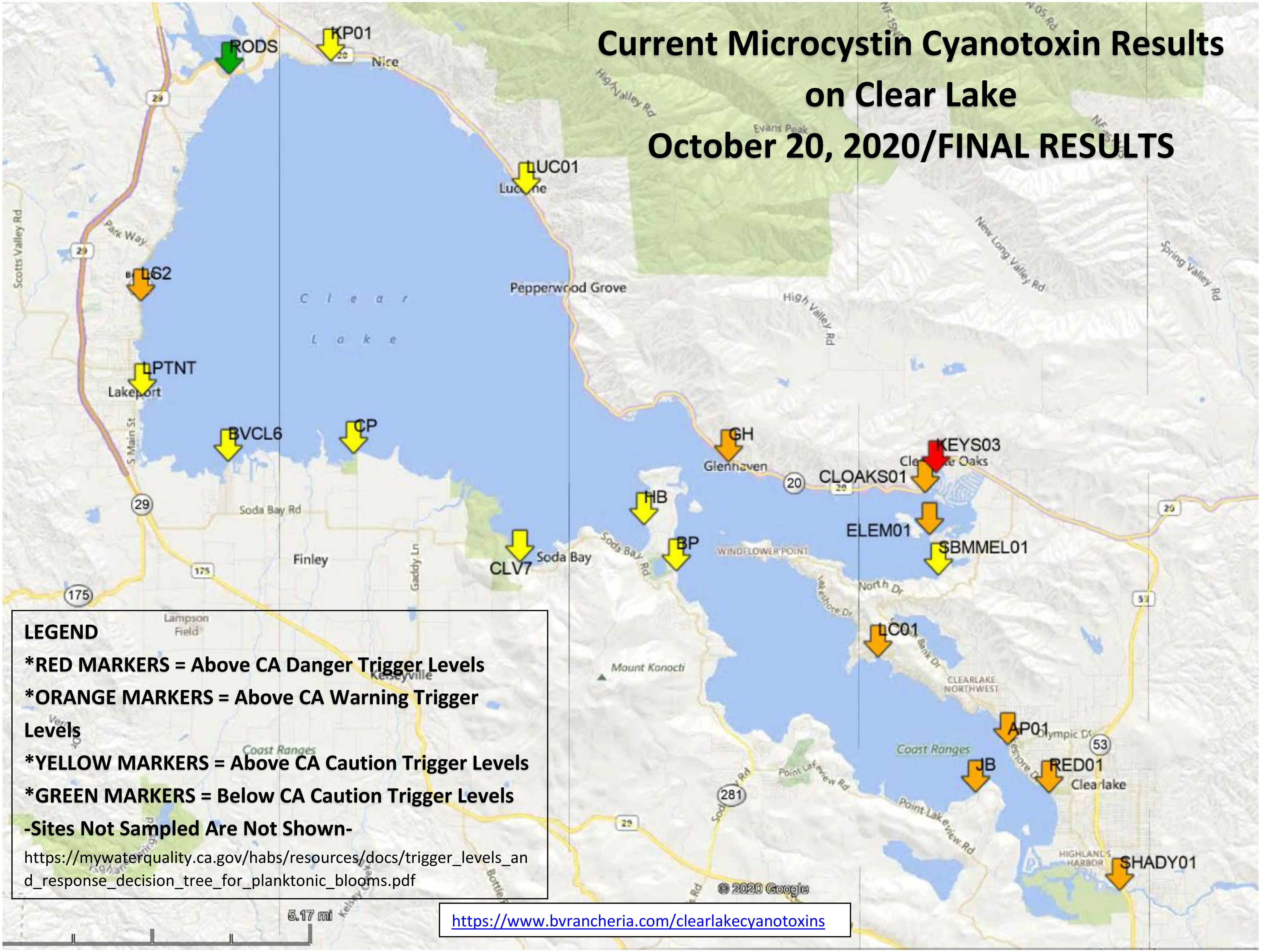
-Sites Not Sampled Are Not Shown-

https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf

https://www.bvrancheria.com/clearlakecyanotoxins



Current Microcystin Cyanotoxin Results on Clear Lake
October 6, 2020
FINAL RESULTS
OAKS ARM RESULTS, LARGER SCALE
UBL
RODS
KP01
LUC01
LS2
LPTNT
BVCL6
CP
GH
HB
CLV7
BP
KEYS01
KEYS03
CLOAKS01
ELEM01
SBMMEL01
LC01
AP01
RED01
JB
SHADY01
LEGEND
*RED MARKERS = Above CA Danger Trigger Levels
*ORANGE MARKERS = Above CA Warning Trigger Levels
*YELLOW MARKERS = Above CA Caution Trigger Levels
*GREEN MARKERS = Below CA Caution Trigger Levels
*Red "A" MARKER = Anatoxin Detects
-Sites Not Sampled Are Not Shown-
https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf
https://www.bvrancheria.com/clearlakecyanotoxins



Current Microcystin Cyanotoxin Results
on Clear Lake
October 20, 2020/FINAL RESULTS
RODS
KP01
Nice
LUC01
Lucerne
LS2
LPTNT
Lakeport
BVCL6
CP
Clear Lake
Pepperwood Grove
GH
Glenhaven
KEYS03
Clearlake Oaks
CLOAKS01
ELEM01
SBMMEL01
HB
BP
CLV7
Soda Bay
Soda Bay Rd
Finley
Windflower Point
North Dr
LC01
Mount Konocti
Clearlake Northwest
AP01
Olympic Dr
JB
RED01
Clearlake
Coast Ranges
Point Lakeview Rd
Highlands Harbor
SHADY01
Lampson Field
Kelseyville
High Valley Rd
New Long Valley Rd
Spring Valley Rd
Scotts Valley Rd
Park Way
S Main St
Gaddy Ln
Evans Peak
5.17 mi
© 2020 Google
LEGEND
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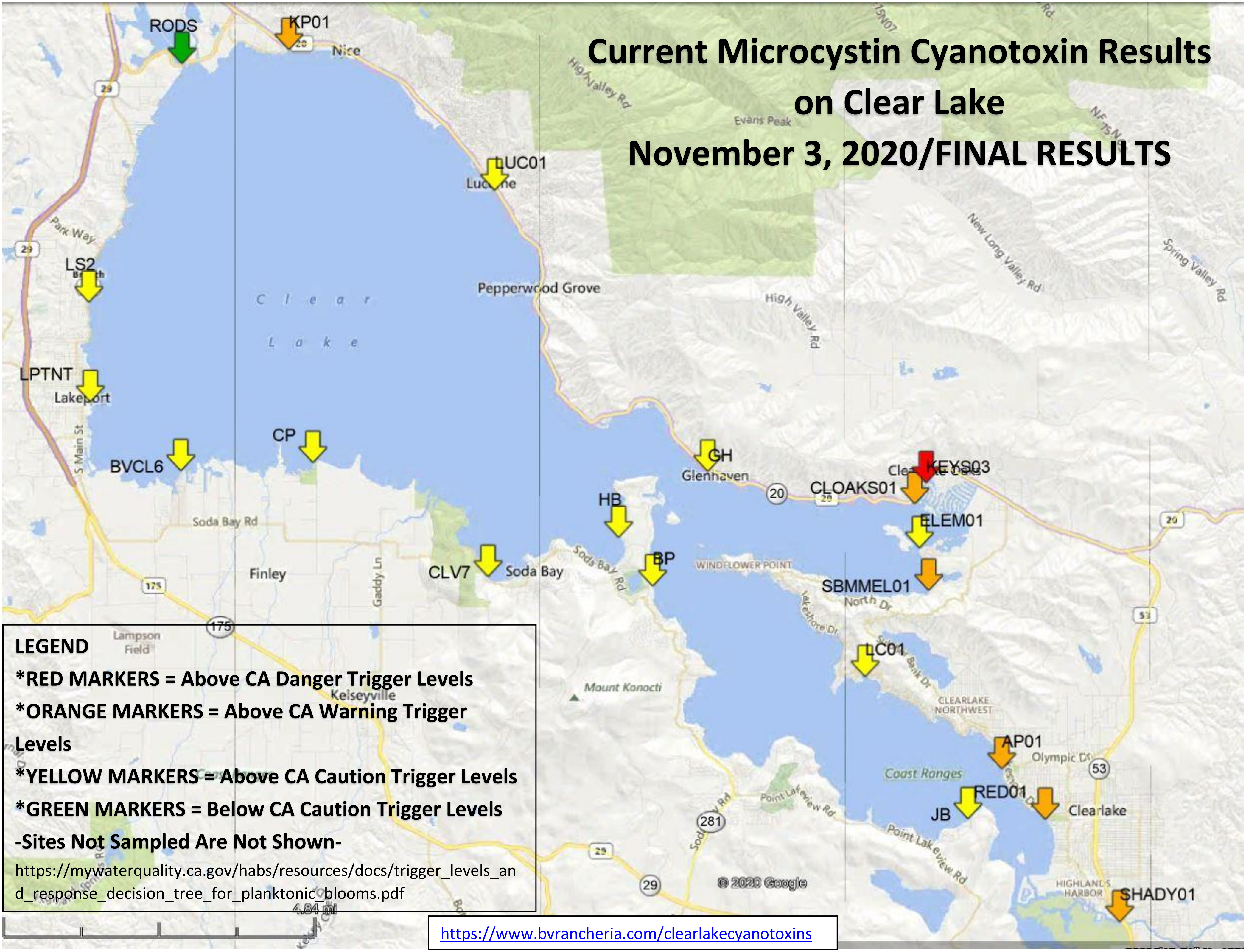
*YELLOW MARKERS = Above CA Caution Trigger Levels
*GREEN MARKERS = Below CA Caution Trigger Levels
-Sites Not Sampled Are Not Shown-
https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf
https://www.bvrancheria.com/clearlakecyanotoxins

Current Microcystin Cyanotoxin Results on Clear Lake

November 3, 2020/FINAL RESULTS



LEGEND

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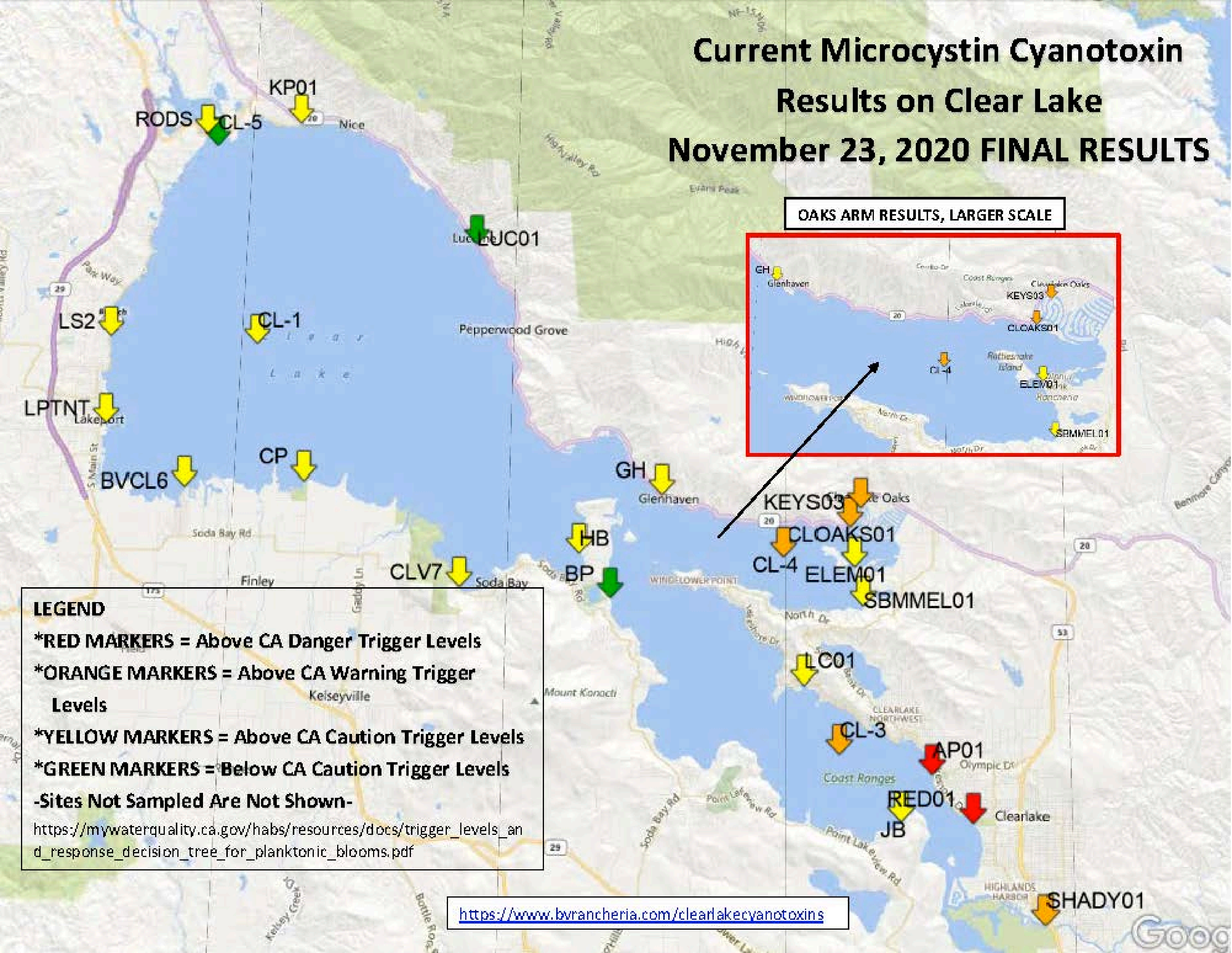
***GREEN MARKERS = Below CA Caution Trigger Levels**

-Sites Not Sampled Are Not Shown-

https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf

https://www.bvrancheria.com/clearlakecyanotoxins

Current Microcystin Cyanotoxin Results on Clear Lake November 23, 2020 FINAL RESULTS



LEGEND

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-Sites Not Sampled Are Not Shown-

https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf

https://www.bvrancheria.com/clearlakecyanotoxins

Big Valley Rancheria
Clear Lake Cyanotoxin Monitoring Program

The Big Valley Band of Pomo Indians began a cyanobacteria and cyanotoxin monitoring program on Clear Lake in 2014 with another shoreline Tribe, Elem Indian Colony. Together the two Tribes have collaborated with equipment, resources and time to test the water for toxins produced by cyanobacteria (AKA "Blue Green Algae"). These toxins can be neurotoxins, liver toxins and skin toxins. The Tribes began this program because despite the fact that Clear Lake had thick, noxious blooms covering its surface every summer since 2009, there was no regular and active monitoring of these blooms for the cyanotoxins that the California Office of Environmental Health Hazard Assessment had reviewed and suggested Action Levels for in 2012, and for which the World Health Organization provided guidance regarding exposure in the 1990's. https://www.waterboards.ca.gov/water_issues/programs/peer_review/docs/calif_cyanotoxins/cyanotoxins053112.pdf

After a fish kill and Clear Lake's waters turning milky turquoise blue during Labor Day 2014, Big Valley and Elem EPA staff followed the protocol in their surface water Quality Assurance Plans and visited 8 shoreline sites on Clear Lake. Field measurements to determine water quality were taken, and samples were collected for a regional lab that analyzes cyanotoxins. The lab results were astounding, with microcystin (a liver toxin) levels of almost 17,000 micrograms per liter at one site 100 feet from the intake of a major drinking water for Lake County residents. For reference, OEHHA has recommended caution for recreational exposure at any levels above 0.8 micrograms per liter. The Tribes quickly convened a Clear Lake Cyanobacteria Task Force to meet with Tribal, Lake County, California and USEPA agency staff to discuss the results and formulate actions. This Task Force continues to meet, review and discuss data and trends, and develop proactive projects to protect the beneficial uses and all those who enjoy and utilize the many gifts of Clear Lake.

Since that time, the Tribes have increased their number of monitoring locations to 20 sites along the Clear Lake shoreline, and are now collaborating with the California Department of Water Resources to obtain samples in the center of each arm of the lake, providing an enhanced view of the cyanotoxin issues throughout the lake. The Tribes also conduct microscopy on each sample to determine the cyanobacteria genera which then guides toxin analyses requested. Big Valley Rancheria also obtained 2 grants from CalEPA – one to add sampling locations that are important to all the Pomo Tribes, and to sample prior to traditional uses of the lake, to ensure that the Tribes receive toxin information so that they can make informed decisions about uses. The second grant is currently in process and is a study on whether Tribally important fish and shellfish contain cyanotoxins. Fish and shellfish have been collected from various locations and throughout different seasons to identify aquatic organisms that may have toxin levels that could impact Tribal subsistence consumption.

Big Valley and Elem EPA staff regularly post the cyanotoxin results and other lake monitoring details on a social media page which is shared with the whole Lake County community and has been an important resource that is quoted by the Central Valley Regional Water Quality Control Board and the County to inform lake users. The posts about the current cyanotoxin levels reach thousands of viewers and generate discussion about health, watershed management and nutrient controls. A recent video of kayaking down one of the creeks and doing cyanotoxin monitoring had over 20,000 views. https://www.facebook.com/ClearLakeWaterQuality/

How Often Did Clear Lake Cyanotoxin Monitoring Sites Exceed the Microcystin Threshold for Potential Health Risks?

0.8 micrograms per Liter (µg/L) is the CCHAB recommendation for public notification of microcystin cyanotoxins at potential health risk levels http://www.mywaterquality.ca.gov/monitoring_council/cyanohab_network/docs/triggers.pdf

		PERCENTAGE OF TIMES EACH SITE EXCEEDED 0.8 µg/L EACH YEAR (PUBLIC NOTIFICATION THRESHOLD FOR MICROCYSTIN)				HIGHEST MICROCYSTIN LEVEL RECORDED AT EACH SITE EACH YEAR * *Red cell is highest value for Clear Lake each year*			
SAMPLING SITE ID	ARM OF LAKE	2014	2015	2016	2017	2014	2015	2016	2017
BVCL6	U	17%, n=6	0%, n=20	0%, n=9	0%, n=8	1.2	ND	0.14	0.21
CLV7	U	86%, n=7	0%, n=13	0%, n=9	13%, n=8	105	ND	0.34	3.5
M4	U	33%, n=6	0%, n=14	not sampled	not sampled	8.3	ND	not sampled	not sampled
LPTNT	U	83%, n=6	0%, n=12	0%, n=9	0%, n=8	877.6	ND	0.17	0.14
RODS	U	not sampled	0%, n=12	0%, n=9	0%, n=8	not sampled	ND	0.15	0.11
CP	U	not sampled	0%, n=11	0%, n=9	0%, n=9	not sampled	ND	0.16	ND
LS	U	not sampled	0%, n=11	0%, n=9	not sampled	not sampled	Trace	0.11	not sampled
LS2	U	not sampled	not sampled	not sampled	0%, n=3	not sampled	not sampled	not sampled	0.12
LUC01	U	67%, n=6	0%, n=13	0%, n=9	0%, n=8	13	ND	0.14	ND
HB	U	not sampled	0%, n=9	0%, n=8	0%, n=8	not sampled	Trace	0.12	0.35
KP01	U	not sampled	0%, n=12	0%, n=9	0%, n=8	not sampled	ND	0.15	0.34
ELEM01	O	50%, n=4	29%, n=14	not sampled	0%, n=7	4.4	18.7	not sampled	0.38
SBMMEL01	O	100%, n=7	20%, n=10	0%, n=9	25%, n=8	5,311.70	278	0.67	2.4
CLOAKS01	O	100%, n=7	31%, n=16	0%, n=9	13%, n=8	16,920	21	0.16	46.00
GH	O	not sampled	not sampled	not sampled	0%, n=6	not sampled	not sampled	not sampled	0.2
BP	L	not sampled	27%, n=11	0%, n=9	13%, n=8	not sampled	9.4	0.16	1.3
RP	L	not sampled	33%, n=10	0%, n=9	13%, n=8	not sampled	134	0.13	1.2
SHADY01	L	not sampled	40%, n=10	0%, n=9	0%, n=8	not sampled	36.1	0.34	0.39
RED01	L	not sampled	33%, n=12	0%, n=9	0%, n=8	not sampled	65.5	0.28	0.44
AP01	L	100%, n=9	41%, n=17	0%, n=9	0%, n=9	769.2	10,162	0.21	0.52
JB	L	not sampled	not sampled	0%, n=9	0%, n=8	not sampled	not sampled	0.19	0.34

n = number of times sampled

** = in µg/L*

Big Valley Rancheria EPA and Elem Indian Colony EPA 2014 to 2017 Health Threshold Exceedances

For more information, please contact Big Valley Rancheria Environmental Director Sarah Ryan sryan@big-valley.net or 707-263-3924 x132. Current Clear Lake toxin levels can be found at www.bvrancheria.com/clearlakecyanotoxins

Appendix F: 2020 Committee Roster

Name	AB 707 Membership Category	Appointing Entity
Eric Sklar	Appointed Chair	California Natural Resources Agency
Brenna Sullivan	Agriculture	Lake County
Harry Lyons	Environmental	Lake County
Keith Ahart	Public Water Supply	Lake County
Jennifer LaBay	Regional Water Board	Central Valley Regional Water Quality Control Board
Eddie "EJ" Crandall	Lake County Board of Supervisors	Lake County
Alix Tyler	Tribal Representative	Elem Indian Colony
Linda Rosas-Bill	Tribal Representative	Habematolel Pomo of Upper Lake
Mike Shaver	Tribal Representative	Middletown Rancheria of Pomo Indians
Paul Dodd	UC Davis	UC Davis
Sarah Ryan	Tribal Representative	Big Valley Band of Pomo Indians
Terre Logsdon	Tribal Representative	Scotts Valley Band of Pomo Indians
Wilda Shock	Local Economy	Lake County
Karola Kennedy	Tribal Representative	Koi Nation
Irenia Quitiquit	Tribal Representative	Robinson Rancheria

Appendix G: Clear Lake Watershed Modeling Plan

U.S. Geological Survey, California Water Science Center

Feb. 27, 2020

The proposed modeling work for the Clear Lake watershed is divided into six tasks: 1) Project management and outreach; 2) SPARROW dynamic modeling of nutrients & sediment; 3) SPARROW dynamic management tool; 4) HSPF modeling of flow, sediment, and nutrient transport; 5) VELMA modeling of nutrient and mercury transport; and 6) Sediment fingerprinting. These tasks are described below in section A. Budgets for 3-year and 6-year periods of effort are provided in section B. References cited are listed in section C.

A. Task Descriptions

Task 1. Project management and outreach

The USGS project chief will meet regularly with USGS task leaders and project staff. The project chief and task leaders will meet occasionally with stakeholders in the Clear Lake area and participate in regularly scheduled conference calls to discuss progress. Workshops will be held at least annually to introduce study concepts and get feedback from the Blue Ribbon Committee for the Rehabilitation of Clear Lake and to other stakeholders and the general public.

Task 2. SPARROW modeling of nutrients & sediment

The SPARROW (SPAtially Referenced Regression On Watershed attributes) model is a watershed modeling technique developed by the USGS used for relating water-quality measurements made at a network of monitoring stations to attributes of the upstream watersheds, such as contaminant sources and environmental factors that affect rates of delivery to streams and in-stream processing. Using the calibration from the monitoring stations, predictions of total nitrogen, total phosphorus, and suspended sediment can be made in ungaged and/or unmonitored regions of the watershed. Statistically significant characterizations of the nitrogen, phosphorus, or sediment sources along with hydrological factors that influence the transport or removal of the constituents make up the model output. The output is linked to a geographic information system (GIS) which can be display how the constituents move to downstream areas and what factors influence the movement. The SPARROW model uses a set of non-linear equations for the prediction of stream load at a point in the watershed using attributes, such as land use, point sources, fertilizer or manure applications, atmospheric deposition, and natural geological material. Processing or loss of the constituents is accomplished using hydrological data such as soil characteristics, slope, geology, and hydraulic conductivity.

The SPARROW model has previously been applied to estimate annual loads of nitrogen, phosphorus, and sediment in California for base year 2002 (Domagalski and Saleh, 2015;

Saleh and Domagalski, 2015) and for base year 2012 (Wise, 2019). These simulations covered the Clear Lake drainage basin, but did not have any calibration points in the area. A new version of the SPARROW model (Dynamic SPARROW) can extend the capabilities from using long-term annual averages to monthly time scales which provides better predictions of actual loadings in variable climatic or land-use settings. This allows for modeling of nutrient sources to actual times of fertilizer applications, monthly rainfall, temperature, etc. Model output can be mapped on a monthly basis which should greatly help development of best management practices regarding locations and time frames on which to focus source reduction.

The proposed work would apply the Dynamic SPARROW model to the Clear Lake drainage basin using local calibration points which will provide model results with a much higher degree of confidence than the previous state-wide modeling efforts. In Year 1, the SPARROW model would be calibrated using existing data for nitrogen, phosphorus, and sediment from monitoring stations in the area from years up to and including Water Year 2020. In Year 2 monitoring data from Water Year 2021 will be incorporated. In Year 3, monitoring data from Water Year 2022 will be included. An interpretive report will be written with the results from the Year 3 SPARROW modeling.

If the project is extended for an additional three years, in Years 4 and 5 there will be interim recalibrations using available data from Water Years 2022-23, and in Year 6 there will be a final calibration using data from Water Years 2021-25 (five years of new monitoring data).

<u>3) SPARROW decision support tool</u>

Output from the SPARROW model can be used in a web-based mapper or decision support system to display how water quality would change under different management options (Booth et al., 2011). An existing decision support tool for the SPARROW model will be adapted by USGS to accommodate output from the Dynamic SPARROW model.
In Year 1, Dynamic Sparrow results from the Upper Klamath Basin will be implemented into a decision support system. In years 2 and 3, results from Clear Lake will be incorporated.

If the project is extended for an additional three years, the results described in Task 2 will be incorporated into the decision support system so that watershed stakeholders can use the information to develop best management practices.

<u>4) HSPF modeling of flow, sediment, and nutrient transport</u>

Hydrological Simulation Program - FORTRAN (HSPF) is a comprehensive semi-distributed watershed model developed by Donigian et al. (1995) and has been applied successfully to numerous watersheds globally to describe runoff, sediment transport, and nutrient transport (Stern et al., 2016; https://www.epa.gov/ceam/hydrological-simulation-program-fortran-hspf). HSPF was applied to the lower Cache Creek watershed and successfully demonstrated post-fire effects (from the Jerusalem and Rocky fires in 2015) on sediment and mercury transport (Stern et al., in review). HSPF is the only comprehensive model of watershed hydrology and water quality that allows the integrated simulation of land and soil contaminant runoff processes with in-stream hydraulic and sediment-chemical interactions. In addition to streamflow, sediment and total mercury, the HSPF model will be updated to simulate dissolved oxygen, nitrate, nitrite, ammonia, organic nitrogen, orthophosphate, organic phosphorus, and algae at an hourly time step.

The HSPF model requires continuous time series of air temperature, precipitation, and potential evapotranspiration (PET) as climate inputs. Climate data can be a large source of error in modeling and it is important to reduce this error as much as possible. Techniques will be used to distribute station data that have been shown on a daily scale to improve the characterization of local and regional climate patterns in areas with sparse data (Flint et al., 2014). These interpolation techniques will be applied to available hourly observed data to produce daily gridded climate variables that drive the HSPF water-balance calculations, using methods described by Stern et al. (in review).

As with the SPARROW modeling in Task 2, in Year 1 the HSPF model will be extended spatially and temporally and calibrated using data for streamflow, nitrogen, phosphorus, and sediment from monitoring stations in the area from years up to and including Water Year 2020. In Year 2 monitoring data from Water Year 2021 will be incorporated. In Year 3, monitoring data from Water Year 2022 will be included. An interpretive report will be written with the results from the Year 3 HSPF modeling. Because the HSPF model can be run on a daily or hourly time step, HSPF output will be useful as input to models of nutrients in Clear Lake that are being developed by UC Davis.

If the project is extended for an additional three years, in Years 4 and 5 there will be interim recalibrations using available data from Water Years 2022-23, and in Year 6 there will be a final calibration using data from Water Years 2021-25 (five years of new monitoring data).

5) VELMA modeling of nutrient and mercury transport

The Visualizing Ecosystems for Land Management Assessment (VELMA) model was developed by the U.S. Environmental Protection Agency with the capability of simulating concentrations and loads of nutrients and dissolved organic carbon. Mercury transport equations were added to VELMA to create VELMA-Hg, which associates total mercury fluxes with multi-soil layer hydrologic transport along with carbon, nitrogen, and mercury cycling. The carbon cycling module housed in its structure allows the VELMA-Hg model to provide insights on Hg bound to dissolved organic matter (Golden et al., 2012). Knightes et al. (2014) indicated that "VELMA does not simulate erosion of soils, so simulated VELMA output is for the flux and concentrations of dissolved Hg(II) and MeHg. VELMA simultaneously simulates hydrology, N, C, and Hg, thus enhancing VELMA's utility for simulating Hg exposure concentrations and associated climate and land use/cover change impacts."

An updated version of VELMA (version 2.0) is now available: https://www.epa.gov/water-research/visualizing-ecosystem-land-management-assessments-velma-model-20
Mercury transport capabilities of VELMA 2.0 are being refined (USEPA, written communication to C. Alpers, Jan. 2020). USEPA scientists have expressed interest in collaborating on this project to use VELMA to simulate nutrients, dissolved organic carbon (DOC), and DOC-complexed species of dissolved mercury and methylmercury.
The VELMA model simulates four soil layers throughout the model domain. The STATSGO database will be used as a starting point for model calibration. Field sampling of soils will be done to provide data on concentrations of total N, total P, organic C, inorganic C, total Hg, methyl-Hg, and reactive Hg(II), and to ground-truth soil thickness estimates.
As with the SPARROW modeling in Task 2 and the HSPF modeling in Task 4, in Year 1 the VELMA model will be calibrated using existing data for nitrogen, phosphorus, and DOC from monitoring stations in the area from years up to and including Water Year 2020. In Year 2 monitoring data from Water Year 2021 will be incorporated. In Year 3, monitoring data from Water Year 2022 will be included. An interpretive report will be written with the results from the Year 3 VELMA modeling.

If the project is extended for an additional three years, in Years 4 and 5 there will be interim recalibrations using available data from Water Years 2022-23, and in Year 6 there will be a final calibration using data from Water Years 2021-25 (five years of new monitoring data).

6) Sediment Fingerprinting

The sediment fingerprinting approach to determine sources of sediment in a watershed was first developed by Walling (2005). The approach uses chemical and isotopic data to determine characteristics of sediment source types including land uses such as agriculture, forests, and urban sources.

Recently, the USGS and USEPA developed the Sediment Source Assessment Tool (Sed_SAT) for the purpose of determining sources of fine-grained sediment (Gellis et al., 2016; Gorman Sanisaca et al., 2017a,b). A USGS Fact Sheet (Gellis et al., 2018) summarizes key points in the sediment fingerprinting approach:

> "The sediment fingerprinting procedure establishes a minimal set of physical and (or) chemical properties (tracers) based on samples collected in upland or channel locations identified as potential sources of sediment. These properties are unique for each source within the watershed. Fluvial sediment samples (target sediment) also are collected that exhibit a composite, or "fingerprint" of source properties. Through statistical procedures, the target sediment properties can be matched to their respective upland or channel source "fingerprints".

There are six statistical steps in the Sed_SAT approach: 1) Outlier evaluation, 2) Size and organic corrections, 3) Bracket test, 4) Stepwise discriminant function analysis, 5) Source apportionment using an unmixing model, and 6) Error analysis (Gorman Sanisaca et al., 2017a,b).

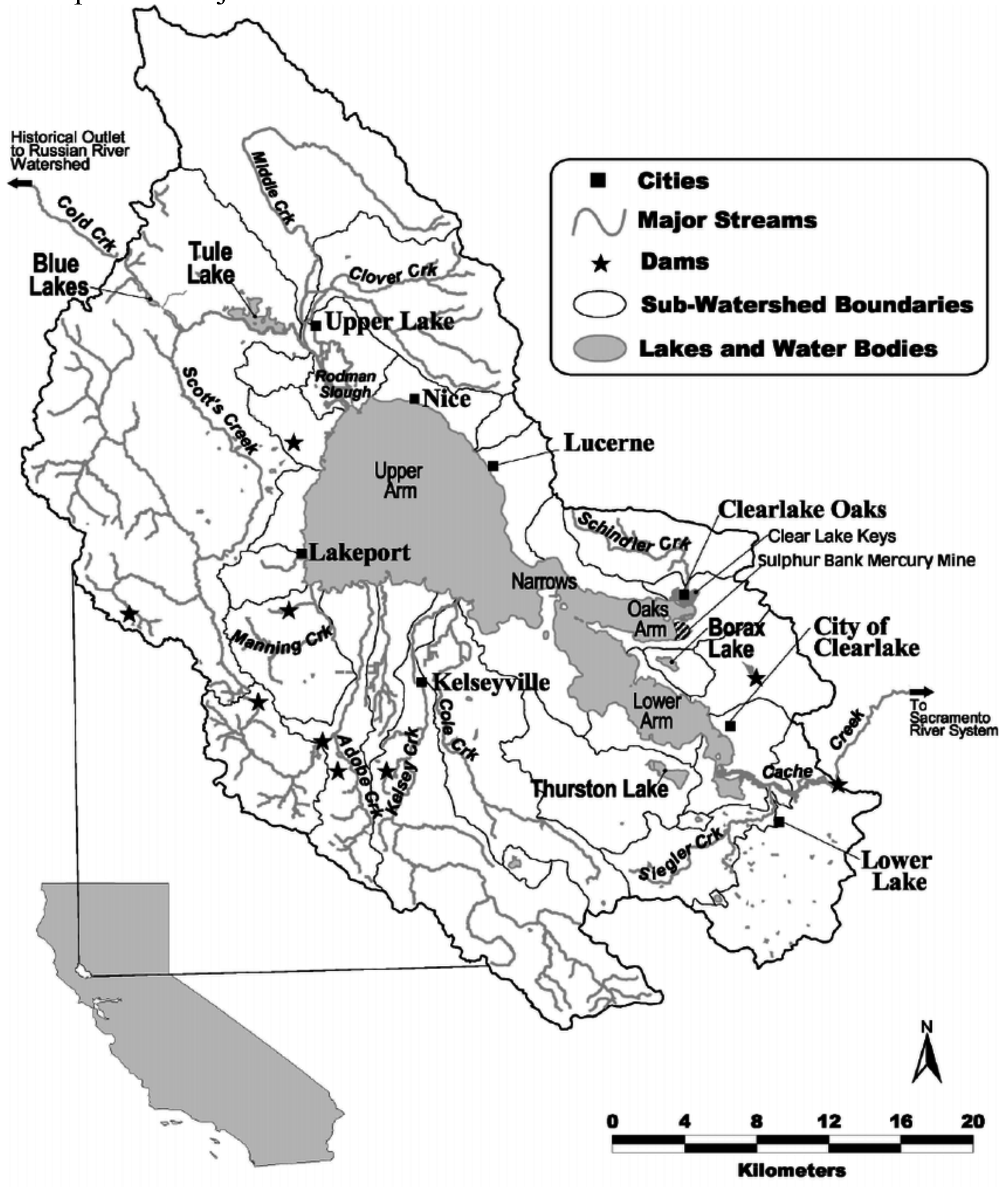
At Clear Lake, we propose to sample streambed sediment, stream banks, soils, and suspended sediment in the main tributaries to Clear Lake. The samples will be distributed as evenly as possible across various land uses that are of interest as possible sources of sediment. A preliminary breakdown of land uses and sample types to be targeted is show in the following table:

	Number of Samples				
Land Use	**Streambed sediment**	**Stream bank**	**Soil - A Horizon**	**Soil - B Horizon**	**Total**
Forest - minimal logging or ORV use	12	12	12	12	48
Forest - logging	12	12	12	12	48
Forest - Heavy Off-Road Vehicle use	12	12	12	12	48
Rangeland - cattle grazing	12	12	12	12	48
Agriculture - row crops	12	12	12	12	48
Agriculture - other	12	12	12	12	48
Urban / Suburban	12	12	12	12	48
Total	84	84	84	84	336

The main tributary catchments to Clear Lake (see map) would be represented by the above sample types as well as suspended sediment samples collected near the mouth of each tributary as it enters Clear Lake. The suspended sediment will be collected from large water samples (10 to 100 liters) that will be dewatered to isolate the suspended sediment. Alternatively, Walling tubes installed in the streams may also be used to collect time-integrated fluvial sediment samples. The suspended sediment samples will be "unmixed" using the Sed_SAT approach to determine sediment sources.

	Number of Samples					
Samples by Sub-watershed	**Streambed sediment**	**Stream bank**	**Soil - A Horizon**	**Soil - B Horizon**	**Suspended Sediment**	**Totals**
Adobe Creek	12	12	12	12	3	51
Burns Valley	6	6	6	6	3	27
Clover Creek	6	6	6	6	3	27
Cole Creek	12	12	12	12	3	51
Kelsey Creek	12	12	12	12	3	51
Manning Creek	6	6	6	6	3	27
Middle Creek	12	12	12	12	3	51
Schindler Creek	6	6	6	6	3	27
Scotts Creek	12	12	12	12	3	51
Total	84	84	84	84	27	363

A map of the major streams in the Clear Lake watershed is shown below:



The sediment and soil samples will be analyzed for a suite of chemical and isotopic constituents that have proven to be useful in other, similar studies (e.g. Gellis et al., 2016 in Chesapeake Bay, Virginia and Maryland; Shenk et al., 2019 in Upper Klamath Basin, Oregon). In addition, the detailed grain-size distribution (50 size bins, at ¼-phi intervals) will be determined using a Beckman-Coulter laser-scattering instrument.

Planned analyses	Cost per analysis
Total N	$ 20
Total P	$ 20
Total C	$ 20
Total Inorganic C	$ 20
Major elements & Trace elements (ICP)	$ 200
Total Hg	$ 150
d15N	$ 5
d13C	$ 5
d18O in PO4	$ 200
137-Cs	$ 100
210-Pb	$ 100
Pb stable isotopes	$ 100
Hg isotopes	$ 150
Sr isotopes	$ 125
Grain-size distribution	$ 72
Total cost per sample	$ 1,287
Total cost	$ 467,039
Cost per year (3 yrs)	$ 155,680

B. Budget

Total Costs	Year 1	Year 2	Year 3	3-year Total
Task	2020/21	2021/22	2022/23	2020-2023
1. Project management & outreach	$ 35,793	$ 36,867	$ 37,973	$ 110,633
2. SPARROW - Nutrient & sediment modeling	$ 53,679	$ 55,290	$ 89,644	$ 198,613
3. SPARROW - Decision support tool	$ 20,000	$ 20,000	$ 20,000	$ 60,000
4. HSPF - Flow, sediment & nutrient transport modeling	$ 38,501	$ 39,656	$ 40,845	$ 119,001
5. VELMA - Nutrient & mercury modeling	$ 103,571	$ 107,777	$ 160,881	$ 372,228
6. Sediment fingerprinting	$ 253,505	$ 256,439	$ 296,223	$ 806,167
Totals	$ 505,048	$ 516,028	$ 645,566	$ 1,666,642

Total Costs	Year 4	Year 5	Year 6	3-year Total	6-year Total
Task	2023/24	2024/25	2025/26	2023-2026	2020-2026
1. Project management & outreach	$ 18,433	$ 18,986	$ 41,770	$ 79,190	$ 189,823
2. SPARROW - Nutrient & sediment modeling	$ 27,645	$ 28,474	$ 98,608	$ 154,727	$ 353,340
3. SPARROW - Decision support tool	$ 10,000	$ 10,300	$ 22,000	$ 42,300	$ 102,300
4. HSPF - Flow, sediment & nutrient transport modeling	$ 19,828	$ 20,423	$ 44,930	$ 85,180	$ 204,181
5. VELMA - Nutrient & mercury modeling	$ 53,889	$ 55,505	$ 176,969	$ 286,362	$ 658,591
6. Sediment fingerprinting	$ 128,220	$ 132,066	$ 325,846	$ 586,131	$ 1,392,298
Totals	$ 258,014	$ 265,755	$ 710,123	$ 1,233,891	$ 2,900,534

State of California Costs	Year 1	Year 2	Year 3	3-year Total
Task	2020/21	2021/22	2022/23	2020-2023
1. Project management & outreach	$ 32,055	$ 33,017	$ 34,008	$ 99,080
2. SPARROW - Nutrient & sediment modeling	$ 48,074	$ 49,516	$ 80,283	$ 177,872
3. SPARROW - Decision support tool	$ 17,912	$ 17,912	$ 17,912	$ 53,735
4. HSPF - Flow, sediment & nutrient transport modeling	$ 34,480	$ 35,515	$ 36,580	$ 106,575
5. VELMA - Nutrient & mercury modeling	$ 92,755	$ 96,522	$ 144,081	$ 333,358
6. Sediment fingerprinting	$ 227,032	$ 229,661	$ 265,290	$ 721,983
Totals	$ 452,308	$ 462,142	$ 578,153	$ 1,492,603

State of California Costs	Year 4	Year 5	Year 6	3-year Total	6-year Total
Task	2023/24	2024/25	2025/26	2023-2026	2020-2026
1. Project management & outreach	$ 16,509	$ 17,004	$ 37,408	$ 70,921	$ 170,001
2. SPARROW - Nutrient & sediment modeling	$ 24,758	$ 25,501	$ 88,311	$ 138,570	$ 316,442
3. SPARROW - Decision support tool	$ 8,956	$ 9,224	$ 19,703	$ 37,883	$ 91,617
4. HSPF - Flow, sediment & nutrient transport modeling	$ 17,757	$ 18,290	$ 40,238	$ 76,285	$ 182,860
5. VELMA - Nutrient & mercury modeling	$ 48,261	$ 49,709	$ 158,489	$ 256,459	$ 589,818
6. Sediment fingerprinting	$ 114,830	$ 118,275	$ 291,819	$ 524,925	$ 1,246,908
Totals	$ 231,071	$ 238,003	$ 635,968	$ 1,105,042	$ 2,597,645

USGS Federal Matching Funds	Year 1	Year 2	Year 3	3-year Total
Task	2020/21	2021/22	2022/23	2020-2023
1. Project management & outreach	$ 3,738	$ 3,850	$ 3,965	$ 11,553
2. SPARROW - Nutrient & sediment modeling	$ 5,605	$ 5,774	$ 9,361	$ 20,740
3. SPARROW - Decision support tool	$ 2,089	$ 2,089	$ 2,089	$ 6,266
4. HSPF - Flow, sediment & nutrient transport modeling	$ 4,020	$ 4,141	$ 4,265	$ 12,427
5. VELMA - Nutrient & mercury modeling	$ 10,815	$ 11,255	$ 16,800	$ 38,870
6. Sediment fingerprinting	$ 26,472	$ 26,779	$ 30,933	$ 84,184
Totals	$ 52,740	$ 53,886	$ 67,413	$ 174,039

USGS Federal Matching Funds	Year 4	Year 5	Year 6	3-year Total	6-year Total
Task	2023/24	2024/25	2025/26	2023-2026	2020-2026
1. Project management & outreach	$ 1,925	$ 1,983	$ 4,362	$ 8,269	$ 19,822
2. SPARROW - Nutrient & sediment modeling	$ 2,887	$ 2,973	$ 10,297	$ 16,157	$ 36,898
3. SPARROW - Decision support tool	$ 1,044	$ 1,076	$ 2,297	$ 4,417	$ 10,683
4. HSPF - Flow, sediment & nutrient transport modeling	$ 2,071	$ 2,133	$ 4,692	$ 8,895	$ 21,322
5. VELMA - Nutrient & mercury modeling	$ 5,627	$ 5,796	$ 18,480	$ 29,903	$ 68,773
6. Sediment fingerprinting	$ 13,389	$ 13,791	$ 34,026	$ 61,207	$ 145,391
Totals	$ 26,943	$ 27,751	$ 74,155	$ 128,849	$ 302,888

Costs by Management Category				
	Year 1	Year 2	Year 3	3-year Total
Category	2020/21	2021/22	2022/23	2020-2023
Labor	$ 296,930	$ 305,837	$ 429,967	$ 1,032,734
Laboratory	$ 167,216	$ 167,562	$ 155,680	$ 490,458
Vehicles	$ 3,105	$ 3,198	$ 2,677	$ 8,980
Supplies	$ 2,523	$ 3,998	$ 2,059	$ 8,580
Communications	$ 776	$ 800	$ 824	$ 2,399
Shipping	$ 776	$ 800	$ 412	$ 1,988
Contracts	$ 30,000	$ 30,000	$ 50,000	$ 110,000
Travel	$ 3,722	$ 3,833	$ 3,948	$ 11,503
Totals	$ 505,048	$ 516,028	$ 645,566	$ 1,666,642

	Year 4	Year 5	Year 6	3-year Total	6-year Total
Category	2023/24	2024/25	2025/26	2023-2026	2020-2026
Labor	$ 152,919	$ 157,506	$ 472,963	$ 783,388	$1,816,122
Laboratory	$ 83,781	$ 86,294	$ 171,248	$ 341,324	$ 831,782
Vehicles	$ 1,599	$ 1,647	$ 2,944	$ 6,191	$ 15,171
Supplies	$ 1,999	$ 2,059	$ 2,265	$ 6,323	$ 14,903
Communications	$ 400	$ 412	$ 906	$ 1,718	$ 4,117
Shipping	$ 400	$ 412	$ 453	$ 1,265	$ 3,252
Contracts	$ 15,000	$ 15,450	$ 55,000	$ 85,450	$ 195,450
Travel	$ 1,917	$ 1,974	$ 4,343	$ 8,234	$ 19,738
Totals	$ 258,014	$ 265,755	$ 710,123	$ 1,233,891	$2,900,534

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Sampling and Analysis Costs, Including New Gages	Year 1	Year 2	Year 3	3-year total
Water Year	2021	2022	2023	
State Fiscal Year	2020/21	2021/22	2022/23	
Sediment Fingerprinting	$ -	$ -	$ 3,838	$ 3,838
Tribs - Water samples - Schedule A (includes Hg and filtered nutrient species)	$ 127,834	$ 134,226	$ 140,937	$ 402,997
Tribs - Water samples - Schedule B (includes filtered nutrient species)	$ 106,794	$ 112,134	$ 117,740	$ 336,668
Tribs - Water samples - Schedule C (includes total N and P only)	$ 97,680	$ 102,564	$ 107,692	$ 307,936
Clear Lake - Cyanotoxins and chlorophyll	$ 76,050	$ 79,853	$ 83,845	$ 239,748
Clear Lake - Sediment Samples	$ 50,000	$ 50,000	$ 50,000	$ 150,000
Total Sampling & Analysis Costs	**$ 458,358**	**$ 478,776**	**$ 504,053**	**$ 1,441,187**

Total cost for 4 new gaging stations	**$ 263,860**	**$ 109,368**	**$ 114,836**	**$ 488,064**
Total Other Infrastructure costs	**$ 8,000**	**$ -**	**$ -**	**$ 8,000**
Total Sampling & Analysis Costs	**$ 458,358**	**$ 478,776**	**$ 504,053**	**$ 1,441,187**
Grand Total Monitoring Costs	**$ 730,218**	**$ 588,144**	**$ 618,889**	**$ 1,937,251**
percent by year	38%	30%	32%	100%

Appendix I: Committee Letters of Support

Letter of Support for Reinstatement of Funds for Long-Term Clear Lake Water Quality Monitoring

September 23, 2020

Hon. Gavin Newsom, Governor
Hon. Cecilia Aguiar-Curry, CA State Assembly
Hon. Mike McGuire, CA Senate
Sec. Wade Crowfoot, CA Natural Resources Agency

On behalf of the Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee), I am writing to respectfully request a reinstatement of funds for the long-term Clear Lake water quality monitoring and sampling conducted by the California Department of Water Resources (DWR). All Committee members approved this letter and expressed their support for funding this effort in the County of Lake (County) on September 23, 2020.

Since 1968, DWR has conducted ambient water quality monitoring and sampling of Clear Lake. Data derived from this sampling allows the State, County, tribes, and other impacted local organizations to identify and track key nutrients and potential contaminants. This publicly available water quality information is essential for making water quality management decisions for Clear Lake and dependent downstream areas, including the Cache Creek Watershed and ultimately, the California Delta. It is also supportive of California's effort to increase monitoring on streams as part of SB 19 (2019).

Although we are acutely aware of challenges posed by the economic downturn and the COVID-19 pandemic, a relatively small investment in a consistent water quality monitoring program has significant management and research implications. Without the consistent efforts and expertise of DWR, it is unlikely sampling will occur on a regular basis for the foreseeable future. This will likely impact not just County water quality management efforts, but also the 17 public and private drinking water supplier operations around Clear Lake, downstream water users, and the environment.

Furthermore, ongoing research to create a full understanding of environmental challenges facing Clear Lake is structured to heavily rely on this ambient monitoring to create accurate models. In conjunction with the efforts of the Committee, these models are expected to provide a first ever scientific understanding of in-lake and watershed processes. Models will be used to develop specific management actions and projects to improve water quality conditions and the environment of California's largest natural lake. This monitoring will also be needed to assess post management action success, an essential tool to evaluate and maximize Blue Ribbon Committee, and other water quality improvement efforts. The Committee supports a reinstatement of funding for a continuation of monitoring and sampling in Clear Lake and believes DWR's expertise and history of implementing the effort is invaluable. The information stemming from this sampling effort will assist in creating a more sustainable water supply for County residents and create opportunities for the restoration and enhancement of one of California's most unique water bodies in the face of ever-increasing environmental pressures. We appreciate your careful consideration of this request.

Sincerely,

Eric L Sklar

Eric Sklar
Committee Chair

Appendix I: Committee Letters of Support

Letter of Support for a Continuation of Funding UC Davis Clear Lake Research

September 23, 2020

Hon. Gavin Newsom, Governor
Hon. Cecilia Aguiar-Curry, CA State Assembly
Hon. Mike McGuire, CA Senate
Sec. Wade Crowfoot, CA Natural Resources Agency

On behalf of the Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee), I am writing to respectfully request an extension of funds for research programs in the Clear Lake Basin conducted by the UC Davis Tahoe Environmental Research Center (TERC) and Center for Regional Change (CRC). All Committee members approved this letter and expressed their support for funding this effort in the County of Lake (County) on September 23, 2020.

Since 2017, TERC and CRC have engaged in long-term research efforts to better understand in-lake processes driving environmental challenges in Clear Lake, as well as socioeconomic pressures impacting Clear Lake communities.

TERC is in the process of developing a dynamic hydrologic model of lake processes for the largest natural lake in California. This model will provide a first of its kind look at the key drivers of environmental challenges such as cyanobacteria and cyanotoxin production in the Lake. As a key partner in the Committee process, TERC is designing it model to integrate with a broader watershed-wide model recommended by the Committee in its 2019 Annual Report. Combined, these models are expected to provide essential information for the development of specific management actions and projects to improve environmental conditions in and around the Lake. If funding is unavailable, research activities will cease in Spring 2021. Future funding to reinstate the research program will necessarily be increased due to new startup costs.

Similarly, CRC is engaged in socioeconomic research to identify the conditions driving poor economic growth opportunities in Lake County. The communities adjacent to Clear Lake have been hard hit by natural disasters, notably by significant wildfires in four of the last five years. Moreover, some residents of neighboring communities that have been displaced from their homes have turned to Clear Lake communities for temporary and permanent housing. These disasters highlight how important and urgent the need for data-driven decision-making by local jurisdictions and state agencies. This research can inform important state priorities, including affordable housing, economic development, and assisting vulnerable communities such as youth and Tribal communities. Similar to TERC, if funding is prematurely halted and reinstated in the future, significant start up costs can be expected, resulting in a more costly research effort.

The Committee supports a continuation of funding for the TERC and CRC research efforts. The information stemming from this research will assist in creating more sustainable physical *as well as* economic environments for Clear Lake and its surrounding communities. We appreciate your careful consideration of this request.

Sincerely,

Eric L Sklar

Eric Sklar
Committee Chair

Appendix I: Committee Letters of Support

Letter of Support for the Middle Creek Restoration Project

August 15, 2020

Hon. Gavin Newsom, Governor
Hon. Cecilia Aguiar Curry, CA State Assembly
Hon. Mike Maguire, CA Senate

On behalf of the Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee), I am writing to respectfully to urge your support for the Middle Creek Flood Damage Reduction and Ecosystem Restoration Project (Project). All Committee members approved this letter and expressed their support for the Project on March 11, 2020.

Since 1995, the County of Lake has worked with Lead Federal Agency, the United States Army Corps of Engineers, in this ongoing effort to acquire 1,650 acres of reclaimed land at the North end of Clear Lake and restore it to wetlands.

Although the Project's stated goals are flood damage reduction and ecosystem restoration, substantial water quality improvement is anticipated. Additionally, the Project is expected to provide critical improvements to terrestrial, aquatic, and bird habitats, as well as public access for recreation. The Central Valley Regional Water Quality Control Board describes the project as a key element in efforts to fulfill requirements of the Clean Water Act for Clear Lake.

Restored wetlands will filter water and intercept sediment from the Scotts Creek and Middle Creek Watersheds, which contribute an estimated 57% of the water inflow and 71% of the sediment load to the Clear Lake ecosystem. Sediment supplies 97% of Clear Lake's phosphorus, the critical plant nutrient that empowers the overgrowth of the ecosystem's plants, including Harmful Algal Blooms. Additionally, a projected 34% decrease in chlorophyll concentration would also upgrade the Lake as our drinking water source and improve water clarity for our tourism-dependent economy.

The return of the reclaimed land to marsh also supports traditional uses and actions by tribal groups in the area and serves as a significant step forward to implement the Governor's California Water Resilience Portfolio.

Since 2003, some $12.7 million has been expended on purchase of over 725 acres in the project zone and on relocation of residences and businesses. A 2018 influx of $15 million is allowing resumption of acquisitions. All funds, derived from Water Bonds, have been granted through the Flood Protection Corridor Program of the California Department of Water Resources in the State's Natural Resource Agency.

The Committee, initiated by AB 707 (Aguiar Curry), consists of fourteen individuals with a unique knowledge of Lake County and its history; our job is to provide actionable and reasonable recommendations for the rehabilitation of Clear Lake. We endorse the Project as a key measure to rehabilitate the Lake and achieve the goals of AB 707. The agencies and organizations we represent see it as a significant, worthwhile undertaking and urge again continued support for the Project from the State of California.

Sincerely,

Eric Sklar Eric Sklar
Committee Chair Committee Chair
California Natural Resources Agency

Cc: Congressman Mike Thomson
Congressman John Garamendi