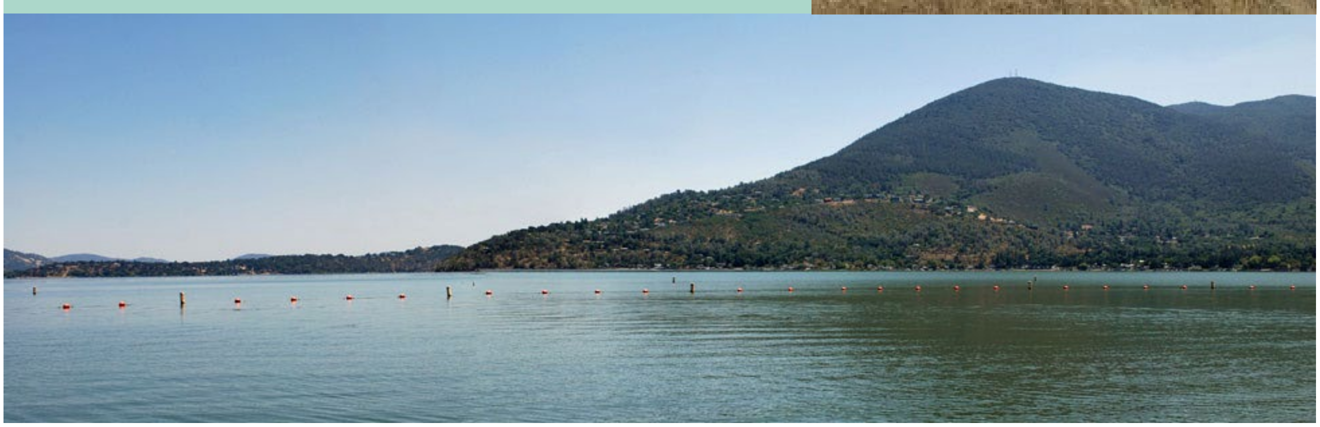
2021 Report to the Governor of California and California State Legislature

AB 707
Blue Ribbon Committee for the Rehabilitation of Clear Lake

January 12, 2022



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

Prepared by: The Consensus and Collaboration Program, College of Continuing Education, Sacramento State University

GAVIN NEWSOM, Governor
WADE CROWFOOT, Secretary for Natural Resources

Blue Ribbon Committee for the Rehabilitation of Clear Lake

2021 Report to the Governor and California State Legislature

January 1, 2022

Contents

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 California Department of Fish and Wildlife (CDFW). 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 third 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 progress to date and implementation steps for the Committee's 2021 recommendations in Sections 5 and 6 below, which include 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.

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

Section 2: Status of 2020 Recommendation Implementation and Progress to Date

All recommendations included in the 2020 Annual Report and approved by the Committee were fully funded in the 2021 State Budget. These recommendations are focused primarily on research and data collection to better understand the physical processes and issues associated with the health of the lake, with a particular focus on the causes of harmful algal blooms (HABs).

The status of each recommendation is as follows:

- Extension of funding for UC Davis in-lake monitoring and modeling: <u>funded and contract executed; work underway</u>
- Upper watershed monitoring and modeling<u>: funded and contract executed; work underway</u>
- Bathymetry survey; <u>funded and contract executed</u>
- Review of Best Management Practices (BMPs) implementation: <u>funded; scope under development</u>
- Public perception survey and water quality assessment: <u>funded; scope under development</u>

A complete overview of 2020 recommendations is available in the 2021 Annual Report, available online here.

Section 3: 2021 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 2021. 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 A**.

Committee Process to Date

The Committee met five times in 2021. 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. The annual process of engagement between the Committee and the subcommittees is outlined in **Appendix B**.

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

Meeting Date	**Summary**
March 1, 2021	Special Committee meeting to discuss immediate funding for a continuation of in-lake and upper watershed monitoring and modeling by UC Davis and the US Geological Survey (USGS). A summary is available online here.
April 1, 2021	Staff and consultants provided funding and research updates related to 2020 recommendations. Committee members discussed prioritization of remaining recommendations pending funding availability. A summary is available online here.
June 23, 2021	Committee members discussed DRAFT 2021 recommendations, including a straw poll to understand Committee perspectives. A summary is available online here.
September 23, 2021	Committee members discussed approval of DRAFT 2021 recommendations. Summary available online here.
December 2, 2021	Committee members approved final recommendations and this annual report. Additionally, they discussed the process for submitting/approving recommendations in 2022.

Table 1: 2021 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 A**.

The Subcommittee met seven times in 2021. The table below includes a meeting schedule and brief summary of topics discussed during each session.

Meeting Date	**Summary**
January 28, 2021	Members reviewed criteria for Proposition 68 project submissions and funding needs to implement 2020 recommendations. A summary is available online here.

March 25, 2021	Members received funding updates on 2020 recommendations a presentation on potential products to improve water quality. A summary is available online here.
April 22, 2021	Members reviewed potential 2021 recommendations. A summary is available online here.
May 27,2021	Members continued refinement of potential 2021 recommendations for consideration by the Committee at its June 23 meeting.
July 22, 2021	Members discussed the US Fish and Wildlife Clear Lake Hitch Recovery Strategy, California Department of Water Resources long-term datasets on water quality, and continued refinement of 2021 recommendations.
August 26, 2021	Members finalized recommendations for consideration by the full Committee at its September 23rd meeting.
October 28, 2021	Members received updates on projects approved at the September 23rd Committee meeting and a presentation on the USGS Hitch Research Program.

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 participants is included in **Appendix A**.

This subcommittee met three times in 2021. 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**
April 20, 2021	Members discussed UC Davis Center for Regional Change (CRC) research and work group outcomes. A summary is available online here.
June 3, 2021	Members discussed a proposal for the development of a Clear Lake water lab and environmental education proposals.
August 17, 2021	Members continued refinement of environmental education proposals for consideration by the Committee at its September 23rd meeting.

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**.

Finally, numerous Tribal environmental research and restoration programs have been active in and around Clear Lake for many years. These include, but are not limited to, long-term monitoring of cyanotoxins and HABs, mercury monitoring and remediation from legacy issues such as the Sulphur Bank Mercury Mine, and a wide variety of localized restoration projects and programs. Tribes in and around Clear Lake play a vital role in maintaining and improving the health of the Lake.

<u>TERC Information</u>

UC Davis TERC conducted significant research activities in 2021 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.**

<u>CRC Information</u>

The UC Davis CRC conducted ongoing research to develop an economic development strategy for Clear Lake communities in 2021. A summary of CRC's progress to date and next steps is included in **Appendix D**.

<u>Clear Lake Ongoing Cyanotoxin Monitoring Information</u>

The Big Valley Band of Pomo Indians and Elem Indian Colony conducted cyanotoxin monitoring on Clear Lake in 2021 (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 2021, the Committee and Technical Subcommittee continued its 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, local cyanotoxin monitoring efforts as discussed above, and parallel research efforts at UC Davis.

Recommendations approved by the Committee in 2020 and funded in 2021 will seek to quantitatively understand the causes of and provide recommendations to improve these water quality issues. Research outcomes are expected in 2022 and 2023.

As the Committee awaits these long-term research results, in 2021 it focused on a series of recommendations (discussed in **Section 5** below) to address discreet issues within the Clear Lake watershed such as increasing spawning habitat, refuse removal, stormwater discharge planning and remediation, mercury modeling, and native vegetation restoration.

Section 5: 2021 Committee Recommendations and Implementation Steps

This section provides an overview of projects approved by the Committee on December 2, 2021. In 2021, the Committee requests a total of **$3,559,786** from grant or general fund allocations for the projects discussed in **Section 5.1 and 5.2** below. [2]

Additionally, the Committee approved **$600,000** in funding for continued social and economic research by UC Davis in 2020. This funding was included in the 2021/22 California State Budget. Specific recommendations utilizing a portion of this funding are discussed in Section 5.2 below.

Each project description below includes:

- Project title

---

[2] As part of the AB 707 process, $5 million in funds from Proposition 68 were allocated to the Committee for capital improvement and environmental restoration projects meeting the criteria of Resources Proposition 68 Specified River Parkways Grant Guidelines/Procedural Guide, available online here.

- Local project sponsor/contact information
- Total amount requested
- Suggested funding source
- Implementation timeframe
- A short overview of the project

A summary of funded projects, including funding sources, is listed below. These projects are fully funded from General Fund allocations in the FY 2021/22 State Budget and the Committee's allocation of Proposition 68 funds committed as part of the AB 707 (Aguiar-Curry, 2017) process. Grant agreements are under development by Resources and the project sponsors listed in the table below.

Project Title	**Requested Amount**	**Funding Source**	**Project Sponsor**
Clear Lake Dilapidated Structure Abatement	$250,000	Proposition 68	Lake County Water Resources Department
Kelsey Creek Fish Ladder Restoration	$626,000	Proposition 68	Big Valley Band of Pomo Indians
Lake County Stormwater and Trash Remediation	$706,700	Proposition 68	Lake County Water Resources Department
Mercury Modeling	$992,850	General Fund	US Geological Survey
Tule Replanting/Invasive Aquatic Vegetation Removal	$63,800	Proposition 68	Big Valley Band of Pomo Indians
Piloting Environmental Education Resources	$280,000	General Fund	UC Davis
Environmental Education Program Evaluation	$50,000	General Fund	UC Davis
Cobb Mountain Watershed Education Program	$30,000	General Fund	Siegler Springs Community Association

Figure 5A: Funding Summary of 2021 Projects

Section 5.1: Technical and Environmental Restoration Projects

Clear Lake Dilapidated Structure Abatement

- Local sponsor: Lake Count Water Resources Department; William Fox; William.fox@lakecountyca.gov
- Total amount requested: $250,000
- Suggested funding source: Proposition 68 funding allocation to the Committee
- Implementation timeframe: Immediately- project is ongoing as additional structures are identified.

Project Overview: Over the years, numerous structures such as docks, seawalls, boathouses, and piers have been built along the shoreline of Clear Lake and in the lake itself. Many of these structures have fallen into disrepair, causing environmental, navigation, and public safety hazards. Lake County proposes establishing a revolving fund to abate the structures and will use approximately $75,000 in local funds to start the process. However, additional funding is required to maintain the program until such time as it becomes self-supporting through fee assessments on property transfers. Early funding of the program is important, as the Lake County landfill will stop accepting treated wood in the near term. Moreover, low water levels caused by the ongoing drought make structures more easily accessible, reducing the cost of abating individual structures. A complete project workplan is available upon request.

Kelsey Creek Fish Ladder Restoration

- Local sponsor: Big Valley Band of Pomo Indians; Sarah Ryan; sryan@big-valley.net
- Total amount requested: $626,000
- Suggested funding source: Proposition 68 funding allocation to the Committee
- Implementation timeframe: Upon completion of California Environmental Quality Act (CEQA) review

Project Overview: A fish ladder to allow migration and spawning of the Clear Lake Hitch/Chi was built many years ago at the Main Street Bridge over Kelsey Creek in Kelseyville, California. Over time, the structure has fallen into disrepair and now impedes both flow into Clear Lake and fish migration upstream. The derelict structure also poses scouring issues to bridge footings. Big Valley Pomo has prepared a detailed project plan, including complete design build specifications, to replace the structure using modern design and construction methods. This will reconnect fish migration to upstream spawning areas and reduce scour on the bridge. They are currently working on required CEQA documentation but lack funds for project implementation.

Lake County Trash Remediation

- Local sponsor: Lake County Water Resources Department; Angela DePalma-Dow; angela.depalma-dow@lakecountyca.gov
- Total amount requested: $706,700
- Suggested funding source: Combination of Proposition 68 allocation to the Committee and new budget request
- Implementation timeframe: Upon appropriation of Funding

Project Overview: Lake County Water Resources Department (WRD) has developed a trash remediation plan to remove refuse in the shorezone and throughout the Clear Lake area. This project implements that plan and will immediately result in a cleaner, healthier watershed. More information on that plan is available online at http://www.lakecountyca.gov/Government/Directory/WaterResources.htm.

Mercury Modeling

- Project sponsor: UC Davis Tahoe Environmental Research Center (TERC)/US Geological Survey (USGS)
- Total amount requested: $992,850
- Suggested funding source: New budget request
- Implementation timeframe: Upon allocation of funding

Project Overview: The Committee previous approved research projects associated with monitoring and modeling potential sediment/nutrient sources upstream of Clear Lake. The expectation is these efforts will result in specific recommendations to identify causes of and remediation options for harmful algal blooms (HABs). In addition to HABs, Clear Lake is also severely impacted by legacy mercury mining operations, most notably the Sulphur Bank Mercury Mine Superfund Site, managed by the US Environmental Protection Agency (US EPA). While the major source of mercury contamination is well understood and cleanup efforts are underway, it is not known *how* mercury moves through Clear Lake, which sediments are most contaminated, and where remediation efforts should target mercury already in the system. The TERC/USGS team proposes a modeling effort to better understand the movement of mercury-laden sediment. US EPA has contributed the raw data needed to begin modeling development, as well as $75,000 in matching funds. TERC and USGS have developed a detailed 3-year project plan and budget; the project can begin on appropriation of new funding.

Tule Replanting/Invasive Aquatic Vegetation Removal

- Local sponsor: Big Valley Band of Pomo Indians; Sarah Ryan; sryan@big-valley.net
- Total amount requested: $63,800
- Suggested funding source: Proposition 68 funding allocation to the Committee

- Implementation timeframe: Upon allocation of funds

Project Overview: Native tules provide critical natural filtration, spawning/rearing habitat, and lakebed/shoreline stabilization benefits to Clear Lake. They are also used extensively as a key Tribal resource by all Tribes in the region for a wide variety of purposes. However, over the years tules have been removed to increase shoreline access and outcompeted by nuisance/invasive aquatic vegetation such as primrose. By creating a pilot program to remove invasive species and replant areas with native tules, the benefits listed above can be realized on a larger scale than currently exists. Big Valley expects this pilot program will be replicated throughout Clear Lake in appropriate areas as they are identified and has more than 10 years of successful experience on its own Tribal lands.

Section 5.2: Environmental Education Projects

In addition to understanding and addressing environmental concerns associated with Clear Lake, Committee members directed the Socioeconomic Subcommittee to develop recommendations associated with environmental education. The primary goal of these recommendations is to educate students of all ages and the general public about the unique environmental resources of Clear Lake and the surrounding areas.

Piloting Environmental Education Resources

- Project sponsor: UC Davis; Bernadette Austin; braustin@ucdavis.edu
- Total amount requested: $280,000
- Suggested funding source: Funding available from approved 2020 Committee recommendations
- Implementation timeframe: 2 years upon scope approval by the Committee and contract execution by Resources

Project Overview: Participatory approaches that involve diverse publics in research and monitoring -- also known as community and citizen science (CCS) -- have demonstrated evidence for advancing environmental education goals such as environmental literacy and stewardship behaviors and benefits to the community, while also generating valuable data for researchers and local community decision-makers.

The UC Davis Center for Community and Citizen Science, Center for Regional Change, and Tahoe Environmental Research Center (collectively referred to here as the UCD Team), will work with key local partners (including the seven Tribal nations and local governments, non-profit organizations, educators, and other community partners) to identify existing environmental educational (EE) resources and programs to build on these to develop and pilot a CCS education project that can support ongoing lake-area research and be conducted by community partners including youth from Clear Lake communities.

The UCD Team will support the development of Clear Lake focused environmental education (EE) through the development and piloting of resources framed around and engaging with lake-oriented research by Tribes, UC Davis, public agencies, non-profit organizations and other entities. This EE project would curate and adapt existing EE resources from both the Clear Lake region and beyond (such as Lake Tahoe) to be able to leverage work already being done in and around the lake. Those resources would then be synthesized for non-formal educational settings to support piloting youth engagement with the citizen science monitoring program and qualitative data collection focused on environmental stewardship.

Environmental Education Program Evaluation

- Project sponsor: UC Davis; Bernadette Austin; braustin@ucdavis.edu
- Total amount requested: $50,000
- Suggested funding source: Funding available from approved 2020 Committee recommendations
- Implementation timeframe: 2 years upon contract execution

Project Overview: A mixed methods evaluation using developmental, participatory and culturally responsive evaluation frameworks will be conducted with all the relevant stakeholders like Clear Lake residents, Tribes, funders, policy makers, program staff and others identified by the team. The goal of this evaluation will be to identify the social, economical, and cultural factors needed for successful implementation of environmental education programs in the Clear Lake region.

Evaluation methods include observation, interviews (individual and focus groups), surveys, and any other methods that might emerge as the project enfolds with the participation from all relevant stakeholders. The evaluation results are expected to help with educational, community and economic development policy making in the Clear Lake region.

Cobb Mountain Watershed Education Program

- Project sponsor: Cobb Area Council; Elliot Hurwitz; elioth@sscra.org
- Total amount requested: $30,000
- Suggested funding source: Resources allocation from existing Committee funding
- Implementation timeframe: Immediately upon execution of contract

Project Overview: Recognizing that the health of Clear Lake is inextricably tied to the overall health of the Clear Lake Watershed and the responsible stewardship practices engaged in by residents in the entire basin, the proposed WEP targets the Cobb Mountain community, which include the Kelsey Creek, Adobe Creek and Cole Creek watersheds and proposes a five session program of education and field trips, concluding with an exercise to make specific recommendations, including Best Practices, to the Cobb Area Council, and its “Forest Stewardship Working Group” (currently in formation).

These areas also play a critical role for Tribes and fall within the ancestral lands of Middletown Rancheria and Big Valley Band of Pomo Indians. Project sponsors will work in partnerships with local Tribes to develop curriculum and protect Tribal resources.

This program can serve as a template or pilot project for other communities in upland communities in Lake County.

Participation in the program will be developed in partnership and offered to local residents who have significant influence on local stewardship practices including:

- Tribes
- Local schoolteachers (Cobb Mt Elementary)
- Local high school students
- Members of the Cobb Area Council (CAC) and committee chairs
- Significant landowners in the watershed
- Forest management practitioners
- Staff at the Boggs Mountain State Demonstration Forest
- Members of the CAC Forest Stewardship Working Group

Additional Projects for Further Refinement

In addition to the environmental education proposals discussed above, the Committee also discussed two additional recommendations for consideration. The status and a short overview of each project is listed below:

- Citizen Science and Community Science Environmental Monitoring Application: UC Davis has proposed the development of digital app to engage community members in data collection on the health of Clear Lake based on the Citizen Science Tahoe Program.[3] Through discussions with Committee members and UC Davis staff, this recommendation will continue to be discussed and refined as part of the Committee's 2022 deliberations.
- Clear Lake Science Center: The concept of a teaching, learning, and hands-on science center in Clear Lake has been discussed extensively by the Committee's Socioeconomic Subcommittee. A science center could provide local research resources for water science and monitoring, as well as serve as a facility for hands-on learning about the unique Clear Lake environment for interested members of the public. This concept will continue to be discussed and refined as part of the Committee's 2022 deliberations.

[3] https://citizensciencetahoe.org/home

Appendix A: Committee and Subcommittee Rosters

Blue Ribbon Committee Member 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
VACANT	Tribal Representative	Elem Indian Colony
Tracy Treppa	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
Temashio Anderson	Tribal Representative	Robinson Rancheria

Appendix A: Committee and Subcommittee Rosters

Technical Subcommittee Roster/Participants

NAME	ORGANIZATION OR INTERST
Alex Forest	UC Davis Tahoe Environmental Research Center (TERC)
Alicia Cortes	TERC
Angela DePalma Dow	Lake County Water Resources Department
Broc Zoller	Lake County Agriculture
Charles Alpers	US Geological Survey (USGS)
Dina Saleh	USGS
Geoff Schladow	TERC
Jim Steele	At large
Joe Domaglaski	USGS
Karola Kennedy (Co-Chair)	Koi Nation of Northern California, Blue Ribbon Committee
Sarah Ryan (Co-Chair)	Big Valley Band of Pomo Indians, Blue Ribbon Committee

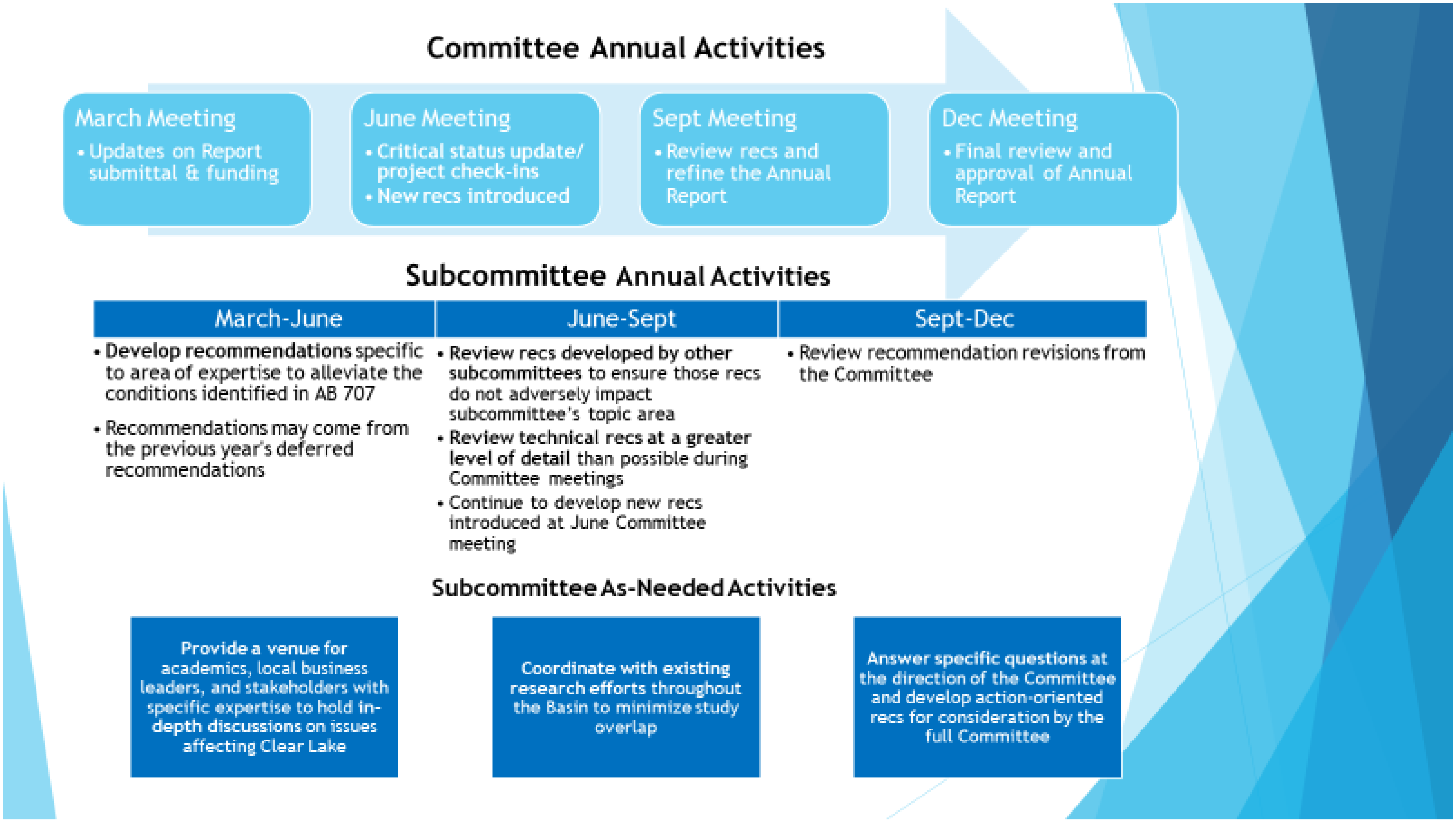
Socioeconomic Subcommittee Roster/Participants

NAME	ORGANIZATION OR INTEREST
Amanda Martin	Manda CoVentures
Bernadette Austin	UC Davis Center for Regional Change
Brock Falkenberg	County Superintendent of Schools
Carolyn Holladay	Lake County Health Services
Christopher Taliaferro	Employment Development Department
Cirilo Cortez	Woodland Community College Lake County Campus
Clare Cannon	UC Davis Center for Regional Change
Eliot Hurwitz	Cobb Area Council
Ernesto Padilla	Lake County Tribal Health Consortium
Jonathan London	UC Davis Center for Regional Change
Jorge Garcia	Konocti Vista Casino, Resort & Marina
Lisa Wilson	Clear Lake Campground and City of Clearlake Planning Commission
Michelle Scully	EDC Board, Tourism Improvement District Board
Monic Flores	Mendocino College/Lake Center
Monica Rosenthal	Lake County EDC, Lake County Fair
Morgen Jarus	Sutter Lakeside Hospital/Lake County Chamber
Rob Eyler	Economic Forensics and Analytics, Inc.
Roberta Lyons	Lake County Land Trust/Anderson Marsh Interpretive Association
Russ Hamel	Konocti Harbor Resort
Susan Jen	Health Leadership Network
TeMashio Anderson	Robinson Rancheria, Blue Ribbon Committee

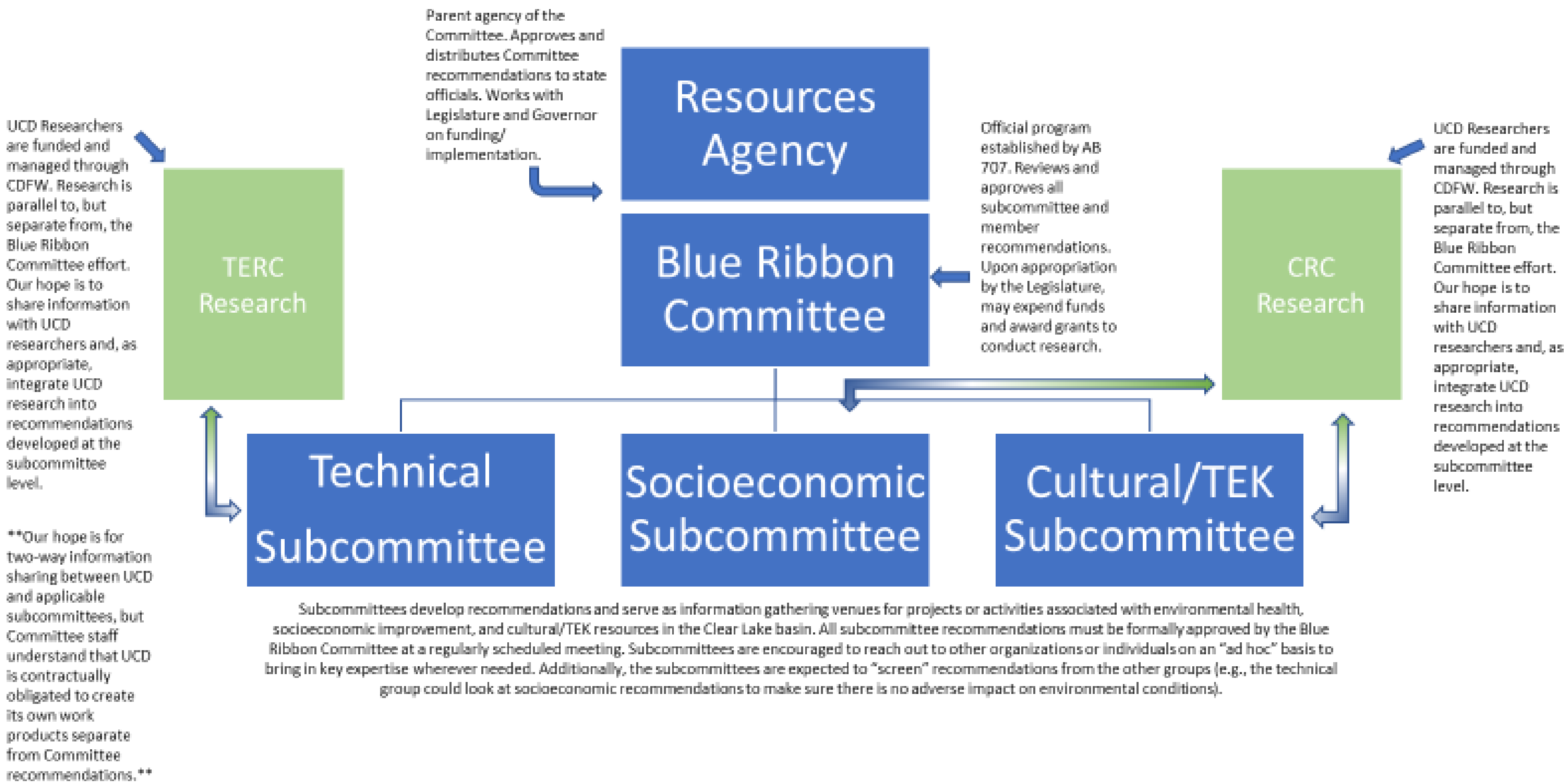
Appendix A: Committee and Subcommittee Rosters

Terre Logsdon (Co-Chair)	Scotts Valley Band of Pomo Indians, Blue Ribbon Committee
Valerie Cox	Hope City
Wilda Shock (Co-Chair)	Lake County Economic Development Corporation, Blue Ribbon Committee
Will Evans	Clear Lake Environmental Research Center

Appendix B: Committee Annual Process Organization Chart



Committee Organizational Chart



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

2021 Annual Research Update for the Blue Ribbon Committee

UC Davis Tahoe Environmental Research Center

Geoffrey Schladow, Alexander Forrest, Steven Sadro, Alicia Cortés, Micah Swann, Samantha L. Sharp, Ruth Thirkill, Kanarat Pinkanjananavee

December 2021

Contents

1. Barriers to Improving Water Quality at Clear Lake

Clear Lake faces numerous water quality challenges, but 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 forcings, 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 restoration projects or 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 challenges include:

- *Increasing Water Temperatures* - Lake water temperatures are increasing globally, and is likely the case at Clear Lake, too. Aside from the direct effect of higher temperatures on community composition, ecosystem metabolic rates, and biogeochemical 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.
- *Extended Periods of Anoxia* - Low dissolved oxygen (DO) events in the deep water are known to occur episodically, producing fish kills, the release of nutrients through a phenomenon known as "internal loading", the 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 to make these solutions feasible and cost-effective.
- *Climatic Eutrophication* - High concentrations and loading of nutrients (nitrogen and phosphorus) fuel eutrophication and contribute to cyanobacterial blooms. 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 address eutrophication in Clear Lake.

- *Increased Frequency of Harmful Algal Blooms* - Harmful algal blooms and the prevalence of cyanotoxins are dependent in part on many of the other water quality problems listed above. Increasing frequency, biomass, duration, and distribution of both algal blooms and *cyanobacterial* blooms remain critical problems. 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 several restoration projects. Warming temperatures need to be accounted for in the design of these projects.

- *Elevated Mercury Levels* - 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 is a range of engineering options for controlling mercury release to the water and the food web.
- *Ecosystem Shifts* - 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.
- *Increasing exposure of lakes to wildfires* – Increasing wildfire activity has dramatically increased in the last years in the Clear Lake watershed, including increases in fire season length and area burned. Very few studies assess wildfire effects in freshwater bodies. Recent efforts have been focused on developing a framework of how wildfires may influence the physical, chemical, and biological properties of aquatic ecosystems such as Clear Lake.

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 2021

3.1. Continued data collection for lake, meteorology, and streams

We continued the high-resolution data acquisition for (1) stream properties at three locations (Middle, Scott, 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 (six permanent water quality stations). In addition, we made measurements of particle size in the water during each of the routine monitoring events as part of our ongoing research on the impact of wildfire smoke on lakes. We also measured nutrient concentrations throughout the water column and across all three lake basins during seven sampling events in 2021. The water samples were analyzed for dissolved and particulate forms of nitrogen, phosphorus, and carbon; chlorophyll; and particle size distribution. The field effort was led by graduate students Micah Swann, Ruth Thirkill, Samantha Sharp, and Kanarat Pinkanjananavee, together with assistance from undergraduate students. The laboratory chemical analysis was led by Anne Liston, Steven Sesma, Lindsay Vaughn, and Tina Hammel, with assistance from graduate and undergraduate students. All of these data are critical for the ongoing development of the numerical models of physical transport and lake production and in better understanding the range of solutions that may be applied in the future. Samples were also collected for phytoplankton identification and quantification and zooplankton identification. The latter have been preserved and will be analyzed if funds become available. Water samples were also collected for the Big Valley Band of Pomo Indians for their cyanobacteria monitoring program. In the last three months of 2021 data collection has been particularly challenging due to the unprecedented low lake levels and the difficulties this presents in launching research vessels. We are particularly grateful for the assistance provided by Lake County.

We also continue our collaboration with the US Geological Survey (USGS) to find a surrogate for mercury that can be monitored continuously using high-resolution sensors, such as the YSI-EXO probes. These instruments have been installed since spring 2020 in our permanent water quality station in the Oaks Arm to develop regressions between time series of chromophoric dissolved organic matter (CDOM) and mercury.

All data are 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.

3.2. Watershed monitoring: USGS-TERC-Lake County

In addition to the in-lake monitoring, we are collaborating with USGS and Lake County to conduct a 3-year upper watershed monitoring study as part of the 2021 BRC-recommended funding. Data collection successfully commenced in fall 2021. Flow permitting, we are planning to sample up to 15 tributaries (natural creeks and culverts) up to 12 times a year. USGS and DWR will be responsible for the sampling. The analytical constituents will vary depending on the sample, but they can be filtered and unfiltered nutrients (N and P), mercury species, and metals. Analyses will be run both at USGS and TERC's labs.

3.3. Interactions with Clear Lake tribes and stakeholders

Interactions with Clear Lake tribes and other stakeholders continue to be a high priority. In 2021, in addition to the previously mentioned cyanobacteria sample collection, we have interacted with Big Valley Rancheria and their consultants to provide advice for the installation of real-time sensors for the monitoring of in-lake dissolved oxygen required for their fish kill project. We have also offered to train tribal members to be able to work with us on ongoing data collection. We are working with Lake County to set up a filtering station for the stream water samples collected during the watershed monitoring program. Our graduate student Kanarat Pinkanjananavee is collaborating with Buckingham Park Water District to analyze disinfection by-products. Geoff Schladow has been collaborating with Clear Lake tribe members and other stakeholders on the goals for future education programs.

3.4. Quantifying external and internal phosphorus loading in Clear Lake

Fueled by excessive nutrient concentrations, principally phosphorus (P), harmful cyanobacteria blooms (HABs) occur across much of Clear Lake during the summer and fall each year. Phosphorus is derived from both external sources (i.e., runoff from agricultural and urban areas conveyed into the lake via streamflows and urban flows) and internal sources (i.e., recycling of legacy phosphorus pools released from lake sediments). Internal loading of phosphorus can be caused by anoxic conditions in the sediment, benthic bioturbation, and mechanical resuspension. While significant mitigation and restoration efforts have been implemented to reduce external, watershed inputs of P, limiting the contribution of internal loading has received far less attention. To investigate the timing and relative contribution of each loading source to the lake's phosphorus budget, our graduate student Micah Swann has quantified external and internal phosphorus loads to Clear Lake for a two-year period (2019-2020).

Watershed phosphorus loads were calculated utilizing streamflow data and stream-specific linear regressions relating discharge to total phosphorus (TP) concentration. Integrating over a stream's hydrograph, a total mass of phosphorus loaded into the lake from each stream was quantified and then a cumulative load from all sub-watersheds was estimated. Internal phosphorus loading was calculated using two different methods. Anoxic and oxic sediment P release rates were quantified by laboratory chamber experiments while the spatial and temporal extent of anoxia was measured by moored hypolimnion dissolved oxygen sensors throughout Clear Lake's three arms.

A preliminary whole-lake mass balance for 2019-2020, depicting monthly estimates of external and internal loads, is shown in Figure 1. In both years, the cumulative external load from the previous water year (~183 tons in 2019 and 20.5 tons in 2020) was significantly smaller than the net observed internal load, 384 and 616 tons in 2019 and 2020 respectively and thus internal recycling of phosphorus accounted for 75-95% of the annual phosphorus load during the period, with the relative magnitude of internal loading increasing dramatically under drought conditions. The magnitude of the internal load highlights the need to focus restoration strategies on mitigating internal sources in addition to controlling watershed inputs.

Modeled internal loads released via diffusion from anoxic sediments closely agreed with the observed increase in water column TP in the lake's two deeper arms (Oaks and Lower). However, in the large and shallow Upper Arm, theoretical estimates significantly unpredicted the observed increase of TP. The discrepancy between observed and theoretical internal P load estimates in the Upper Arm is a current research focus. This research highlights that while external load reductions are necessary to rehabilitate lake water quality in the long term, understanding the mechanisms and timing of internal loading will be necessary to effectively manage Clear Lake in the future.

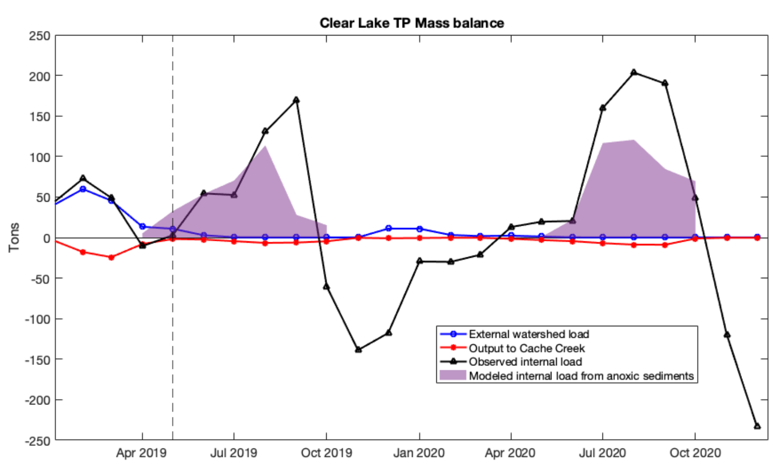


Figure 1 – Total phosphorus mass balance for Clear Lake (2019-2020). Dashed vertical line indicates the start of the UC Davis Lake monitoring program.

3.5. Measurement of cyanobacteria blooms

We have continued our efforts to measure cyanobacteria blooms in Clear Lake using a variety of remote sensing methods. The work from the 2019 study was published this past year in Frontiers in Environmental Science by our graduate student Samantha Sharp (https://www.frontiersin.org/articles/10.3389/fenvs.2021.612934/full). This work included the measurement of cyanobacteria blooms in Clear Lake across scales of multiplatform remote sensing tools. These tools included measurement by discrete sampling, autonomous underwater vehicles (AUV), unmanned aerial vehicles (UAV) or drones, and satellite-based sampling and calculation of the Cyanobacteria Index (CI). Sampling across scales allowed us to gain a synoptic view of the cyanobacteria bloom and quantify its spatial variability (Figure 2). We identified two shortcomings of these methods in this study: (1) daytime fluorometer measurements (such as those on the AUV) are impacted by a process known as non-photochemical quenching (NPQ), and (2) a limitation of the CI remote sensing algorithm is that it tells you a relative abundance of cyanobacteria and not the specific species present and whether those species are toxin-producing cyanobacteria.

These are the focus of two new research efforts commenced in 2021 by Samantha Sharp, through her graduate student fellowship with NASA.

1. The first project will develop a correction method for NPQ-impacts to fluorometer measurements. This project includes data collection at Clear Lake and Lake Tahoe to develop a correction method based on solar radiation.

2. The second project is to evaluate the use of hyperspectral data to determine cyanobacteria bloom types based on the dominant species present. Hyperspectral data is a measurement of reflectance across hundreds of wavelengths, which contrasts to the tens of wavelengths measured by multispectral sensors, such as the OLCI sensor on Sentinel-3 used in the CI algorithm. Hyperspectral data is currently not readily available. However, there are satellite missions planned for the near future that would collect routine hyperspectral data, such as NASA's Surface, Biology, and Geology (SBG, https://sbg.jpl.nasa.gov/) mission. For this project, we are collecting routine boat-based hyperspectral measurements during our water quality monitoring program, similar to those that will be measured in future satellite missions. This data will be analyzed along with concurrent data characterizing the cyanobacteria bloom type to determine a method to identify the dominant species present from hyperspectral data.

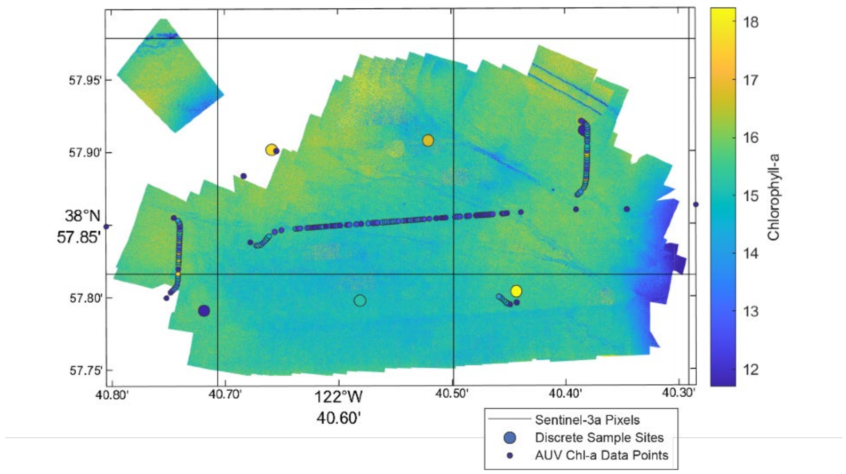
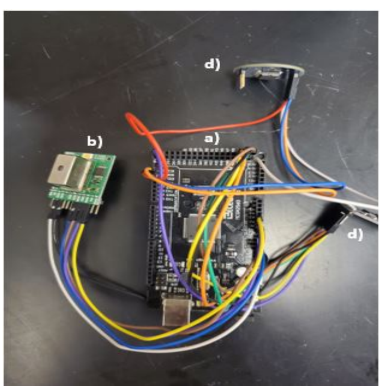


Figure 2. Multiplatform remote sensing measurements of cyanobacteria blooms in the Lower Arm, Clear Lake on August 16, 2019. UAV-derived chlorophyll-a show as background image with discrete sample and AUV measurements. Sentinel-3 satellite pixel outlines are also shown.

3.6. Developing in-situ cyanobacteria sensors and studying the impacts on treated water during HABs

Graduate student Kanarat Pinkanjananavee is leading two applied projects related to HABs:

1- *Development of in-situ cyanobacteria sensor: In situ* monitoring of HABs is limited by the high cost. This has prompted the need for the development of a low-cost *in situ* cyanobacteria sensor. The sensor is developed using the Arduino Mega as the mainboard for computing and software development, a Hamamatsu C12880MA mini spectrophotometer, and a 250nm UV-LED for the cyanobacteria excitation as shown in



2- .

The software development of the sensor itself is now completed, and trial deployments are planned at Clear Lake.

Figure 3. In situ cyanobacteria sensor hardware a) Arduino MEGA b) Hamamatsu C12880-MA spectrophotometer c) ChronoDot RTC d) SD card reader

3- *A plant-scale study on the potential impacts on treated water quality of recycling dewatered sludge supernatant during HABs:* Although the conventional treatment method of coagulation-flocculation and sedimentation is considered effective in removing cyanobacteria cells, the process only neutralizes the charges on the surface of the cells but does not deactivate cellular functions. Thus, cells that were not removed by the sedimentation could repopulate in downstream filtration media and negatively impact treated water quality when the water is recycled in the treatment process. The goal of this study is to investigate the possible effects of cyanobacteria blooms and the recycling of dewatered supernatant during bloom conditions.

The sampling site of this research is at the Buckingham Park Water District (BPWD), which is one of the better-instrumented drinking water treatment plants using the water from Clear Lake. The samples collected from the plant were analyzed for the disinfection by-products (DBPs), cyanotoxins, and species identification and quantification with qPCR. The results for the DBPs are shown in

Figure . Our results show the treatment system of BPWD was able to remove the DBPs that were created through the elimination of cyanobacteria from the final drinking water produced out of the treatment plant.

The water quality analysis for this project is still ongoing every month. Also, a 48-hour experiment to investigate the effects of the recycling process is planned for Winter 2022.

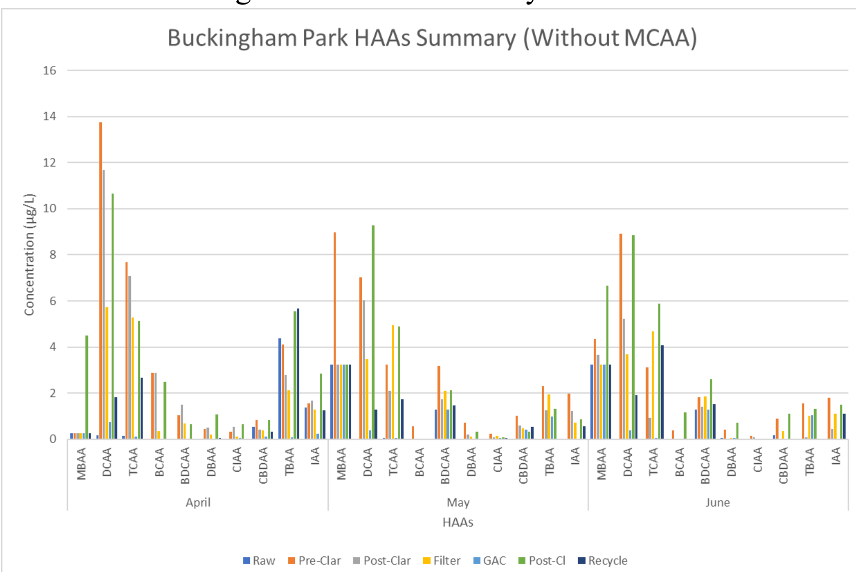


Figure 4. Comparison of HAAs concentration between samples with preservatives and samples without preservative (No NH_4 label)

3.7. Trends in nitrogen and phosphorus across the decades in Clear Lake

In 2006, the Central Valley Regional Water Quality Control Board (CVRWQCB) implemented a phosphorus Total Maximum Daily Load (TMDL) to decrease the nutrient load into the lake as a treatment method towards reducing the occurrence of HABs. Winder et al. (2010) analyzed water quality parameters in addition to biological variables to develop a conceptual model to account for the long-term behavior of Clear Lake. Graduate student Ruth Thirkill has produced an updated version of this data report looking at the entire period when data are available (1970 through 2021).

The data analysis revealed high interannual variability. The nitrogen variables showed a general downward trend across the entire historical record whereas phosphorus values had increasing trends. For the period 2000-2021 dissolved Kjeldahl nitrogen (DKN), nitrate, and nitrite concentrations either trended upwards or had no trend for the first ten years and trended downwards for the second ten years. Ammonium, by contrast, continued to rise over both decades though at a decreasing rate from 2011 to 2021 (Table 1).

The historical analysis of nitrogen and phosphorus data from Clear Lake indicates that the lake continues to suffer from excessive phosphorus loading even though the TMDL has required a reduction in external inputs.

Table 1. Trend direction of depth-averaged concentration for each arm and the whole lake during the period of record, as well as the statistical significance of each trend. Downward trends are indicated by a negative number and upward trends by a positive number. Significance of trends shown by color (see bottom of table for color description). [NO3+NO2, nitrate and nitrite concentration; NH4, ammonium concentration; DKN, dissolved Kjedahl nitrogen concentration; SRP, orthophosphate concentration; TP, total phosphorus concentration; NT, no statistically significant trend.]

Analyte	Lower Arm	Oaks Arm	Upper Arm	Whole Lake
NO3+NO2 1970 – 2021	0.08	-0.12	-0.17	**NT**
NO3+NO2 2000 – 2010	NT	NT	0.24	**0.13**
NO3+NO2 2011 – 2021	NT	NT	-0.27	**-0.16**
NH4 1970 – 2021	-0.12	-0.07	-0.07	**0.07**
NH4 2000 – 2010	0.42	0.30	NT	**0.28**
NH4 2011 – 2021	NT	0.15	0.20	**0.11**
DKN 1970 – 2021	-0.34	-0.28	-0.20	**-0.24**
DKN 2000 – 2010	NT	NT	NT	**NT**
DKN 2011 – 2021	-0.32	-0.33	0.11	**-0.18**
SRP 1970 – 2021	0.30	0.27	0.27	**0.39**
SRP 2000 – 2010	0.46	0.44	0.38	**0.50**
SRP 2011 – 2021	0.17	NT	NT	**NT**
TP 1970 – 2021	0.20	0.20	0.14	**0.25**
TP 2000 – 2010	0.16	0.18	0.19	**0.23**
TP 2011 - 2021	0.16	NT	NT	**NT**

Range of p-values	Color	Color Explanation
$p < 0.01$		Highly Significant
$0.01 < p < 0.05$		Significant
$0.05 < p < 0.1$		Marginally Significant

3.8. Numerical modeling: Fully calibrated and validated hydrodynamic model. Water quality model under development

The field and laboratory measurements are essential to build, calibrate, and validate a three-dimensional (3-D) numerical lake model. 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*). In 2021 we completed the calibration and validation of the hydrodynamic model. Root mean square errors for temperature are less than 1ºC between modeled and observed lake temperatures for a two-year simulation in all Clear Lake basins (Figure 5).

We are concurrently developing a water quality or biogeochemical model to simulate the evolution of different constituents, such as dissolved oxygen, nitrogen species, phosphorus species, phytoplankton, and suspended solids. This model will include cyanobacteria as one of the phytoplankton groups. This module needs the same type of calibration/validation described for the hydrodynamic module. We are planning to complete this task in 2022.

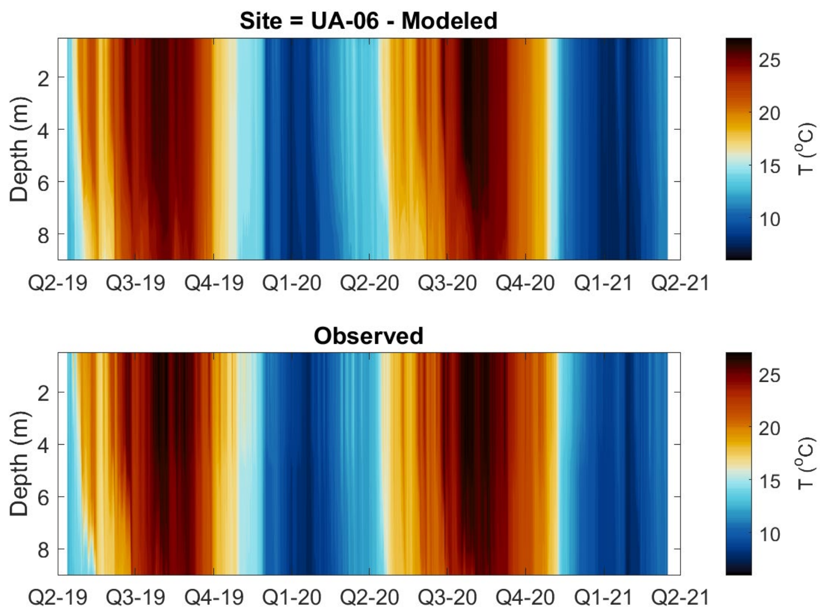


Figure 5. Comparison of modeled (top) and observed (bottom) lake water temperatures between spring 2019 and spring 2021 in the Upper Arm (UA-06)

4. UC Davis TERC Next Steps in 2022

In 2022 we will continue with the monitoring of the lake and the watershed as detailed in the Scope of Work with the California Natural Resources Agency. In addition, we will undertake the following:

4.1. Bathymetry survey

Existing bathymetric data lack the horizontal and vertical spatial resolution necessary to drive our hydrodynamic models, posing a severe constraint on predictive in-lake modeling. A new lake bathymetric survey will be conducted in 2022 and include a combined bathymetry and side-scan sonar survey of all three arms of the lake. This work would have commenced in 2021, but low lake levels prevented the launching of the research boat after September. A new project technician has been hired for this project and is set to start early in the new year.

We are collaborating with the USGS Volcanology Center to use the bathymetric data to better understand volcanic formations that are believed to exist below the lake's surface. This work will be focused on Soda Bay. The USGS is providing additional funding for the bathymetry survey to allow this work to proceed.

4.2. Modeling: Scenario development

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. 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. For example, testing the use of hypolimnetic oxygenation and identifying the location in the lake where we should install this system to mitigate cyanobacteria blooms.
- Model exploration of the fate of stream and culvert loads
- Model controls on cyanobacteria: We are aiming to model the onset, duration, location of the blooms and their movement due to lake currents.
- Model climate change impacts
- Model sediment capping

4.3. Modeling: Daily hazard assessment and lake conditions

Models can be used 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
- Providing data on the spread, concentration, and breakdown of accidental toxic releases to the lake

4.4. New collaboration with the University of Southern California, USC (Biology department)

Recent conversations between TERC and USC have led to a commitment to work together in 2022 to understand the succession of the cyanobacteria blooms in Clear Lake. That will inform TERC's 3-D transport and water quality model. TERC has also offered the possibility of collecting water samples for USC metagenomics analyses in 2022. Both groups are working to identify periods when multiple platforms were measuring data to help us understand the succession of cyanobacteria blooms in Clear Lake.

4.5. Link 3-D model to mercury model (USGS)

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. This work is subject to the availability of federal funding (EPA).

4.6. On-going project about wildfire smoke impacts

In fall 2020, TERC was awarded an NSF RAPID grant to measure the impacts of wildfire smoke and particulates on the productivity of lakes in the western US. During the numerous and large wildfires that occurred in our region in 2021, we have continued our post-fire sampling to investigate the smoke impacts in Clear Lake and other lakes such as Lake Tahoe affected by the wildfires.

4.7. Design of a hypolimnetic oxygenation pilot project

Depending on the confirmation with modeling, the use of hypolimnetic oxygenation is considered to be one of the more likely rehabilitation strategies. This is a capital-intensive investment and one that should be preceded by a pilot-scale project. In 2022, using the validated model, we will scope out a pilot-scale project.

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

Appendix D: UC Davis CRC 2020 Research Outcomes

UCDAVIS
Center for Regional Change

TO: Sam Magill, Senior Facilitator
Consensus and Collaboration Program
California State University, Sacramento

FROM: Bernadette Austin, Executive Director
UC Davis Center for Regional Change

RE: 2021 Clear Lake Final Annual Report
DATE: September 16, 2021

Clear Lake 2021 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 socioeconomic research to guide the Blue Ribbon Committee in improving the health and well-being of residents of the Clear Lake region communities. During the reporting year, the CRC worked closely with the BRC and Socioeconomic Subcommittee (SES) to refine its projects and ultimately delivered final reports and recommendations to the BRC in June 2021. However, the COVID-19 pandemic continued to severely impact CRC's ability to conduct ongoing research, and the Clear Lake communities are still striving to recover from the devastating 2020 wildfire season. Both realities underscore the importance of CRC's work to improve community vitality in the Clear Lake region. This report covers the final year in the CRC's initial three-year contract.

Clear Lake Socioeconomic Analysis

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

During 2020, the CRC socioeconomics assessment team investigated barriers to socioeconomic improvement in Lake County and presented their findings in a draft report to the BRC and SES committees in June 2020. This comprehensive framework analyzed data across five main domains – demographic, economic, housing, workforce, and industry – for the Clear Lake region.

The CRC team spent much time and effort this past year refining these analyses in response to feedback from both committees and in June 2021 released a final draft of the analyses titled, "California's Clear

Lake Region – A Socioeconomic Profile". In this profile, the CRC team examined the Clear Lake area 1) compared to broader regions in northern California, 2) over time (2000, 2010, and 2018, specifically), and, 3) across several important socioeconomic domains. This analysis did not create a set of recommendations for the BRC; rather, it provided a framework for the broader socioeconomic conditions in Lake County and presented several key takeaways for the region:

1. The region is challenged by an aging population
2. There are significant changes in racial and ethnic composition towards a more diverse population
3. These are concerning trends towards decreasing regional economic competitiveness
4. Health care and social assistance industry as a key source of employment
5. There is a need for support for small new businesses
6. There are high renter and homeownership cost burdens
7. It is crucial to address wildfire risks in developments in the wildland-urban interface (WUI) through multijurisdictional plans, land use and development regulations
8. Strengthening current data systems will assist in community economic development

Read the full report: ***California's Clear Lake Region: A Socioeconomic Profile***

Preferred citation: Noli Brazil, Asiya Natekal, Carlos Becerra. 2021. California's Clear Lake Region: A Socioeconomic Profile. UC Davis Center for Regional Change.

Lake County Community Economic Development

Dr. Clare Cannon, Assistant Professor of Human Ecology at UC Davis
Dr. Jonathan London. Faculty Director, Center UC Davis Center for Regional Change
Carolyn Abrams, Research Data Analyst at the UC Davis Center for Regional Change
Sara Watterson, Project Manager at the UC Davis Center for Regional Change

During 2020, the CRC team conducted a total of 13 formal interviews and two informal interviews stakeholders in economic development 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. As a result of these interviews as well as discussions with the BRC and SES, the CRC team ran nine focus groups, involving 50 participants, in four community-economic development themes: Environmental Education, Agricultural and Natural Resource Tourism, Youth and Workforce Development, and Broadband. The CRC team synthesized results from the focus groups, developed a set of recommendations for the BRC, and produced four white papers.

Environmental Education recommendations

- Develop new and enhanced environmental education programs to ensure the active engagement of youth and the community to promote values to protect environmental resources.
- Develop a multi-site and mobile education infrastructure that offers educational experiences such as interactive exhibits, opportunities for hands-on community science, and educational programming.
- Create a Clear Lake Environmental Education Roundtable (CLEER) that brings together K-12 and community college educators, area tribes, non-profit organizations, public agencies, local scientists, and other interested parties to coordinate and leverage programs and resources.

Read the full report: ***Strategies for Growing Environmental Education in Lake County, California***

Preferred citation: Preferred Citation: Sara Watterson, Jonathan K. London. 2021. Strategies for Growing Environmental Education in Lake County, California. UC Davis Center for Regional Change.

Agricultural and Natural Resource Tourism recommendations

- Identify agricultural commodities for export and local tourist consumption, and leverage unique natural resources for recreation and tourism opportunities.
- Leverage and coordinate local government policies and planning practices, (e.g., rural zoning codes), to support a successful tourism sector.
- Diversify the local economy to ensure a well-balanced and sustainable foundation that benefits from, but is not solely dependent on, tourism.
- Enhance the narrative about Lake County and the Lake region based on its unique natural and cultural features as a draw for tourists.

Read the full report: ***Building Opportunities for Enhancing Agritourism and Ecotourism in Lake County, California***

Preferred Citation: R.V. Alexander Volzer, Carolyn Abrams. 2021. Building Opportunities for Enhancing Agritourism and Ecotourism in Lake County, California. UC Davis Center for Regional Change.

Youth and Workforce Development recommendations

- Strengthen the college to career pipeline through partnerships between K-12, community colleges, and business sectors.
- Focus attention to include historically underserved populations and places in the region.
- Leverage local educational resources to support environmental and natural resource-based career development.

Read the full report: ***Linking Youth Education and Workforce Development with a Healthy Lake Environment in Lake County, California***

Preferred Citation: Abrams, Carolyn, Jonathan K. London. 2021. Linking Youth Education and Workforce Development with a Healthy Lake Environment in Lake County, California. UC Davis Center for Regional Change.

Broadband recommendations

- Strengthen data collection at a granular level to more accurately reflect broadband access gaps in Lake County.
- Pursue short- and long-term funding strategies that enable widespread, high-quality broadband access in Lake County.
- Explore alternative methods for broadband access appropriate for rural communities such as Wireless Internet Service Providers and Community Service Districts.
- Create a coalition of local government, business, and civic organizations as an umbrella structure to increase broadband access and infrastructure in Lake County.

Read the full report: ***Improving Rural Broadband Access in Lake County, California***

Preferred Citation: Preferred Citation: Abrams, Carolyn, Sara Watterson, Jonathan K. London. 2021. Improving Rural Broadband Access in Lake County, California. UC Davis Center for Regional Change.

Clear Lake Natural Disaster Planning and Recovery with Tribal and Broader Regional Stakeholders

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
Alex Volzer, Student Researcher, Community and Regional Development at UC Davis

Starting in 2020 and continuing through 2021, the CRC team conducted listening sessions, interviews, and focus groups with 21 leaders from the Clear Lake area Tribal governments and other stakeholders As a result of this work, the CRC team wrote two reports that provide an overview of practices to support natural disaster recovery, with a focus on Tribal communities as well as a set of recommendations for pre- and post-disaster planning.

In these reports, the CRC team identify five core areas to support recovery for Tribal communities in the Clear Lake Region (below) and a series of critical activities to support recovery within these areas when planning and mitigating risks from the increasing frequency and severity of natural disasters (e.g., wildfire, flooding) in the Clear Lake area. The reports also provide resources available from the University of California to address disasters.

1. **Economic Recovery** efforts should be focused on returning economic activities to a healthy state while promoting new business development and economic sustainability. Critical activities in this area should focus on identifying and removing the inhibitors to fostering economic stabilization after natural disasters, supporting communication and robust problem-solving among economic recovery stakeholders.
2. **Health and Social Service** efforts can restore and improve health and social service capabilities and networks to promote community and individual health and well-being. Critical activities in this area should focus on identifying populations that are likely to be affected by natural disasters, streamlining services across key service providers, and continually monitoring and assessing community health and social service needs.

3. **Housing efforts** should focus on supporting and contributing to building a sustainable, resilient, and affordable housing stock for the region. Critical activities in this area include assessing the interim housing needs of communities and assessing and identifying options for permanent housing during pre and post disasters for Tribal members.
4. **Infrastructure Systems** efforts should focus on stabilizing critical infrastructure, minimizing Health and safety threats, and efficiently restoring and revitalizing systems and services. Here pre-disaster recovery planning that includes Tribal governments at the regional level can help leverage resources available that can support capacity building for Tribal communities.
5. **Environmental Stewardship** efforts should focus on protecting natural and cultural resources by undertaking appropriate planning, mitigation, and responses both pre and post natural disasters. Critical activities in this area include supporting the discovery and implementation of options to support the protection of environmental resources.

Read the full report: ***Five Core Areas to Support and Promote Recovery to Natural Disasters: Insights from Tribal Communities in the Clear Lake Region***

Preferred citation: Visser, M.A., Cannon, C., and L. Panyanouvong. 2021. Five Core Areas to Support and Promote Recovery to Natural Disasters: Insights from Tribal Communities in the Clear Lake Region. Center for Regional Change. University of California, Davis.

Read the full report: ***Promising Practices for Rural Economic Development After Disasters in Lake County, California***

Preferred citation: R.V. Alexander Volzer. 2021. Promising Practices for Rural Economic Development After Disasters in Lake County, California. UC Davis Center for Regional Change.

Next Steps

The Center for Regional Change, together with the UC Davis Tahoe Environmental Research Center and the UC Davis Center for Community and Citizen Science are developing proposed scopes of work focused on the BRC's priorities on environmental education. Pending approval, these activities would start in January 2022.

Appendix E: 2021 Big Valley Band of Pomo Indians Cyanotoxin Monitoring Report

Big Valley Band of Pomo Indians

Summary of the 2021 Clear Lake HAB events

The Clear Lake Cyanotoxin Monitoring Program https://bit.ly/ClearLakeCyanoProgram which was begun by Big Valley and Elem Indian Colony in 2014 continued with its biweekly sampling for summer 2021. Most likely due to drought and other factors, we began seeing Anatoxin-a, a potent neurotoxin, in multiple locations on the lake. One site (SHADY01 – a recreational location on Cache Creek which is the outflow of Clear Lake) continued to have ever increasing Anatoxin-a detects from August through September. The levels of Anatoxin-a reached Warning levels at this site, with a result value of 35.42 µg/L. Microcystin results also reached the highest levels we've seen on Clear Lake with one site (LC01 – a private Homeowners Association shoreline) reaching a result value in August of 25,843 µg/L which is 32,000 times higher than the State recreational standards, and another site (RED01 – a public park in the City of Clearlake with boat launching and fishing off the shore) reaching a result value of 160,377.50 which is over 200,000 times higher than State recreational standards.

The cyanobacteria blooms varied throughout the year, with Microcystin producing *Microcystis sp*. and *Gloeotrichia sp*., Cylindrospermopsin and Saxitoxin producing *Microseria sp.* wollei (prev. Lyngbya) and Anatoxin-a producing *Planktothrix sp., Aphanizomenon sp. and Phormidium sp.* https://bit.ly/CyanobacteriaToxinsChart

In 2021, our monitoring program became an extremely useful tool which identified the more than 400 at-risk private/individual drinking water systems on Clear Lake. Because of the unprecedented Microcystin and Anatoxin-a toxin levels on Clear Lake, Lake County Public Health issued a Health Advisory on September 16, 2021 of Do Not Drink the tap water for these individual homes (specifically in the Oaks and Lower arms) that draw their drinking water from Clear Lake. Alternate sources of tap water were set up for these homes. http://www.lakecountyca.gov/Government/PressReleases/11172021.htm The Health Advisory was lifted by the Public Health Officer on November 16, 2021 for these homes. http://www.lakecountyca.gov/Government/PressReleases/11172021.htm

The 18 Public Water systems (serving 15 or more residences) which pull and treat water from Clear Lake were also under a State Water Resources Control Board Order with a results based schedule of monitoring their intake and treated water. Requirements of meeting US EPA's 2015 Drinking Water Health Advisory for Microcystins threshold of 0.3 µg/L were met by all the Public Water Systems, there were no exceedances of this Health Advisory. https://bit.ly/EPAMicrocystinHealthAdvisory

2021 Clear Lake Cyanotoxin Sampling Signage Recommendations

SITE ID	ARM	4/27/2021	5/17/2021	6/7/2021	6/21/2021	7/14/2021	7/28/2021	8/11/2021	8/25/2021	9/7/2021	9/21/2021	10/12/2021	10/26/2021	11/16/2021	12/8/2021
AP01	L	CAUTION	NONE	NONE	CAUTION	CAUTION	DANGER	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	CAUTION	N/A
BP	L	NONE	NONE	CAUTION	CAUTION	CAUTION	CAUTION	WARNING	CAUTION	CAUTION	DANGER	WARNING	WARNING	NONE	CAUTION
BVCL6	U	CAUTION	NONE	NONE	NONE	NONE	CAUTION	NONE	CAUTION	CAUTION	CAUTION	NONE	NONE	NONE	NONE
CL-1	U	N/A	N/A	N/A	N/A	N/A	N/A	NONE	N/A	NONE	N/A	NONE	N/A	NONE	NONE
CL-3	L	NONE	N/A	N/A	N/A	NONE	N/A	DANGER	N/A	DANGER	N/A	WARNING	N/A	NONE	NONE
CL-4	O	N/A	N/A	N/A	N/A	NONE	N/A	N/A	N/A	N/A	N/A	NONE	N/A	CAUTION	NONE
CL-5	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CLOAKS01	O	NONE	NONE	CAUTION	CAUTION	NONE	WARNING	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	CAUTION	CAUTION
CLV7	U	CAUTION	NONE	CAUTION	CAUTION	NONE	NONE	CAUTION	CAUTION	DANGER	CAUTION	NONE	NONE	NONE	N/A
CP	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ELEM01	O	N/A	N/A	DANGER	DANGER	CAUTION	DANGER	DANGER	DANGER	CAUTION	CAUTION	DANGER	N/A	CAUTION	CAUTION
GH	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HB	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
JB	L	N/A	N/A	WARNING	CAUTION	WARNING	WARNING	WARNING	DANGER	DANGER	DANGER	DANGER	CAUTION	NONE	N/A
KEYS01	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
KEYS03	O	CAUTION	WARNING	DANGER	WARNING	WARNING	CAUTION	DANGER	CAUTION	CAUTION	N/A	N/A	NONE	NONE	N/A
KP01	U	CAUTION	NONE	CAUTION	CAUTION	NONE	WARNING	WARNING	CAUTION	WARNING	CAUTION	NONE	NONE	NONE	NONE
LA-03	L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	WARNING	N/A	NONE	N/A	N/A	N/A
LC01	L	N/A	WARNING	CAUTION	WARNING	WARNING	WARNING	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	CAUTION	N/A
LPTNT	U	CAUTION	NONE	CAUTION	NONE	CAUTION	WARNING	DANGER	DANGER	WARNING	WARNING	CAUTION	CAUTION	CAUTION	NONE
LS2	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LUC01	U	CAUTION	NONE	NONE	NONE	NONE	NONE	CAUTION	NONE	CAUTION	NONE	NONE	NONE	NONE	N/A
NR-02	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NONE	N/A	N/A	N/A
OA-04	O	N/A	N/A	N/A	N/A	N/A	WARNING	N/A	N/A	WARNING	N/A	DANGER	N/A	N/A	N/A
RED01	L	CAUTION	CAUTION	DANGER	WARNING	DANGER	WARNING	WARNING	DANGER	DANGER	DANGER	DANGER	DANGER	CAUTION	CAUTION
RODS	U	NONE	NONE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S	O	CAUTION	CAUTION	N/A	CAUTION	CAUTION	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	N/A
S	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S	L	WARNING	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	WARNING	NONE	NONE	CAUTION
U	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NONE	N/A	N/A	CAUTION
U	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NONE	N/A	N/A	N/A
UA-07	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UA-08	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NONE	N/A	N/A	N/A
UBL		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

All cyanotoxin monitoring conducted by Big Valley Band of Pomo Indians with assistance from Robinson Rancheria.
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

N/A: not sampled   None: < 0.8 µ/L   Caution: 0.8 µ/L to < 6.0 µ/L   Warning: 6.0 µ/L to <20 µ/L   Danger: > 20 µ/L

Microcystin and Anatoxin Results for 2021 Clear Lake Sampling

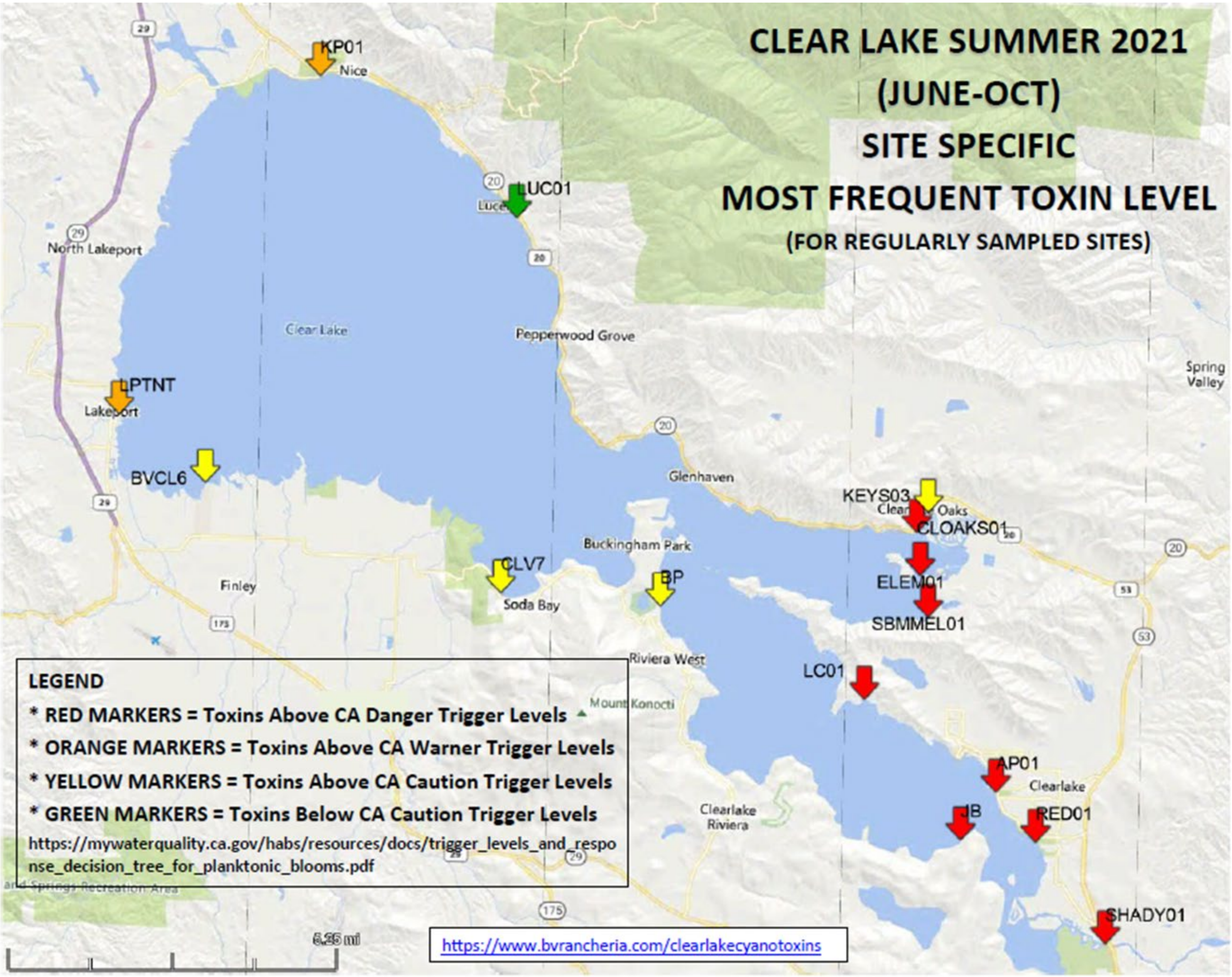
		MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA	MC	ANA
SITE ID	**ARM**	4/27	4/27	5/17	5/17	6/7	6/7	6/21	6/21	7/14	7/14	7/28	7/28	8/11	8/11	8/25	8/25	9/7	9/7	9/21	9/21	10/12	10/12	10/26	10/26	11/16	11/16	12/8	12/8
AP01	L	N/A	N/A	N/A	N/A	0.19	N/A	3.13	N/A	2.01	N/A	370.40	N/A	33.16	N/A	45.22	N/A	**4857.00**	N/A	25.71	N/A	8.63	N/A	9.47	N/A	0.98	N/A	N/A	N/A
BP	L	N/A	N/A	N/A	N/A	N/A	N/A	1.94	N/A	1.45	N/A	1.19	N/A	16.15	N/A	2.21	N/A	1.26	N/A	**24.71**	N/A	8.77	N/A	6.61	N/A	0.69	N/A	1.08	N/A
BVCL6	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.69	N/A	1.22	2.49	0.63	ND	**2.84**	N/A	1.84	N/A	1.09	0.17	0.52	ND	N/A	N/A	N/A	N/A	N/A	N/A
CL-1	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**0.18**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CL-3	L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	asked for	N/A	N/A	N/A	24.17	N/A	N/A	N/A	**4940.00**	N/A	N/A	N/A	16.67	ND	N/A	N/A	N/A	N/A	N/A	N/A
CL-4	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**4.44**	N/A	N/A	N/A
CL-5	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CLOAKS01	O	N/A	N/A	0.31	N/A	N/A	N/A	1.40	N/A	0.40	N/A	13.55	N/A	42.35	N/A	56.74	N/A	29.39	N/A	**1449.50**	N/A	6.35	N/A	17.61	N/A	2.73	N/A	1.89	N/A
CLV7	U	N/A	N/A	N/A	N/A	N/A	N/A	4.69	N/A	0.45	N/A	0.68	N/A	1.72	N/A	3.42	ND	**5910.30**	N/A	1.33	0.17	0.46	ND	N/A	N/A	N/A	N/A	N/A	N/A
CP	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ELEM01	O	N/A	N/A	N/A	N/A	25.00	N/A	43.37	N/A	5.36	N/A	72.04	N/A	56.09	N/A	**786.60**	N/A	5.67	N/A	5.86	0.27	517.20	N/A	N/A	N/A	2.58	N/A	1.55	N/A
GH	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HB	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
JB	L	N/A	N/A	N/A	N/A	19.68	N/A	3.18	N/A	9.73	N/A	17.29	N/A	7.66	N/A	**43.05**	N/A	34.35	N/A	39.07	N/A	24.63	N/A	5.56	N/A	0.65	N/A	N/A	N/A
KEYS01	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
KEYS03	O	N/A	N/A	14.52	N/A	30.00	N/A	**17.11**	N/A	11.89	N/A	2.17	N/A	24.06	0.19	4.05	0.14	0.44	0.30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
KP01	U	N/A	N/A	0.30	N/A	N/A	N/A	N/A	N/A	0.44	N/A	**13.05**	N/A	7.98	N/A	5.10	N/A	7.53	N/A	2.96	0.25	0.27	ND	N/A	N/A	N/A	N/A	N/A	N/A
LA-03	L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**15.09**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LC01	L	N/A	N/A	11.16	N/A	1.69	N/A	8.26	N/A	17.41	N/A	14.67	N/A	49.64	N/A	25843.50	N/A	**204.00**	N/A	71.60	0.32	8.54	ND	9.16	N/A	1.32	N/A	N/A	N/A
LPTNT	U	N/A	N/A	0.20	N/A	N/A	N/A	N/A	N/A	2.03	N/A	12.76	N/A	**135.02**	N/A	31.25	0.14	13.56	0.27	11.71	0.17	1.13	ND	0.82	N/A	0.84	N/A	0.34	N/A
LS2	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LUC01	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.65	0.18	0.70	ND	**2.79**	N/A	0.78	N/A	0.32	ND	N/A	N/A	N/A	N/A	N/A	N/A
NR-02	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	N/A	N/A	N/A	N/A	**2.64**	N/A
OA-04	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.20	N/A	N/A	N/A	N/A	N/A	8.76	N/A	N/A	N/A	**23.12**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RED01	L	N/A	N/A	3.61	N/A	33.45	N/A	7.23	N/A	35.59	N/A	7.08	N/A	9.52	N/A	20.96	N/A	**160377.50**	N/A	144.00	N/A	33.18	N/A	25.11	N/A	3.49	N/A	1.64	N/A
RODS	U	N/A	N/A	**0.23**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SBMMEL01	O	N/A	N/A	2.90	N/A	N/A	N/A	1.82	N/A	2.03	N/A	113.80	N/A	36.85	N/A	365.70	N/A	54.80	N/A	39.73	N/A	**506.60**	N/A	12.07	N/A	10.70	N/A	N/A	N/A
SC01	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SHADY01	L	17.34	N/A	59.65	N/A	87.67	N/A	21.41	N/A	66.10	N/A	51.25	N/A	25.33	2.63	22.69	12.90	22.40	25.95	**87.78**	33.61	19.48	35.42	ND	ND	N/A	N/A	0.36	N/A
UA-01	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**0.17**
UA-06	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UA-07	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UA-08	U	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UBL		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

This table shows the results for both Microcystin (MC) and Anatoxin-a (ANA) analysis at each site. Cells that are highlighted red have the highest toxin value that sampling date. Cells that are bolded and dotted are the highest toxin value for that site during the 2021 sampling year.

Summer 2021 Most Sampled Sites Percentage of Times at Elevated Toxin Levels

SITE ID	ARM	6/21	7/14	7/28	8/11	8/25	9/7	9/21	10/12	10/26	CAUTION	WARNING	DANGER	% OF SAMPLING EVENTS AT C/W/D
AP01	L	CAUTION	CAUTION	DANGER	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	22%	22%	56%	100%
BP	L	CAUTION	CAUTION	CAUTION	WARNING	CAUTION	CAUTION	DANGER	WARNING	WARNING	56%	33%	11%	100%
BVCL6	U	NONE	NONE	CAUTION	NONE	CAUTION	CAUTION	CAUTION	NONE	NONE	44%	0%	0%	44%
CLOAKS01	O	CAUTION	NONE	WARNING	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	11%	33%	44%	89%
CLV7	U	CAUTION	NONE	NONE	CAUTION	CAUTION	DANGER	CAUTION	NONE	NONE	44%	0%	11%	56%
ELEM01	O	DANGER	CAUTION	DANGER	DANGER	DANGER	CAUTION	CAUTION	DANGER	N/A	38%	0%	63%	100%
JB	L	CAUTION	WARNING	WARNING	WARNING	DANGER	DANGER	DANGER	DANGER	CAUTION	22%	33%	44%	100%
KEYS03	O	WARNING	WARNING	CAUTION	DANGER	CAUTION	CAUTION	N/A	N/A	NONE	43%	29%	14%	86%
KP01	U	CAUTION	NONE	WARNING	WARNING	CAUTION	WARNING	CAUTION	NONE	NONE	33%	33%	0%	67%
LC01	L	WARNING	WARNING	WARNING	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	0%	56%	44%	100%
LPTNT	U	NONE	CAUTION	WARNING	DANGER	DANGER	WARNING	WARNING	CAUTION	CAUTION	33%	33%	22%	89%
LUC01	U	NONE	NONE	NONE	CAUTION	NONE	CAUTION	NONE	NONE	NONE	22%	0%	0%	22%
RED01	L	WARNING	DANGER	WARNING	WARNING	DANGER	DANGER	DANGER	DANGER	DANGER	0%	33%	67%	100%
SBMMEL01	O	CAUTION	CAUTION	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	WARNING	22%	11%	67%	100%
SHADY01	L	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	WARNING	NONE	0%	11%	78%	89%

This table shows our most regularly sampled fifteen locations during the summer and late fall months, the cyanotoxin recommendations signage during those months, and the percentage of time that each site was at Caution, Warning or Danger levels of cyanotoxins. Seven of the fifteen sites were at these elevated levels of cyanotoxins every time we sampled: AP01 (Austin Park), BP (Buckingham), ELEM01 (Elem), JB (Jago Bay), LC01 (Lily Cove), RED01 (Redbud Park) and SBMMEL01 (Sulphur Bank Mercury Mine). All but two of the sites were at elevated levels more than 50% of the time we sampled. The map of these sites, along with their most frequent toxin level is below.



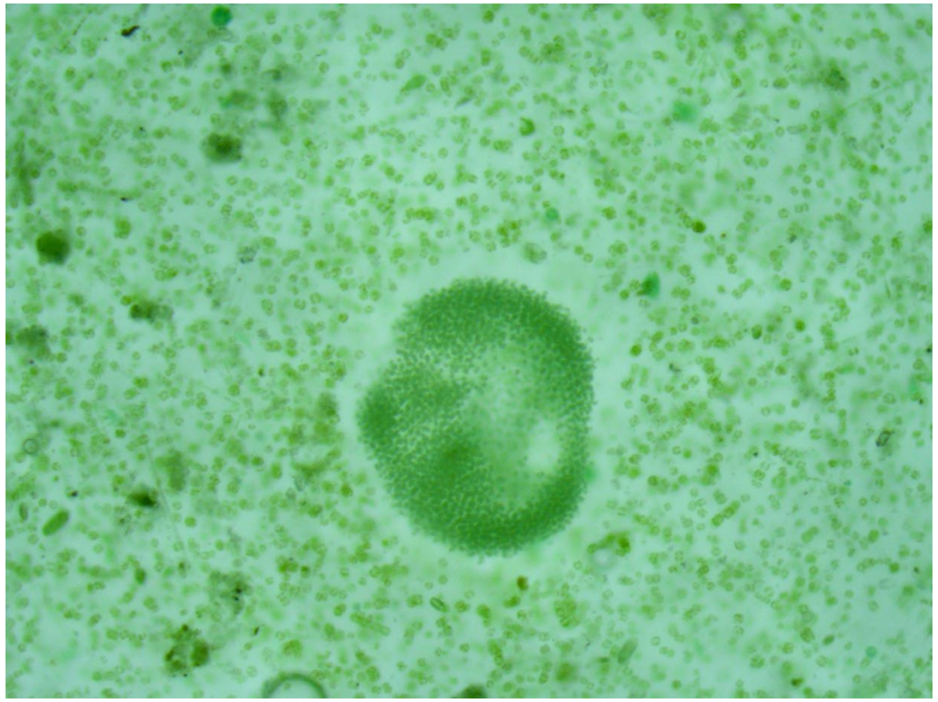
CLEAR LAKE SUMMER 2021
(JUNE-OCT)
SITE SPECIFIC
MOST FREQUENT TOXIN LEVEL
(FOR REGULARLY SAMPLED SITES)
KP01
Nice
LUC01
North Lakeport
Clear Lake
Pepperwood Grove
LPTNT
Lakeport
BVCL6
Glenhaven
KEYS03
Clearlake Oaks
CLOAKS01
Buckingham Park
CLV7
BP
ELEM01
SBMMEL01
Finley
Soda Bay
Riviera West
LC01
Mount Konocti
Spring Valley
AP01
Clearlake
JB
RED01
Clearlake Riviera
SHADY01
LEGEND
* RED MARKERS = Toxins Above CA Danger Trigger Levels
* ORANGE MARKERS = Toxins Above CA Warner Trigger Levels
* YELLOW MARKERS = Toxins Above CA Caution Trigger Levels
* GREEN MARKERS = Toxins Below CA Caution Trigger Levels
https://mywaterquality.ca.gov/habs/resources/docs/trigger_levels_and_response_decision_tree_for_planktonic_blooms.pdf
https://www.bvrancheria.com/clearlakecyanotoxins

CELL ID TRENDS: 2021

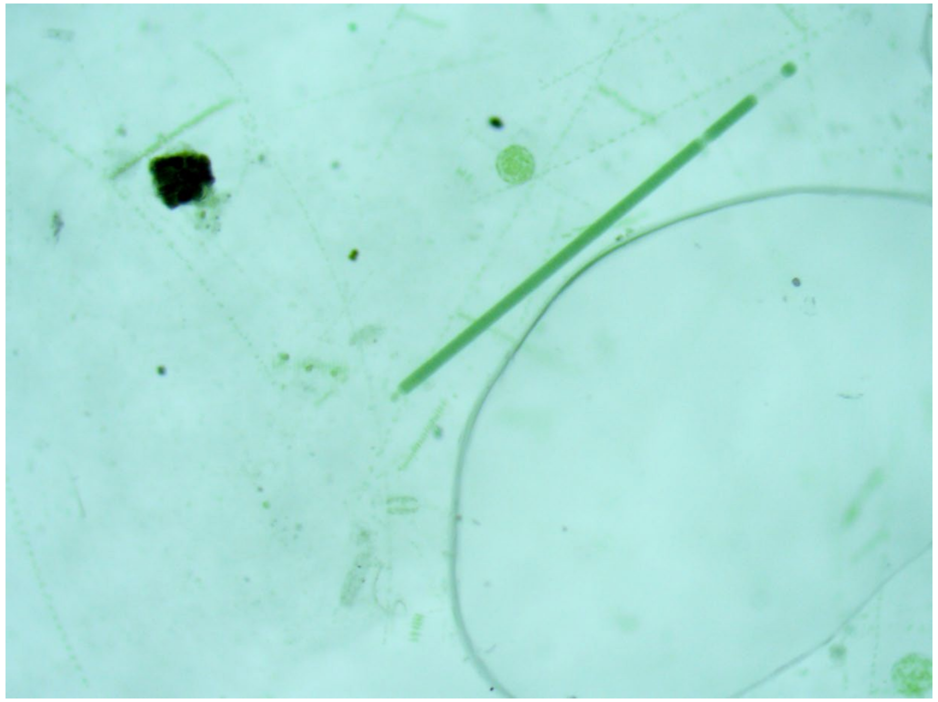
BY: BIG VALLEY RANCHERIA

MARCH, 2021

- Big Valley sampled 10 sites on the shoreline of Clear Lake on a monthly basis
- Microscopy: dominance of *Microcystis* with a secondary dominance of *Lyngbya*.
- Other genera identified: *Pseudanabaena*, *Planktothrix*, *Anabaenopsis*



Microcystis - KEYS03: 03/22/2021

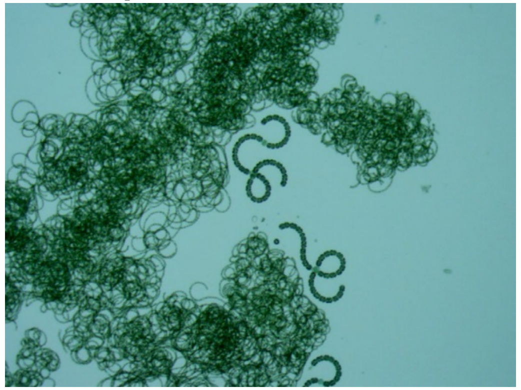


Lyngbya – RED01: 03/22/2021

APRIL, 2021

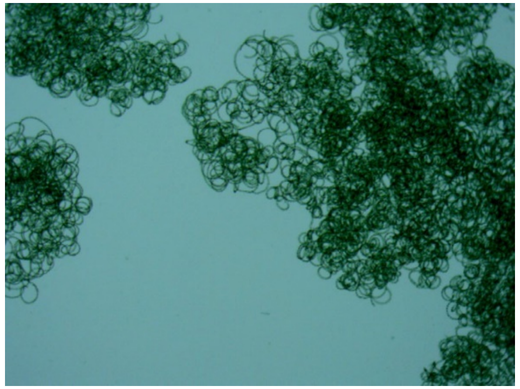
- Big Valley continued to sample 10 sites throughout Clear Lake on a monthly basis
- Microscopy: dominance of *Dolichospermum* with a secondary dominance of *Microcystis*.
- Other genera identified: *Aphanizomenon* and *Anabaenopsis*

Dolichospermum – LPTNT: 04/27/2021

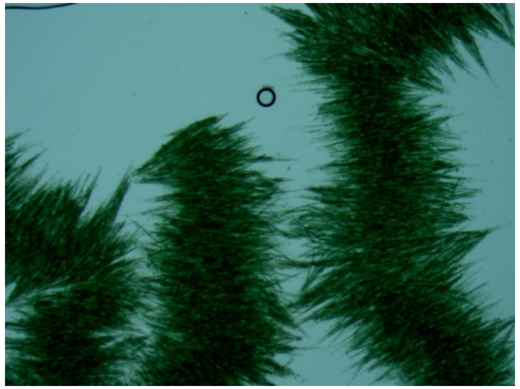


Microcystis – SHADY01: 04/27/2021

Dolichospermum – CLV7: 04/27/2021

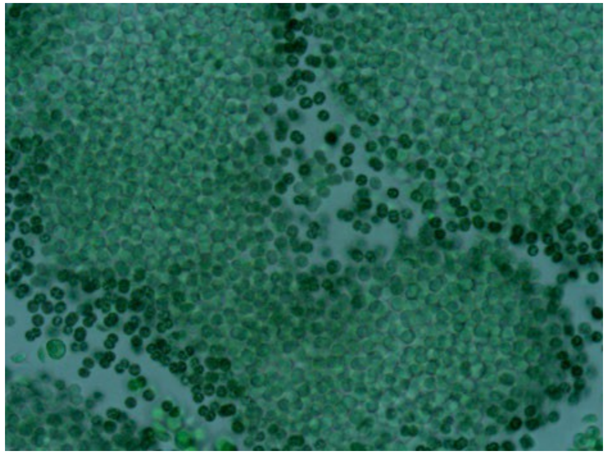


Aphanizomenon – LPTNT: 04/27/2021

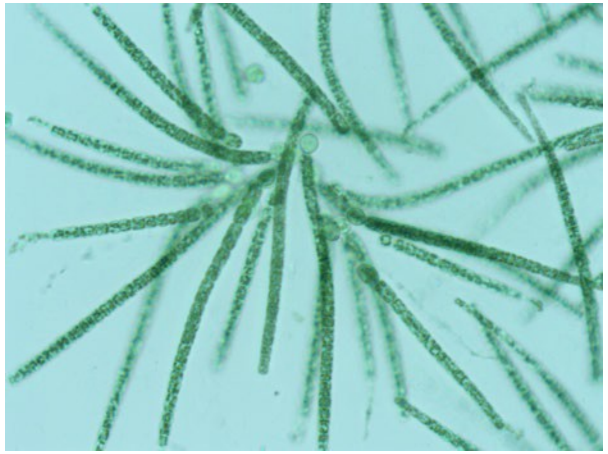


MAY, 2021

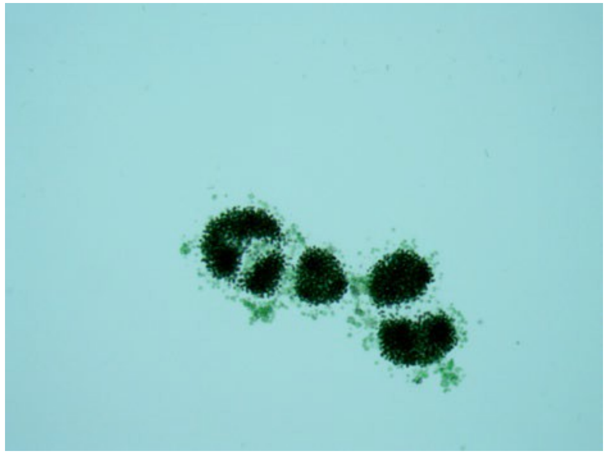
- Big Valley continued to sample 11 sites on the shoreline of Clear Lake on a monthly basis
- Microscopy: dominance of *Microcystis* and a secondary dominance of *Dolichospermum*
- Other genera identified: *Gloeotrichia*



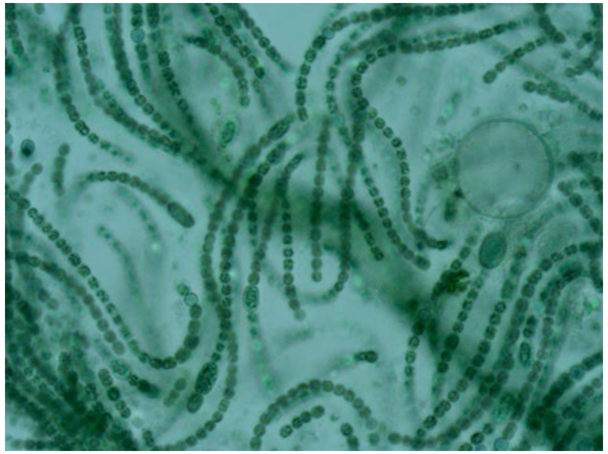
Microcystis – AP01: 05/17/2021



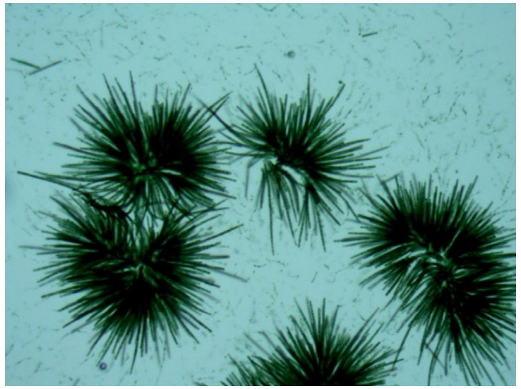
Gloeotrichia – AP01: 05/17/2021



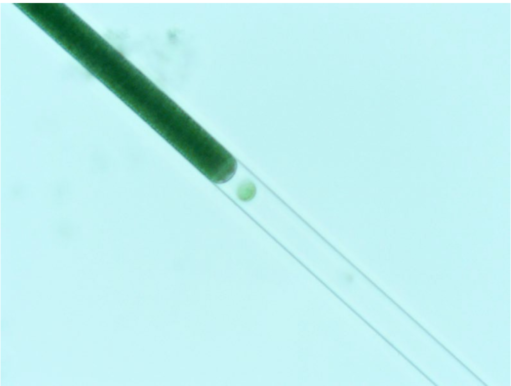
Microcystis - RED01: 05/17/2021



Dolichospermum – BP: 05/17/2021

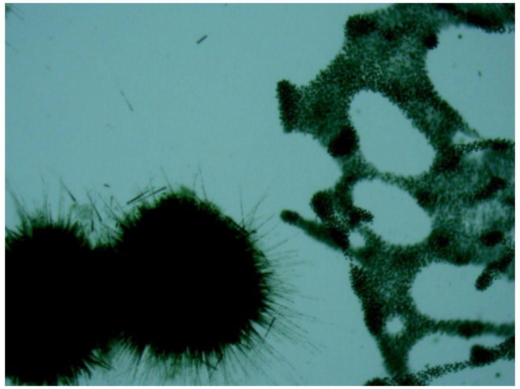


Gloeotrichia – BP: 06/07/2021



Lyngbya – AP01: 06/07/2021

Gloeotrichia – LUC01: 06/07/2021



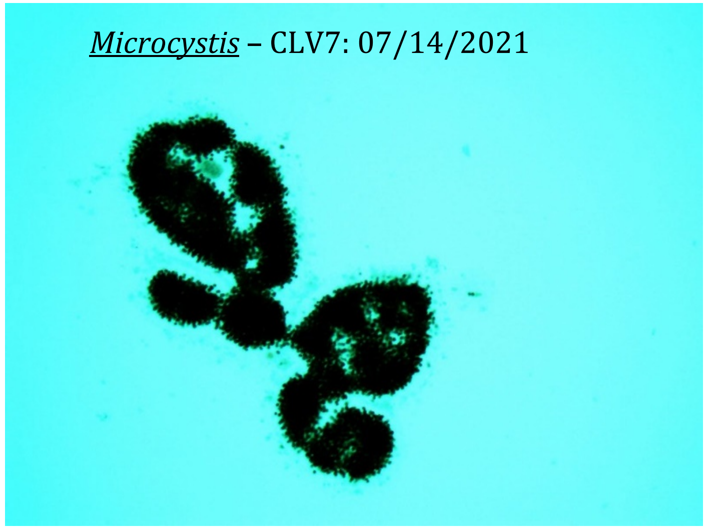
Gloeotrichia and *Microcystis*: CLV7 06/07/2021

JUNE, 2021

- Big Valley began their bi-monthly Summer HAB monitoring of Clear Lake
- 14 sites were sampled
- Microscopy: dominance of *Gloeotrichia* and a secondary dominance of *Microcystis* with *Lyngbya* in the mix
- Other genera identified: *Dolichospermum and Anabaenopsis*

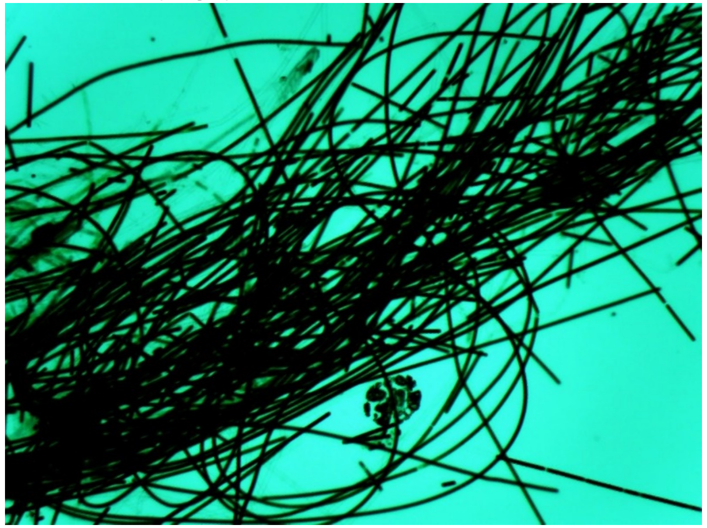
JULY, 2021

- Big Valley continued to sample 15 sites on a bi-monthly basis on Clear Lake
- Microscopy: dominance of *Lyngbya*, and a secondary dominance of *Microcystis*
- Other genera identified: *Gloeotrichia* and *Planktothrix*

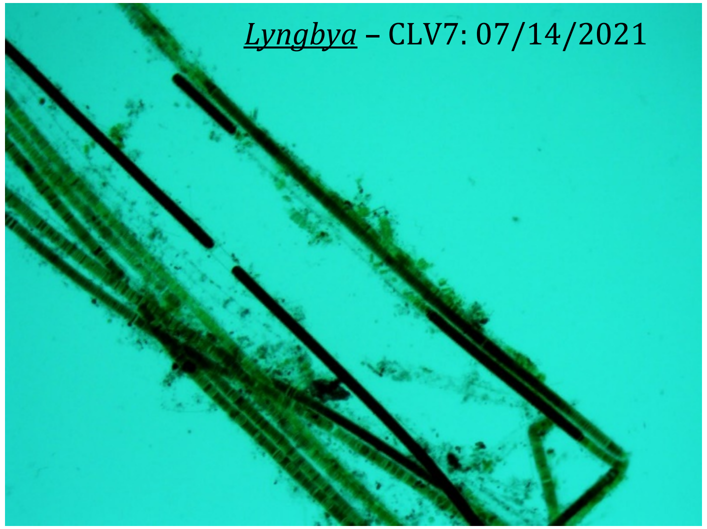


Microcystis – CLV7: 07/14/2021

Lyngbya – LC01: 07/14/2021

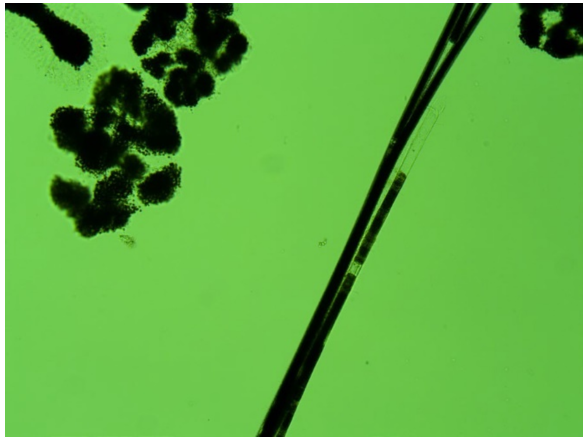


Microcystis – BP: 07/14/2021

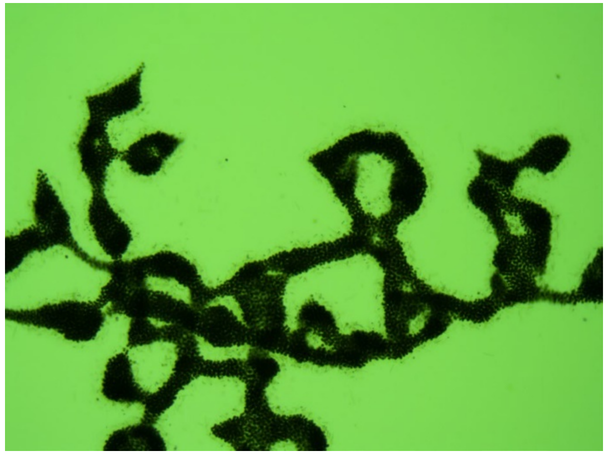


Lyngbya – CLV7: 07/14/2021

- Big Valley continued sampling 15 sites on Clear Lake on a bi-monthly basis
- Microscopy: dominance of *Microcystis* with a secondary dominance of *Lyngbya*
- Other genera identified: *Kamptonema*, *Phormidium*, *Planktothrix,* and *Aphanizomenon*

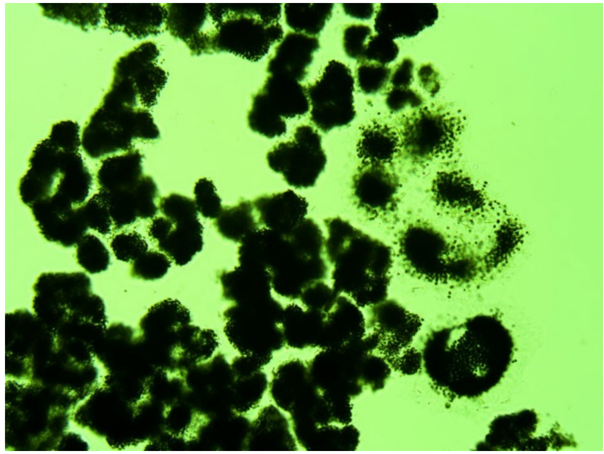


Lyngbya – JB: 08/12/2021



Microcystis – BP: 08/12/2021

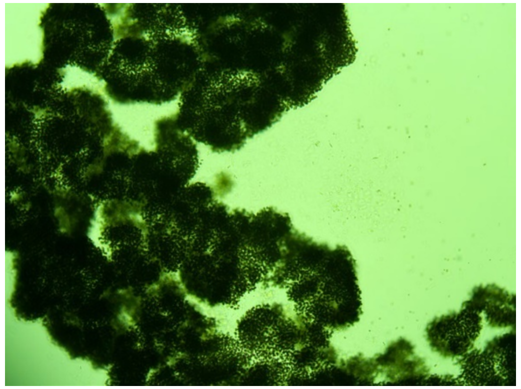
Microcystis – CLOAKS01: 08/12/2021



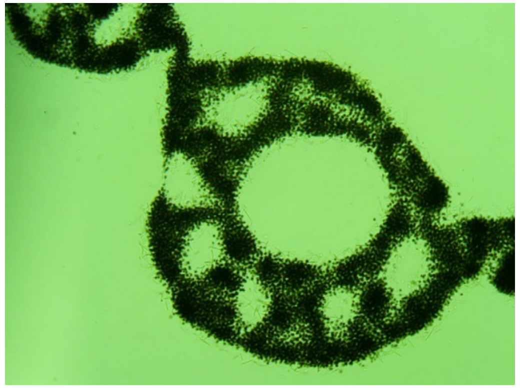
Microcystis – JB: 08/12/2021

SEPTEMBER, 2021

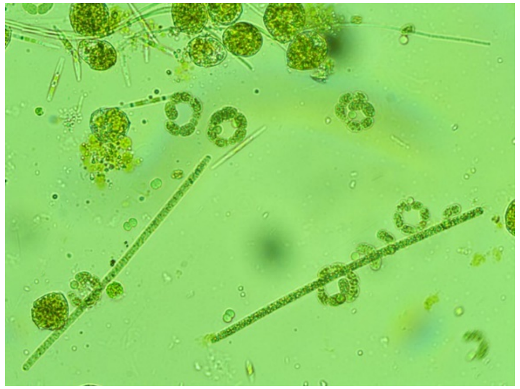
- Big Valley continued to sample 15 sites on a bi-monthly basis around the shoreline of Clear Lake
- Microscopy: dominance of *Microcystis* with a secondary dominance of *Planktothrix*
- Other genera observed: *Oscillatoria*, *Pseudanabaena*, and *Aphanizomenon*



Microcystis – KP01: 09/09/2021



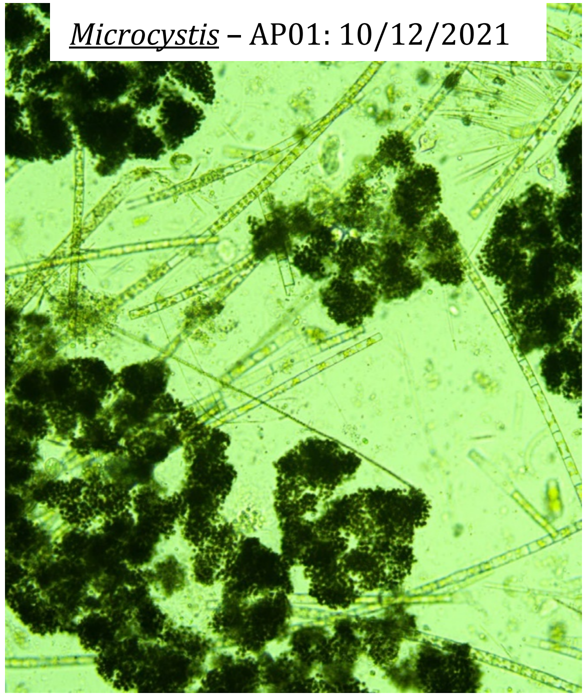
Microcystis – BP: 09/09/2021



Planktothrix – LPTNT 09/22/2021

Planktothrix – LPTNT: 09/22/2021

Planktothrix – CLV7: 10/12/2021



Microcystis – AP01: 10/12/2021

Microcystis – LC01: 10/12/2021

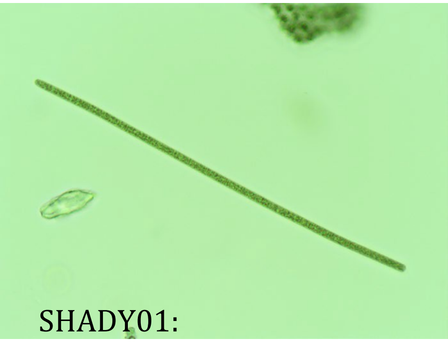
Planktothrix – BP: 10/12/2021

OCTOBER, 2021

- Big Valley continued to sample 15 sites around Clear Lake's shoreline on a bi-monthly basis
- Microscopy: dominance of *Microcystis* with a secondary dominance of *Planktothrix*.
- Other genera identified: *Woronichinia*, *Aphanizomenon*

- 07/28/2021: Big Valley was seeing a dominance of _Planktothrix_ and _Aphanizomenon_ at BVCL6 and SHADY01
- 08/11/2021: Still seeing an abundance of _Planktothrix_ at BVCL6 and SHADY01. LUC01 we were seeing _Aphanizomenon_ and at KEYS03 we were seeing _Phormidium_, all possible anatoxin producers.
- 08/25/2021: SHADY01 and LPTNT had _Planktothrix_ as a secondary dominant cyanobacteria. KEYS03 and LUC01 had a dominance of _Kamptonema_.
- 09/07/2021: SHADY01 had a dominance of _Planktothrix_ and _Aphanizomenon_.
- 09/21/2021: Still seeing _Planktothrix_ and _Aphanizomenon_ at SHADY01. _Planktothrix_ at BVCL6, LPTNT, KP01 and CLV7. We were also seeing some _Oscillatoria_ at LC01.
- 10/12/2021: Still seeing _Aphanizomenon_ at SHADY01, Anatoxin level at 35.42 µg/L. 8 other sites had ND of Anatoxin-a.

DATE	BVCL6	SHADY01	KEYS03	LUC01	ELEM01	LPTNT	LC01	CLV7	KP01
07/28/2021	2.49 µg/L	ND							
08/11/2021	ND	2.63 µg/L	0.19 µg/L	0.18 µg/L					
08/25/2021		12.90 µg/L	0.14 µg/L	0.70 µg/L	ND	0.14 µg/L		ND	
09/07/2021		25.95 µg/L	0.30 µg/L			0.27 µg/L			
09/21/2021	0.17 µg/L	33.61 µg/L				0.17 µg/L	0.32 µg/L	0.17 µg/L	0.25 µg/L

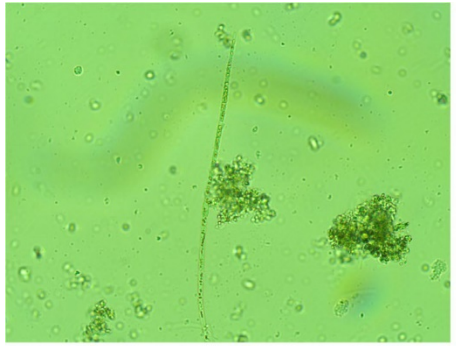

SHADY01:


BVCL6: 08/11/2021


KEYS03: 08/25/2021


SHADY01: 09/07/2021


SHADY01: 09/22/2021


SHADY01: 10/12/2021

CAUTION - PRECAUCIÓN

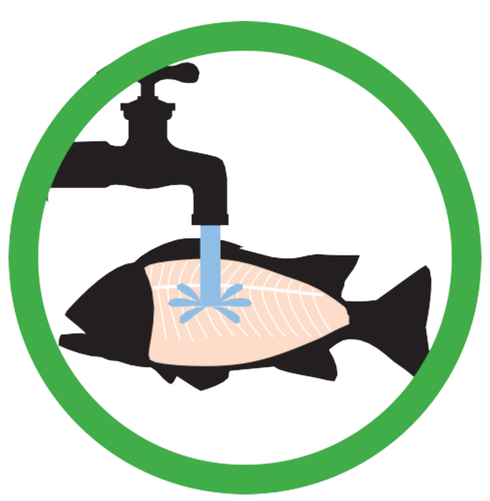
Harmful algae may be present in this water.
Puede haber algas dañinas en estas aguas.

Stay away from algae and scum in the water.

Aléjese de las algas o espuma lamosa en el agua.

Keep children away from algae in the water or on the shore.

Mantenga a los niños alejados de algas en el agua u orilla del agua.



For fish caught here, **throw away guts and clean fillets** with tap water or bottled water before cooking.

Al pescado que pesque aquí, **quítele los intestinos y tírelos a la basura.** Limpie el filete con agua de la llave o embotellada antes de cocinarlo.

Do not let pets and other animals go into or drink the water, or eat scum on the shore.

No deje que sus mascotas o animales se metan o beban el agua, o se acerquen a la espuma lamosa.

Do not drink this water or use it for cooking.

No beba de esta agua o use para cocinar.

Do not eat shellfish from this water.

No coma mariscos de estas aguas.

Call your doctor or veterinarian if you or your pet get sick after going into the water.
Llame a su médico o veterinario si usted o su mascota se enferman después de meterse al agua. For more information go to (Para información) : https://mywaterquality.ca.gov/habs/
For local information, contact (Para información local comuníquese con):

WARNING - ADVERTENCIA

Toxins from algae in this water can harm people and kill animals
Toxinas de algas en estas aguas pueden causar daño a la gente y matar animales

No swimming.
Prohibido nadar.

Stay away from scum, and cloudy or discolored water.

Manténgase alejado de la espuma lamosa, y agua turbia o descolorida.

Do not use this water for drinking or cooking. Boiling or filtering will not make the water safe.

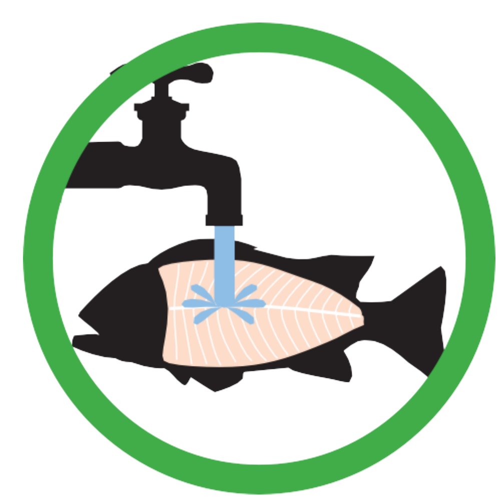
No use esta agua para beber o cocinar. Hervir o filtrar el agua no hace que sea segura.

Do not let pets or other animals go into or drink the water, or go near the scum.

No deje que sus mascotas o animales se metan o beban el agua, o se acerquen a la espuma lamosa.

Do not eat shellfish from this water.

No coma mariscos de estas aguas.



For fish caught here, **throw away guts and clean fillets** with tap water or bottled water before cooking.

Al pescado que pesque aquí, **quítele los intestinos y tírelos a la basura**. Limpie el filete con agua de la llave o embotellada antes de cocinarlo.

Call your doctor or veterinarian if you or your pet get sick after going into the water.
Llame a su médico o veterinario si usted o su mascota se enferman después de meterse al agua. For more information go to (Para información) : https://mywaterquality.ca.gov/habs/
For local information, contact (Para información local comuníquese con):

DANGER - PELIGRO

Toxins from algae in this water can harm people and kill animals
Toxinas de algas en estas aguas pueden causar daño a la gente y matar animales

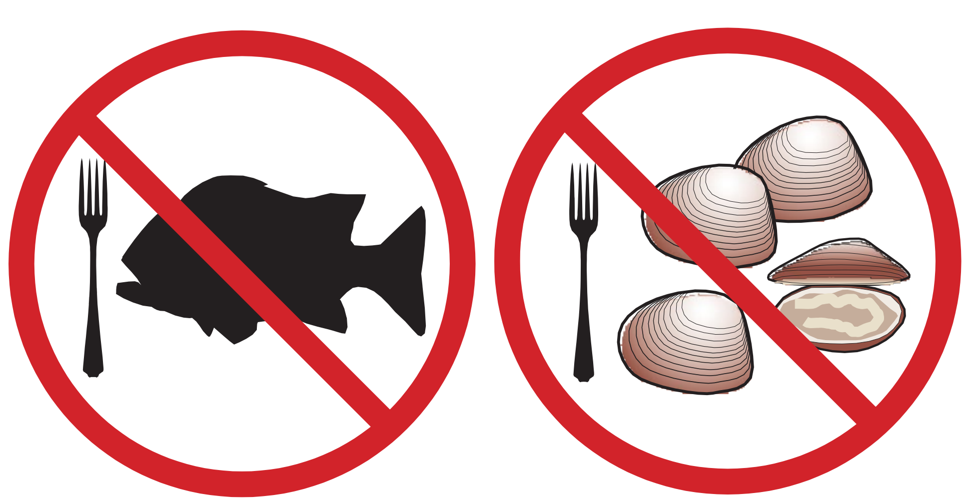
---

Stay out of the water until further notice. Do not touch scum in the water or on shore.

Manténganse fuera del agua hasta nuevo aviso. No toque la espuma lamosa en el agua o en la orilla.

Do not let pets or other animals drink or go into the water or go near the scum.

No deje que sus mascotas o animales beban o se metan al agua, o se acerquen a la espuma lamosa.



Do not eat fish or shellfish from this water.

No coma pescados o mariscos de estas aguas.

Do not use this water for drinking or cooking. Boiling or filtering will not make the water safe.

No use esta agua para beber o cocinar. Hervir o filtrar el agua no hace que sea segura.

Call your doctor or veterinarian if you or your pet get sick after going into the water.
Llame a su médico o veterinario si usted o su mascota se enferman después de meterse al agua. For more information go to (Para información) : https://mywaterquality.ca.gov/habs/
For local information, contact (Para información local comuníquese con):