DRAFT 2022 Report to the Governor of California and California State Legislature

AB 707

Blue Ribbon Committee for the Rehabilitation of Clear Lake

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

Forward by Blue Ribbon Committee for the Rehabilitation of Clear Lake Chair Eric Sklar

2023 has been the most productive year to date for the Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee).

Committee Members, Local Tribes, State Staff, and other stakeholders have all worked together to launch key projects, secure the funding to complete the large-scale multi-year research projects and begin to plan for the major projects that will restore the lake.

The coming year will be challenging with the current economic situation, but everyone involved is geared up to forge a wide path forward in the effort to rehabilitate this very valuable asset. The work of the committee these last few years has been exciting and dynamic. The coming years promise to be even more so. I hope I speak for everyone involved with pride for the work the committee has done and bright optimism for the future of the lake and the county.

This year's annual report is a great resource for all interested parties to learn more about the committee's work thus far and where the effort is heading. Thanks to our great staff for the effort to make it such a valuable resource.

Sincerely,

Eric Sklar

Committee Chair

Blue Ribbon Committee for the Rehabilitation of Clear Lake

2022 Report to the Governor and California State Legislature

December 28, 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 California Native American 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 fourth 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 2022 recommendations in Sections 5 and 6 below, which include specific funding recommendations for the next budget cycle. These steps mark an important step as the Committee begins the transition from study and data collection to specific actions to address the challenges. **Please note: all recommendations appearing in this report were approved by the Committee in May and June of 2022.**

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

Section 2: Status of 2021 Recommendation Implementation and Progress to Date

All recommendations included in the 2021 Annual Report and approved by the Committee were fully funded in the 2021/22 State Budget. These recommendations are focused on a continuation of research efforts, individual restoration projects, and local capacity-building efforts to provide communities with the tools needed for the long-term sustainable management of Clear Lake.

The status of each recommendation is as follows:

- Clear Lake Dilapidated Structure Abatement: contracting completed between the Lake County Water Resources Department (WRD) and Resources. Work began using a combination of state and local funds in Summer 2022.
- Kelsey Creek Fish Ladder Restoration: Contracting underway between the Big Valley Band of Pomo Indians (Big Valley) and Resources; the site of the Kelsey Creek Fish Ladder requires additional right-of-way access agreement and final environmental impact study. Work will begin on completion of these planning activities.
- Lake County Trash Remediation: Contracting is underway between WRD and Resources. Work will begin to conduct trash remediation throughout the Clear Lake basin on completion of contracting.
- Tule Replanting and Invasive Aquatic Vegetation Removal: Contracting is in progress between Big Valley and Resources.
- Piloting Environmental Education Resources: Contracting is complete between UC Davis and Resources. UC Davis has begun work to survey environmental education needs in Clear Lake communities. Work is expected to last 2 years.
- Environmental Education Program Evaluation: Contracting is complete between UC Davis and Resources. Program evaluation will be completed to determine environmental education effectiveness on completion of the pilot project discussed above.
- Cobb Mountain Watershed Education Program: Contracting is complete between the Siegler Springs Community Redevelopment Association (SSCRA) and Resources. Outreach to partner organizations began in fall 2022; final reports and outcomes are expected in 2023.

A complete overview of 2021 recommendations is available in the 2021 Annual Report here. An up-to-date contract tracking sheet is available online here.

Section 3: 2022 Committee Process and Progress to Date

Committee Deliberations

This section provides a brief background on the Committee and its subcommittees, and summarizes their deliberations in 2022. 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 the seven Clear Lake California Native American tribes , 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**.

2022 Committee Process

The Committee met five times in 2022. 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**. Please note, this process has been significantly updated to match the state's fiscal year. As such, the Committee has shifted from a calendar-year schedule of proposal development to a fiscal year schedule.

A major new development for the Committee in 2022 was the development of an overarching vision and goals to guide future Committee activities. The Committee also developed specific project proposal requirements to ensure all projects recommended to Resources for funding and implementation work to achieve that vision. These items are discussed in greater detail in Section 6 below.

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

Meeting Date	Summary
March 10, 2022	2022 project proposals introduced for Committee consideration. Updated annual schedule/process for proposal approval presented.
May 25, 2022	Initial round of approval for select projects discussed in Section 5 below.
June 22, 2022	Final approval of remaining projects discussed in Section 5 below.
September 8, 2022	Initial discussion of Committee Vision and Project Proposal Requirements
December 13, 2022	Approval of Committee Annual Report, Vision, Project Proposal Requirements, and Proposition 68 Funding Availability for Select Restoration Projects

Table 1: 2022 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**.

Socioeconomic Subcommittee Process to Date

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 monthly in 2022 unless otherwise noted. 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.

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. Since that time, the UC Davis Center for Community and Citizen Science (CCCS) has also joined CRC in socioeconomic and environmental education efforts. Research from both entities will inform the Committee's work in the future. Additional information on both research projects is described below.

Additionally, since 2021, the US Geological Survey (USGS) has worked to monitoring Clear Lake tributaries and will develop a model similar to TERC's in-lake model. The goal of this effort is to better understand the sources and drivers of nutrients and sediment entering the Lake which may contribute to HABs and other environmental challenges.

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.

TERC and USGS Information

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 discussed in Section 1 above. A summary of TERC's research and outcomes to date is provided in joint year-end report with the USGS in **Appendix C.** Extensive reports and raw data are available on the UC Davis Clear Lake website here.

Similar to the in-lake work conducted by TERC, USGS is developing tools to better understand processes in Clear Lake tributaries which may lead to HABs and other environmental challenges. In combination with TERC's hydrodynamic model, the data collected as part of the USGS effort will provide a complete picture of the drivers of, and potential solutions to address these challenges.

CRC and CCS Information

The UC Davis CRC and CCCS 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**. Extensive reports and raw data are available on the UC Davis Clear Lake website here. **PLEASE NOTE:** At the time of this Annual Report, CRC and CCCS were awaiting final results for inclusion in the Report. Appendix D will be updated as soon as this information is finalized.

Clear Lake Ongoing Cyanotoxin Monitoring Information

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**. **PLEASE NOTE:** At the time of this Annual Report, Big Valley was awaiting final results for inclusion in the Report. Appendix E will be updated as soon as this information is finalized.

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

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

As the Committee awaits these long-term research results, in 2022 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 May 25 and June 22, 2022. In 2022, the Committee requests a total of **$5,653,500** from grant or General Fund allocations for the projects listed in Figure 5A below.

A complete breakdown of all project proposals approved by the Committee is included in **Appendix G**.

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. Per Proposition 68 guidelines, all funds must be encumbered by the end of Fiscal Year (FY) 2022/23. Funds must be fully expended by the end of FY 24/25 in June, 2025.

A portion of these funds totaling approximate $2 million was applied to approved projects in 2020 and 2021. The remainder of these funds will be applied to selected local restoration projects in 2022/23.

A breakdown of local projects eligible for Proposition 68 funding is provided in Figure 5B below. On December 13, 2022, Committee members present at the final meeting of 2022 unanimously approved this suite of projects for Proposition 68 funding. Application of these funds to select restoration projects reduces the total 2022 General Fund request by $2,251,500 for a total of **$3,402,000**.

Figure 5A: Funding Summary of 2021 Projects

Sponsor/Grantee	Project Name	Amount
Lake County Water Resources Department	Airborne Electromagnetic Survey of Lake County Groundwater Basins*	$300,000

Scotts Valley Band of Pomo Indians	Scotts Valley Aquifer Evaluation*	$80,000
Mendocino College	Environmental Education Pathways Program*	$72,000
Tribal Ecosystem Restoration Alliance (TERA)	EcoCultural Tule Restoration	$404,600
UC Davis	Hypolimnetic Oxygenation Pilot Project-Oaks Arm	$2,250,000
Big Valley Band of Pomo Indians	Adobe Creek Hydrology and Groundwater Monitoring	$150,000
Big Valley Band of Pomo Indians	Groundwater Dependent Ecosystems and Wetland Restoration Analysis/Implementation (50/50 with planning)	$500,000
Big Valley Band of Pomo Indians	Big Valley Harmful Algal Bloom Bank Erosion	$600,000
Big Valley Band of Pomo Indians	Web-based Clearinghouse for Data/Citizen Science App*	$250,000.0
Robinson Rancheria	Clear Lake Common Carp and Goldfish Management	$746,900
Administrative fees		$ 300,000
	Total Funding Request	**$5,653,500**

Figure 5B: Proposition 68 Funding Available for 2022 Restoration Projects

- TERA EcoCultural Tule Restoration ($404,600)
- Big Valley GDE and Wetland Restoration ($500,000)
- Big Valley HAB/Bank Erosion Mitigation ($600,000)
- Robinson Rancheria Common Carp and Goldfish Management ($746,900)

Total: $2,251,500*

*Remaining Proposition 68 funding of $748,500 will be evenly distributed among existing restoration projects to maximize number of sites for tule restoration, invasive species removal, HAB mitigation, and common carp/goldfish management.

Section 6: 2022 Committee Vision, Goals, and Project Proposal Requirements

As discussed above, the Committee dedicated significant time developing an overarching vision to guide activities moving forward. To achieve that vision, specific goals and project proposal requirements were also developed. These items were unanimously approved by all Committee at its December 13, 2022 meeting; future project proposals will be weighed against all three elements (vision, goals, and proposal requirements) before recommendations for funding are submitted to Resources.

Committee Vision

Since 2018, the Committee has supported projects designed to better understand the challenges impacting Clear Lake's water quality, the environment, and the social, cultural, and economic well-being of its communities. Research has focused on harmful algal bloom (HAB) drivers, mercury contamination, and social/cultural/community resilience.

As these activities begin producing results and recommendations for addressing concerns, the California Natural Resources Agency (Resources) and Committee Chair highlighted the need for a clear vision to guide Committee projects and priorities with the end goal of restoring Clear Lake for a sustainable physical environment, Clear Lake cultures and communities, and current and future identified beneficial uses. It is important to note that although legacy contaminants from the Sulphur Bank Mercury Mine are managed by a separate federal process, the Committee recognizes their unique contribution to environmental challenges in Clear Lake. The Committee will continue to pursue specific recommendations related to mercury contamination in addition to lake-wide challenges.

The DRAFT vision and project criteria discussed below were developed through conversations with the Committee's Technical and Socioeconomic Subcommittees in July and August, 2022, refined by the Committee in September 2022, and unanimously approved by all Committee members present on December 13, 2022.

As a program within the California Natural Resources Agency, the Committee is an advisory body; the selection of projects for funding will be determined by the State of California. This document is intended to guide the Committee as it recommends funding and implementing projects. For more information on the Committee, please click here.

After a vision and project criteria are developed, Committee and Subcommittee members will be asked to craft a unified plan for meeting the requirements of AB 707 (Aguiar-Curry, 2017). This legislation established the Committee and sets broad goals for improving the health of Clear Lake thus improving social and economic outcomes in its surrounding communities.

<u>DRAFT Committee Vision Statement</u>

The Committee will support and develop sustainable solutions for the rehabilitation and local management of Clear Lake through a collaborative community process recognizing the interrelated nature of the Clear Lake environment, its communities, governments, cultures, and the economy.

DRAFT Committee Goals

The Committee will pursue efforts and projects which seek to:

1. Improve water quality and ecological health for environmental, Tribal, subsistence consumption, drinking water, and other beneficial uses
2. Increase native and beneficial species abundance and diversity through habitat restoration while decreasing the prevalence and impact of invasive species
3. Enhance climate resilience and adaptability
4. Recognize and respectfully incorporate the critical importance of tribal heritage and cultural uses of Clear Lake and the surrounding area
5. Restore and enhance responsible recreational use while mitigating negative impacts
6. Create and enhance outreach and education programs to strengthen local community understanding of capacity for the stewardship of Clear Lake
7. Restore and enhance local and regional pride in North America's oldest and California's largest natural lake
8. Improve the economic prosperity of Clear Lake communities
9. Utilize traditional ecological knowledge and the best available science to inform all solutions

Proposal Requirements

The Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee) Vision and Goals serve as "guiding principles" for Committee activities, providing "sideboards" for project proposals brought to the Committee for eventual funding and implementation. This document provides suggested proposal requirements, reporting standards, and a timeline for proposal submission at the request of Committee members. This document was approved by all members present at the Committee's December 13, 2022 meeting.

Only those projects designed to achieve elements of the Vision should move forward. To the greatest extent possible, the Committee should seek to approve projects which create a cohesive path forward for achieving that vision; however, it is assumed that some individual projects may address aspects of the Vision absent a direct link to other projects.

For all project proposals seeking Proposition 68 funds must follow the Proposition 68 Specified River Parkways Grant Guidelines/Procedural Guide available here.

1. Proposal Requirements

The following requirements will be used to develop a prioritization system for the Committee's consideration as it considers proposals. Depending on the type of proposal under consideration (i.e., environmental restoration, nutrient management, environmental education, etc.) not all requirements will apply. As projects are submitted for consideration, each Committee member is expected to consider how well the project addresses the items below.

Primary Requirements. These are critical for the Committee's consideration of each proposal:

1. Does the project contribute to improving the physical and biological health of Clear Lake?
2. Does the proposal describe baseline conditions (the current state) and goals (desired future state) it seeks to achieve?
3. How does the project demonstrate progress towards achieving the Committee's vision?
4. How will the seven Native American Tribes in Lake County be actively included in project design and implementation (starting with project concept development)?
5. How will the fully implemented project be maintained in the long-term with the local community?

Secondary Requirements. To the greatest extent possible, proposals should also:

6. Describe how the project is expected to improve or impact the Lake County economy.
7. Describe the outreach/community engagement necessary to build understanding of and support for the project. This may include (but is not limited to) a description of who will be engaged, and which existing groups will collaborate to increase project awareness/community buy-in.
8. Identify all local, state, and federal permitting requirements (including environmental review through NEPA/CEQA) required for project implementation. Describe a process for coordinating with appropriate local, state, and federal agencies.
9. Describe how the proposal uses existing research in its design and outline how the work leverages/builds on past and current research outcomes.
10. Use existing data to the maximum extent feasible *OR* describe specific data gaps expected to be filled through project implementation.
11. Describe the proposing entity's experience on similar projects.
12. Informational only: Describe whether the project seeks to address an issue under existing statutory or regulatory responsibilities of the entity leading the effort, and why the issue has not been resolved previously (i.e., lack of alternative funding sources, staff resources, local expertise, etc.).

2. Project Reporting Standards

Specific reporting requirements will be dictated in contract agreements after proposals are approved by the Committee and funded by the State, but at a minimum should include:

1. Written and verbal quarterly updates to the Committee on project implementation progress including status of deliverables/deadlines.
2. Quarterly updates to the Committee and Resources on community outreach/engagement and Tribal consultation. Which Tribes were consulted? Why weren't other Clear Lake Tribes contacted?
3. A plan for data management, submittal, and open sharing with all project collaborators and interested stakeholders throughout the life of the project, and post-project data ownership. Include specific discussion and plan for managing sensitive Tribal data.
4. Final report after project implementation.
5. Post-project monitoring updates.

3. Project Proposal Process/Timeline

To date, projects approved by the Committee have been funded through two primary sources: Proposition 68 grants and through the State of California's General Fund. Moving forward, individuals or organizations proposing projects should utilize the timeline in **Appendix B**.

Please note:

- Iterative review and refinement of projects will allow the Committee, Subcommittees, and project teams to ensure any issues are addressed as early as possible each calendar year.
- Proposals will be submitted for final Committee approval in May and June in advance of Resources budget deadlines.
- Approved projects may be funded the following year as part of the state budget process (ex: projects approved in May/June 2022 may be included in the 2023/24 Budget Act).

NOTE: Ultimately the California Natural Resources Agency (CNRA), as the parent agency of the Committee, will make a determination as to whether proposals seek to achieve the Committee's vision and the mandates laid out in AB 707.

Appendix A: Blue Ribbon Committee Member Roster

Name	AB 707 Membership Category	Appointing Entity
Eric Sklar	Appointed Chair	California Natural Resources Agency
Rebecca Harper	Agriculture	Lake County
Harry Lyons	Environmental	Lake County
Scott Harter	Public Water Supply	Lake County
Jennifer LaBay	Regional Water Board	Central Valley Regional Water Quality Control Board
Eddie "EJ" Crandell	Lake County Board of Supervisors	Lake County
Fred Kirschner, PhD	Tribal Representative	Elem Indian Colony
Tracy Treppa	Tribal Representative	Habematolel Pomo of Upper Lake
Mike Shaver	Tribal Representative	Middletown Rancheria of Pomo Indians
Dr. Jay Lund	UC Davis	UC Davis
Sarah Ryan	Tribal Representative	Big Valley Band of Pomo Indians
Terre Logsdon	Tribal Representative	Scotts Valley Band of Pomo Indians (through September 2022)
Wilda Shock	Local Economy	Lake County
Karola Kennedy	Tribal Representative	Koi Nation
TeMashio Anderson	Tribal Representative	Robinson Rancheria (through September 2022). Scotts Valley Band of Pomo Indians (beginning in December 2022).

Technical Subcommittee Roster/Participants [2]

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

[2] Note the Technical and Socioeconomic Subcommittees are advisory only; participation fluctuates depending on the subject matter of each meeting and the individual availability of participants. This list is intended to show a snapshot of regular attendees only.

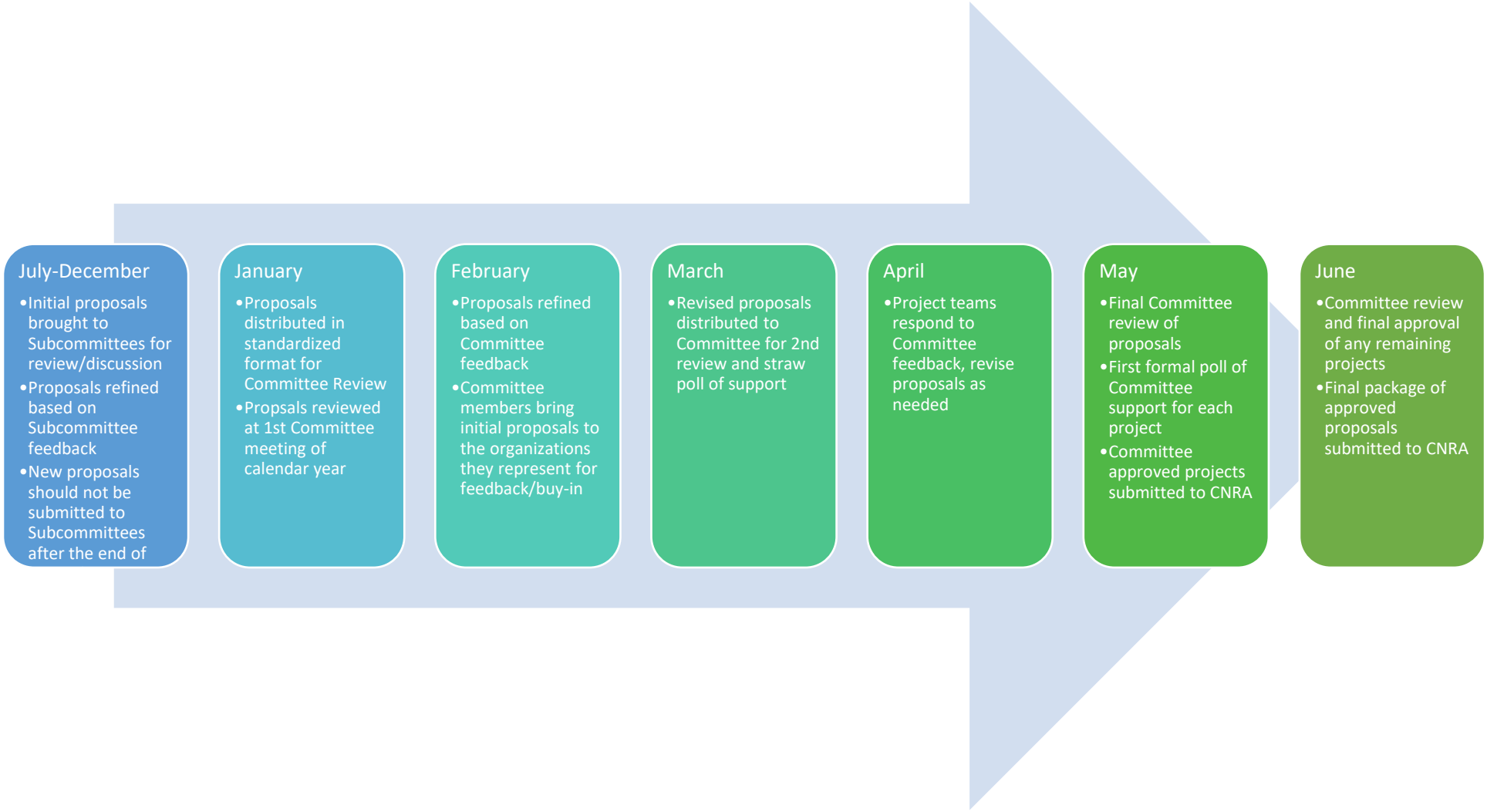
William Fox	WRD

Socioeconomic Subcommittee Roster/Participants[3]

NAME	ORGANIZATION OR INTEREST
Alyssa Nelson	UC Davis Center for Community and Citizen Science
Amanda Martin	Lake County Land Trust
Bernadette Austin	UC Davis Center for Regional Change
Brock Falkenberg	County Superintendent of Schools
Clare Cannon	UC Davis Center for Regional Change
Eliot Hurwitz	Cobb Area Council
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
Monica Flores	Mendocino College/Lake Center
Susan Jen	Health Leadership Network
TeMashio Anderson	Robinson Rancheria, Blue Ribbon Committee
Terre Logsdon (Co-Chair)	Scotts Valley Band of Pomo Indians, Blue Ribbon Committee
Wilda Shock (Co-Chair)	Lake County Economic Development Corporation, Blue Ribbon Committee
Will Evans	Clear Lake Environmental Research Center

[3] Note the Technical and Socioeconomic Subcommittees are advisory only; participation fluctuates depending on the subject matter of each meeting and the individual availability of participants. This list is intended to show a snapshot of regular attendees only.

Appendix B: Annual Committee Engagement and Proposal Development Process



Appendix C: Joint UC Davis Tahoe Environmental Research Center (TERC)/ US Geological Survey Updates

2022 Annual Research Update for the Blue Ribbon Committee

Clear Lake Watershed and Lake Remediation Project

[1]UC Davis Tahoe Environmental Research Center

[2]U.S. Geological Survey

[1]Geoffrey Schladow, Alexander Forrest, Steven Sadro, Alicia Cortés, Micah Swann, Samantha L. Sharp

[2]Joseph L. Domagalski, Charles N. Alpers, Dina K. Saleh, Michelle A. Stern, Connor J. McVey

December 2022

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PART A: UC Davis Tahoe Environmental Research Center (TERC): Lake Monitoring and Modeling in Clear Lake

1. UC Davis TERC Accomplishments in 2022

1.1. 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 and multi-variable profiles throughout the water column and across all three lake basins during eight sampling events in 2022 (January 28th, April 1st, May 13th, June 13th, August 2nd, September 12th, October 20th, and December 2nd). The water samples were analyzed for dissolved and particulate forms of nitrogen, phosphorus, and carbon; chlorophyll; particle size distribution; phytoplankton and zooplankton identification and quantification. A new laboratory staff member (Helen Fillmore) has been successfully on-boarded, who helped greatly with data analysis. All of these data are critical for the ongoing development of the numerical models of physical transport and lake production and for a better understanding of the range of solutions that may be applied in the future.

Water samples were also collected for the Big Valley Band of Pomo Indians for their cyanobacteria monitoring program. During most of 2022, data collection has been particularly challenging due to the 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 colored dissolved organic matter (CDOM) and mercury.

1.2. Publicly available data

In 2022, we launched a new TERC-Clear Lake website, with a publicly available data repository for all our data. This website also includes a brief description of our field monitoring plan, displays data interactively, shows field observation animations, stores photos and publications, and posts updates on a blog. We continue to improve this website with the support of the IT Department of the College of Engineering at UC Davis.

1.3.Continued watershed monitoring collaboration (USGS-TERC-Lake County)

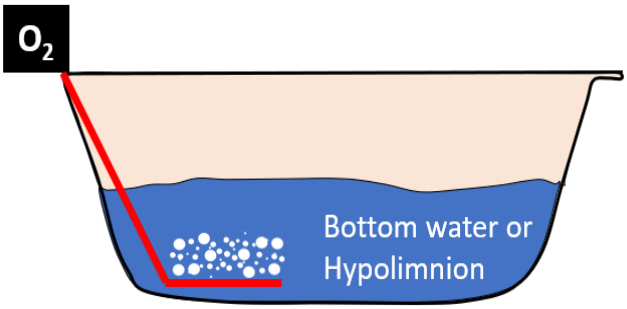
In addition to the in-lake monitoring, we are collaborating with USGS and Lake County Water Resources Department (LC-WRD) to conduct a 3-year upper watershed monitoring study. Fall 2022 has been the beginning of the second sampling year. We have developed a new protocol for storm sampling at Clear Lake. Flow permitting, we are planning to sample up to 15 tributaries (natural creeks and culverts) up to 12 times a year. USGS and LC-WRD will be responsible for the sampling and filtering. 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.

1.4.Participation in BRC and Technical meetings

We participated in quarterly BRC meetings and monthly Technical BRC meetings. We have also participated in the "Clear Lake October Fest 2022" meeting organized by the USGS Volcano Hazards Program to provide an update on the TERC Clear Lake project and the BRC Open House on December 13th. Alicia Cortes presented work conducted at Clear Lake during her Invited Speaker talk at the Joint Aquatic Sciences Meeting (JASM) in May 2022 (Grand Rapids, Michigan).

1.5.Approved hypolimnetic oxygenation pilot project in the Oaks Arm

Historical monitoring data and more recent monitoring, experiments, and modeling by UC Davis TERC have shown that periods of low dissolved oxygen next to the lakebed sediments are a major factor in the poor water quality and ecological health of Clear Lake. Hypolimnetic oxygenation is a technique that has been used nationwide (and in California) in impaired water bodies. It entails the direct injection of pure oxygen into the lake's hypolimnion (the lower stratum of the lake) during the summer months (Fig. 1). TERC has suggested a pilot research project that consists of the design, construction, implementation, monitoring, water testing, and scenario testing of Hypolimnetic Oxygenation (HO) in the Oaks Arm of Clear Lake.



This project has been approved by the Blue Ribbon Committee. Our proposal will be forwarded to the California Natural Resources Agency (CNRA) for funding in the Fiscal Year (FY) 2023/24 California State Budget. If the project is funded by the State of California, it will be conducted between July 2023 and July 2025, with the first year focusing on permitting, design, outreach, and construction, and the second year dedicated to oxygen injection in the lake, monitoring, and final report

1.6. Summary report on metals and metalloids in Clear Lake based on historical data (TERC-USGS)

This report addressed concerns raised about possible toxicity threats from metals in Clear Lake if the proposed Hypolimnetic Oxygenation (HO) pilot project in the Oaks Arm is executed. The HO comprises the addition of oxygen to the bottom waters of the lake when it falls to low levels (hypoxia), which typically occurs during the summer months. During the rest of the year, when the lake is actively mixing, Clear Lake has more than 5 mg/L in the bottom waters (oxic conditions). Thus, we can learn much about how the concentration of various metals responds to changes in dissolved oxygen (DO) concentrations by analyzing existing historic data. Here, we analyzed the long-term data for metals and metalloids in Clear Lake collected monthly across the lake by the California Department of Water Resources (DWR) during the last 50 years to infer if oxic conditions result in the release of metals. Results from this report confirmed that metal concentrations (except for nickel, at environmentally low levels) do not increase during oxic periods. This strongly supports the hypothesis that increasing summer DO concentrations using hypolimnetic oxygenation will improve lake water quality and pose no new threats (Fig. 2).

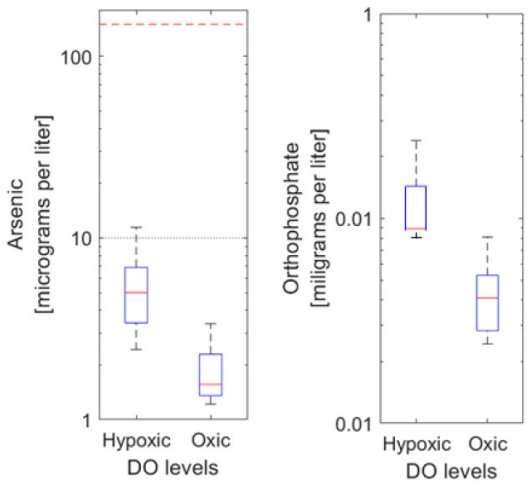


Fig. 2. Boxplots for arsenic and orthophosphate concentrations under hypoxic and oxic conditions in

1.7. Interactions with Clear Lake Tribes and stakeholders

Interactions with Clear Lake tribes and other stakeholders continue to be a high priority.

- In 2022, in addition to the previously mentioned cyanobacteria sample collection, some members from the Big Valley Band of Pomo Indians community have joined our sampling crew (Alix Tyler, Amida Verhey).
- We have helped the Lake County Department of Water Resources to set up a filtering station for the stream water samples collected during the watershed monitoring program.
- We also had conversations with Temashio Anderson (Robinson Rancheria) and Eddie Crandell (Lake County Supervisor) to identify their concerns about our lake remediation recommendation.
- We delivered our first outreach presentation of the Hypolimnetic Oxygenation Pilot Project in the Oaks Arm at the Clearlake Homeowners Association meeting on September 24th, 2022.

We are still in touch with this community while developing remediation strategies for their specific problems.

- Our graduate student Kanarat Pinkanjananavee is collaborating with Buckingham Park Water District to analyze disinfection by-products.

1.8. Internal loading and cyanobacteria blooms in Clear Lake

Graduate student Micah Swann has completed a new laboratory experiment to evaluate the release rates of nutrients from the sediments during early summer in the Upper Arm (referred to as Incubation Experiment 3.0). This new experiment aimed to (1) evaluate if nutrient release rates in early summer were the same as in the fall, and (2) evaluate the effect of pH on oxic release rates. The collection of the sediment samples was successfully conducted on June 29th. The sediment samples were subject to anoxic and oxygenated conditions in the laboratory (incubation) during the whole month of July and samples were sent to TERC lab for analysis of nutrients, pH, metals, and redox. Preliminary results confirmed the phosphorus release rates observed in previous incubation experiments under anoxic conditions (2019 and 2020). Nutrient release rates under oxygenated conditions were not as high as expected for high pH values.

Micah Swann has also completed the first draft of his scientific manuscript "Drivers of cyanobacteria blooms in a polymictic lake", where he combined data from a range of sources to determine the internal and external nutrient fluxes and their connection to the magnitude of the summer cyanoHAB season in Clear Lake (Fig. 3).

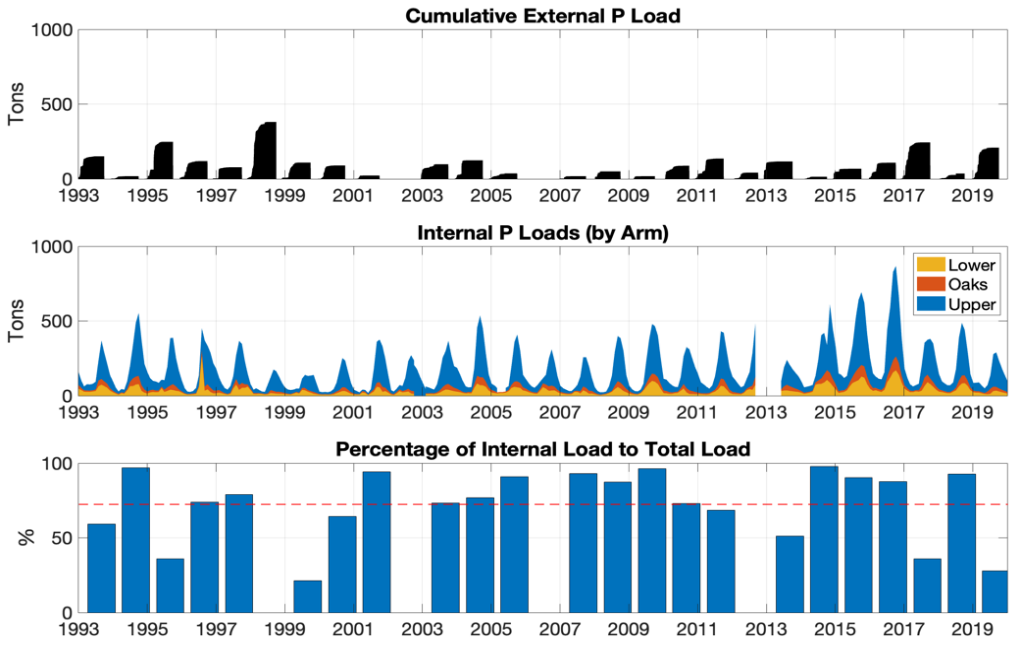


Fig. 3. Time series of cumulative external P load, internal P load by arm, and percentage of

Former graduate student, Nick Framsted. completed his MS thesis, half of which focused on nutrient-release experiments from Clear Lake sediments. He is currently working on a peer-reviewed publication describing his findings.

1.9. Remote sensing and cyanobacteria blooms

We have continued our efforts to measure cyanobacteria blooms in Clear Lake using a variety of remote sensing methods, led by our graduate student Samantha Sharp. Satellite-based remote sensing of cyanobacteria blooms is emerging as a useful tool for researchers and water managers because of the high spatial coverage and the frequent data availability. However, a limitation of currently available multispectral cyanobacteria algorithms is that they detect the presence and abundance of cyanobacteria but do not tell you whether a bloom contains cyanobacteria species that produce cyanotoxins. With the upcoming launches of satellites with hyperspectral sensors, higher spectral resolution data will be readily available. These rich datasets will allow for new algorithms to be developed based on detailed spectral differences between targets. With the prospect of these upcoming hyperspectral satellite missions, Samantha's research focuses on exploring the use of hyperspectral data to distinguish algal bloom types, with the goal that the dominant genera of cyanobacteria may be distinguished to determine if cyanotoxins may be present in an algal bloom, which has public health repercussions. During the summer and fall of 2022, Samantha Sharp collected hyperspectral data and phytoplankton samples coincident with DESIS image collections to refine remote sensing tools for algal species at Clear Lake (Fig. 4).

Fig. 4. Hyperspectral image collected during a DESIS flight in October 2022

1.10. Numerical Modeling: progress on water quality modeling

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 1^{o}C between modeled and observed lake temperatures for a two-year simulation in all Clear Lake basins. 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 (Fig. 5). This module needs the same type of calibration/

validation described for the hydrodynamic module. So far, we have conducted the following tasks:

- We have worked on the development of algorithms to represent the different nutrient cycles (P, N, C) and dissolved oxygen at Clear Lake.
- We have worked on the input files to run the Water Quality Model for Clear Lake.
- We have run the developed 3D Aquatic Ecological Model (AEM) for nutrients and phytoplankton and compare results with data collected in the summer of 2020 when the highest data quality is available so far.

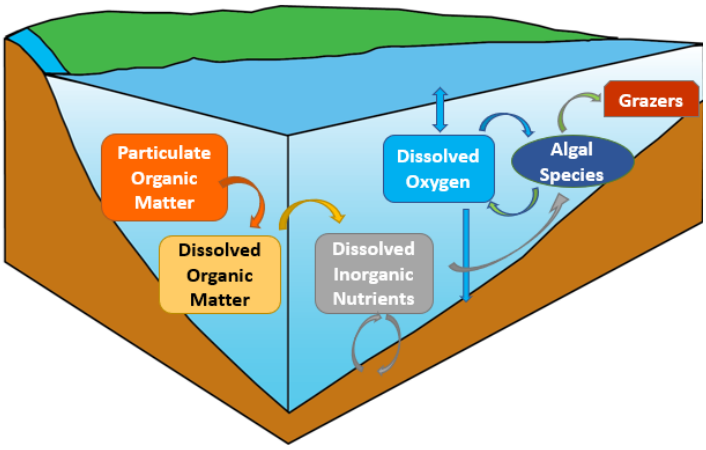
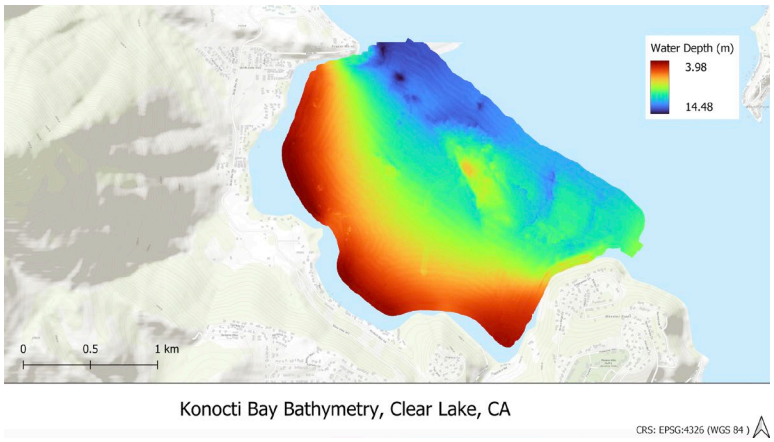


Fig. 5. Conceptual diagram of the biogeochemical model developed for the 3D Clear Lake model

- We have started monthly meetings with USGS watershed modeling team members (Michelle Stern and Dina Saleh) to coordinate the modeling products of this project (watershed and lake).

1.11. Bathymetrical survey update

In early 2022, we successfully onboarded a research staff member dedicated to the collection of bathymetry data at Clear Lake. We also integrated the necessary survey equipment onto the research vessel. The project team conducted over three weeks of field operations at Clear Lake in May/June 2022. In late June 2022, we ceased survey operations on Clear Lake due to water levels being too low to launch our survey vessel (<-0.5 ft Rumsey). Data collected during the 3-week initial survey showed some data quality artifacts due to hardware and software interferences (Fig. 6).



Over the summer we resolved the hardware/software issues of our sonar equipment by troubleshooting in Lake Tahoe. As a result, we are confident that we can collect high-quality

bathymetric data efficiently once water levels rise enough to resume the survey. The troubleshooting process revealed many sub-optimal system configurations. This includes both software settings and physical locations of instruments on our vessel. The instrumentation has now an adequate mount and location on the vessel to minimize interference. We plan to purchase software that allows us a more accurate data collection and post-postprocessing of the raw data. The software allows us to maintain higher (on the order of 10 cm or better) horizontal resolution more consistently using proprietary triangulation algorithms. The software will also correct for vessel motion (pitch, roll, head) with the required accuracy after the data has been collected.

We are appreciative of the support provided by the USGS Volcanology Section for this work.

2. UC Davis TERC Next Steps in 2023

2.1. Continue bathymetrical survey

We are developing an efficient workflow to make sure that raw data can be organized, backed up, and processed readily as soon as it is collected in the field. That will ensure final products from the sonar survey are produced in a timely fashion. The lead sonar operator is attending a week-long, immersive, training course in early December 2022 to ensure optimal workflows and facilitate the training of other staff. Progress on the sonar survey depends on water levels at Clear Lake. Once the Rumsey gauge is above -0.5 ft Rumsey, we can launch our survey vessel with the modified equipment configuration and updated software. We estimate that this will happen and, hence, we will be able to start surveying again before spring 2023.

2.2. New Proposal: 'Early warning system for HABs'

During the next cycle of proposals for consideration of the BRC in 2023, TERC would like to present a new project about an early warning system for HABs, which consist of a model-based early warning system, that comprises a one-dimensional model to provide an initial risk index and a three-dimensional lake model forecast of HAB location for the coming three days. The three-dimensional lake model will use daily remote sensing data for initial conditions and a combination of measured meteorological data and National Weather Service forecast meteorological data to "drive" the model. Three-day lake forecasts will be published daily on a public website. This forecasting tool will provide water purveyors, members of the tribes, and the general public with lead time to respond to episodic HAB events.

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

A new contract is being established with CNRA for mercury modeling, to involve USGS, private consultants, and TERC. The project team has started planning for the project which is anticipated to commence in January 2023. The addition of a mercury model to the lake 3D model will provide projections of mercury levels throughout the lake and would be the basis for developing a food web model for predicting levels of methylmercury in fish and other biota.

2.4.On-going work on wildfire smoke impacts

In the fall of 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 wildfires that occurred in our region in 2022, 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. We have also conducted multiple data analysis tasks with the data collected during the last two years.

PART B: U.S. Geological Survey (USGS): Watershed Monitoring and Modeling in Clear Lake Tributaries

1. USGS Accomplishments in 2022

1.1. Four stream gages installed

USGS constructed stream gages and began monitoring stream flow, water temperature and turbidity at four new locations in Clear Lake tributaries. The links in the table below are to real-time data for the parameters indicated.

USGS Station	Station Name	Flow	Turbidity	Temperature
11449255	Scotts Cr at Hwy 29 nr Upper Lake	G	A	A
11449235	Clover Cr bypass at Elk Mtn Rd nr Upper Lake	G	A	A
11449820	Cole Cr at Kelseyville CA	G	A	A
11449370	Molesworth Cr nr Old Hwy 53	G	A	A

G = Gage height only (pending rating curve)
A = Active

Because of the lengthy permitting process, the four gages listed above were not activated until late September 2022.

USGS also operates and maintains three other stream gages on Clear Lake tributaries.

USGS Station	Station Name	Flow	Turbidity	Temperature
11449500	Kelsey C nr Kelseyville	D	--	--
11448750	SF Scotts C nr Lakeport	D	A	A
11448800	Scotts C bl SF Scotts C nr Lakeport	D	A	A

D = Discharge
A = Active
– Not measured

Operation and maintenance of the gages on Scotts Creek and South Fork Scotts Creek are funded by the Bureau of Land Management (BLM). Station 11448800 also has an ISCO autosampler and the USGS computes daily sediment loads.

1.2. Water-Quality Sampling

The USGS team carried out water-quality sampling at nine Clear Lake Tributary locations during Water Year 2022 (October 2021 through September 2022). Sampling at the three sites in Scotts Creek drainage was funded by the BLM. The number of samples at each location is summarized below in Table 1.

USGS Station Number	USGS Station Name	WY 2022 samples	Filtered and unfiltered nutrients (UCD TERC lab)	Filtered and unfiltered nutrients (USGS lab)	Filtered and unfiltered mercury species (USGS lab)
11449235	CLOVER C BYPASS A ELK MTN RD NR UPPER LAKE CA	6	6		6
11449500	KELSEY C NR KELSEYVILLE CA	7	7		
390030122502101	KELSEY C AB SODA BAY RD BR NR KELSEYVILLE CA	6	6		6
391057122544301	MIDDLE C A RANCHERIA RD BR NR UPPER LAKE CA	7	7		7
391227122553101	MIDDLE C BL ELK MOUNTAIN RD BR NR UPPER LAKE CA	4	4		
391448122565601	MIDDLE C NR VANN CA	4	4		
11448750	SF SCOTTS C NR LAKEPORT CA *	8	1 #	8	
390236122575901	SCOTTS C A SCOTTS C ROAD NR LAKEPORT CA *	8	1 #	8	
390544122574201	SCOTTS C AB EICKHOFF RD BRIDGE NR LAKEPORT CA *	8	1 #	8	
	Totals	**58**	**37**	**24**	**19**

* BLM funding # Inter-lab comparison

(Note that USGS station number 390236122575901 is located about one mile downstream of USGS gaging station 11448800.)

The USGS team coordinated with UC Davis and Lake County regarding water sampling. Lake County staff collected water samples at some of the same sites during 2022 (at different times) and some additional sites. Water samples collected by Lake County were transported by USGS to Davis, where they were filtered at UC Davis and then submitted to the UCD TERC lab.

1.3. Sediment Fingerprinting

USGS collected streambed, streamside, soil, roadside ditch, and integrator samples throughout the Clear Lake tributary watersheds (Table 1). The tributaries that are being sampled for this work are: Adobe Creek (ADB), Burns Valley and Molesworth Creek (BVM), Clover Creek (CLV), Cole Creek (COL), Kelsey Creek (KEL), Manning Creek (MAN), Middle Creek (MID), Schindler Creek (SCH), and Scotts Creek. Scotts Creek is subject to the highest density of sampling and was discretized into the following sub-watersheds: Benmore Creek and South Fork Scotts Creek (BSF), Black Oak Springs and Lyons Valley Creek (BLV), Blue Lakes (BLL), Cooper Creek and Dayle Creek (CDC), Middle Scotts Creek (SCB), Scotts Creek Main (SCM), Tule Lake (TLL), and Willow Creek and Eight Mile Valley (WEM). Much of the work performed in the

Scotts Creek watershed was supported by Bureau of Land Management (BLM) funding, to fingerprint and track sediment and nutrient sources coming from BLM's South Cow Mountain Off-Highway Vehicle (OHV) Recreation Area. Sampling methods and analyses from the BLM-funded work coincide with those applied to the rest of the Clear Lake tributary samples so a common dataset will be established for all Clear Lake tributaries.

To balance the study design and sample collection efforts throughout the Clear Lake watershed, many of the tributary watersheds were paired together based on proximity, regional lithologies, land use, and other similarities. The final configuration was: ADB and MAN, BVM and SCH, CLV and MID, COL and KEL, Upper Scotts Creek (BSF, BLV, SCM, WEM), Middle Scotts Creek (SCB), and Lower Scotts Creek (BLL, CDC, TLL). Each of the tributary watersheds, including all Scotts Creek sub-watersheds, were assigned 'integrator' sites, which will be sampled multiple times over approximately a one-year period to evaluate possible seasonal effects on some parameters being measured.

The overall sediment fingerprinting study design calls for 750 samples to be taken – 75 each from 10 watersheds or subwatersheds; the 75 samples from each area will be distributed as 15 of each of the 5 sample types indicated in Table 1. As of December 2022, a total of 386 sediment fingerprinting samples have been collected to date (Fig. 1); to date, about half of the samples have been shipped to USGS Sample Control in Denver, CO for sample preparation (drying and sieving), and the rest will follow during early 2023.

Table 1: A summary of sediment fingerprinting samples collected in the Clear Lake tributaries. Samples organized by tributary and sample type.

Tributary	Streambed sediment	Streamside	Soil	Roadside ditches	Integrator	Totals
ADB + MAN	10	10	3	3	8	34
BVM + SCH	0	0	0	0	8	8
CLV + MID	7	4	7	1	15	34
COL + KEL	15	14	2	2	8	41
Scotts Creek	61	62	49	57	40	269
Totals	93	90	61	63	79	386

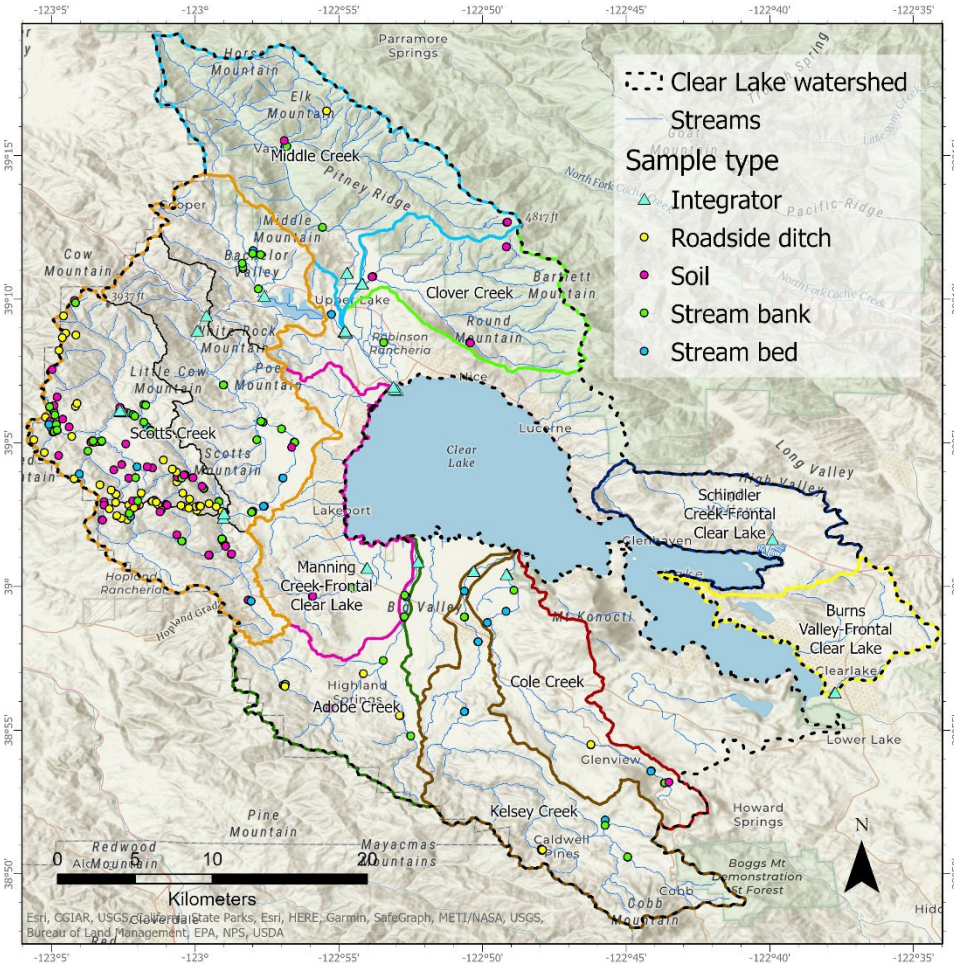


Fig. 7: Map of the Clear Lake watershed depicting tributaries and samples collected in 2022.

1.4. Rainfall-Runoff Modeling (HSPF)

We collected hourly weather data from 33 precipitation and 24 air temperature sensors in and surrounding the Clear Lake study area. Quality assurance/ quality control procedures were run

to remove erroneous and extreme outliers. These stations will be interpolated (Figure 7) to produce gridded hourly climate grids that drive the HSPF and SPARROW models.

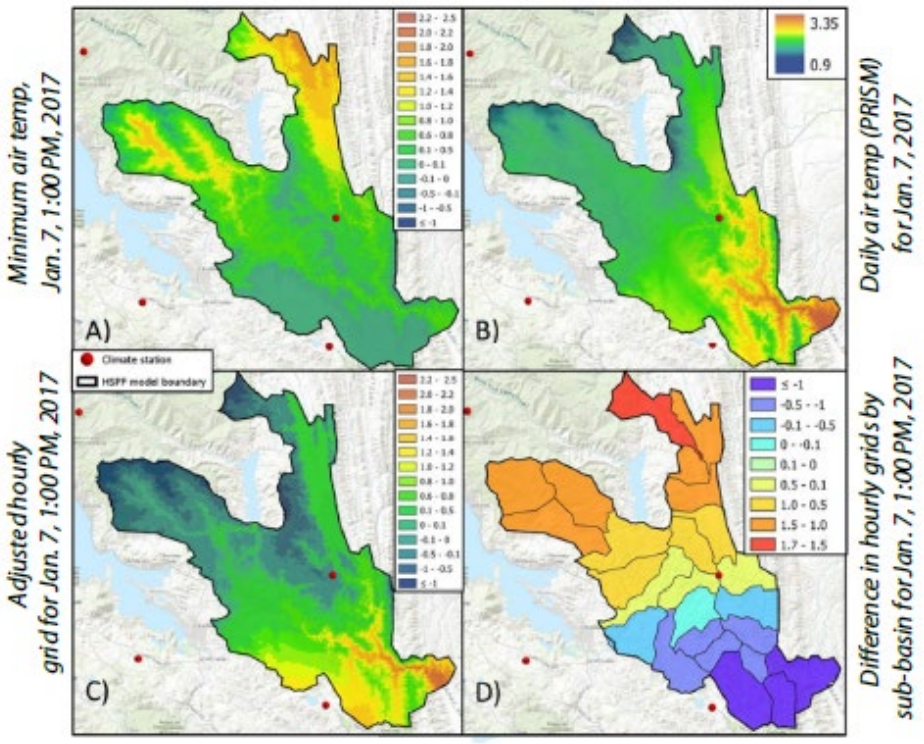


Fig. 8: Interpolation steps from hourly station data to gridded weather grids for Cache Creek, CA.

We worked with Task 2C lead Dina Saleh to use consistent sub-watershed basins for both models. Initial models were built for each tributary that flows into Clear Lake using the BASINS software, including sub-watershed delineation and stream network processing. Initial parameters were set up for each model and sub-basin, and GIS layers of soil properties, land use, elevation, and geology were downloaded and clipped to the study area for further parameter development. We began individual model testing and troubleshooting. We attended meetings with our UC Davis colleagues to coordinate model input and output requirements and to develop a timeline for completing major milestones. We also attended the Blue Ribbon Committee Clear Lake Open House meeting on December 13, 2022.

1.5. Mass-balance Modeling (SPARROW, Spatially Referenced Regression on Watershed attributes)

We are developing a SPARROW model to represent the sources, fate, and transport of nutrients and suspended sediment in streams in the Clear Lake watershed during 2022-2024 time period. The model will estimate mean seasonal total nitrogen, total phosphorus, and suspended sediment loads and yields in monitored and unmonitored stream reaches. The model will also quantify the relative contribution of different sources to total nitrogen, total phosphorus, and suspended sediment loads and yields. We compiled detailed historical datasets that describe water-quality conditions in all of the sub basins during the 2012 water year obtained from Wise

(2019) (https://pubs.er.usgs.gov/publication/sir20195112), to evaluate the hydrologic conditions during that time period. These databases include agricultural practices (fertilizer and manure application), atmospheric deposition, geology, soils, and land-use data, and other datasets that affect the fate and transport of nutrients and suspended sediment in the watershed (Fig. 9).

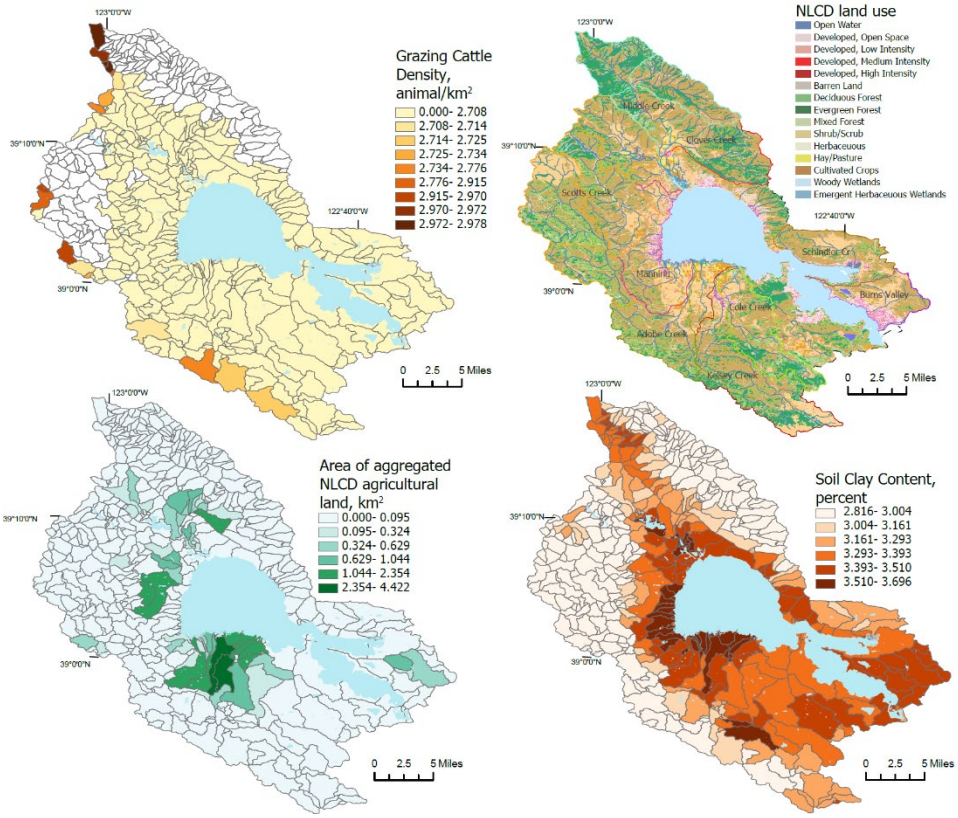


Fig 9. SPARROW data sets

Some of these datasets (for example, fertilizer and manure applications) will be updated for the 2022-2024 time period. These datasets will be used in developing the SPARROW model and used either as nutrient or sediment source terms or as delivery terms that transport nutrients to downstream portions of the watershed or the lake. We accumulated and verified stream reach attributes for the Clear Lake watershed from the NHD-Plus dataset (https://www.usgs.gov/national-hydrography/nhdplus-high-resolution). These attributes include a comprehensive set of digital spatial data that contain information about surface water features such as lakes, ponds, streams, and rivers, as well as the sub basin watershed boundaries. These data sets were formatted into the SPARROW input file for the first time period, and we will continue to format the entire 2022-2024 time period on a seasonal time step.

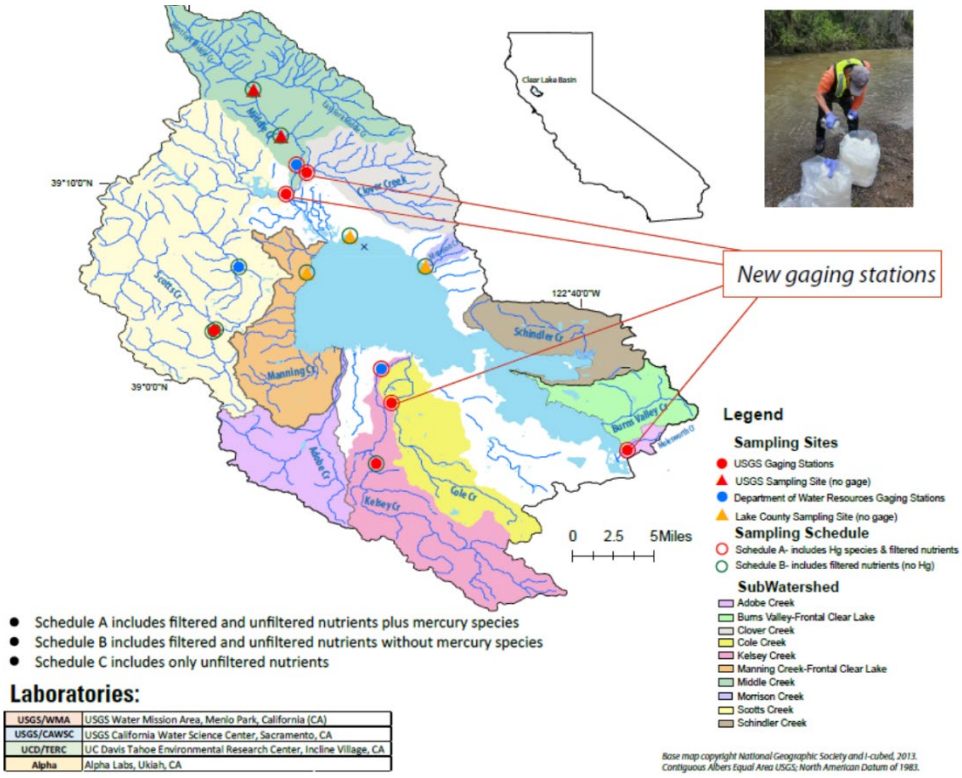


Fig. 10. Water-sampling locations for Clear Lake tributaries.

We retrieved historic streamflow data from 3 USGS and 3 California Department of Water Resources (DWR) gaging stations (Fig. 10). Data from 4 new USGS gaging stations (Figure 9) will be retrieved when available. We also retrieved historic water quality data from the DWR sites. All this data was formatted to be used for load calculations and will be used to calibrate the SPARROW model.

Updates to the Dynamic SPARROW model were obtained from the USGS National SPARROW team. This new model was evaluated, applied, and calibrated to a different watershed to give us a better understanding of the new model and how to apply it to the Clear Lake watershed.

1.6. Web portal with data access

USGS has developed two public Internet sites to allow for overall information on the project and to view water quality and discharge for the individual stream sites monitored for this study. The first site (https://www.usgs.gov/centers/california-water-science-center/science/hydrologic-and-aquatic-ecology-studies-clear-lake) provides general information about the water quality and aquatic ecology studies in progress at Clear Lake. From this site, the user can click on the Web Tools link which will then direct the page to the Watershed Monitoring in Clear Lake Tributaries page. A direct link to the monitoring Internet page is (https://www.usgs.gov/tools/watershed-monitoring-clear-lake-tributaries). This page directs the viewer to a map of the watershed which shows boundaries of individual stream

watersheds and monitoring sites. The monitoring sites include USGS stream gaging stations where water-quality samples are also collected, California Department of Water Resources stream gaging stations where water-quality samples are also collected, and additional locations for water-quality sampling without stream gaging stations both for USGS and Lake County. The viewer can click on an individual station where further information on each site can be accessed, such as river discharge and/or water quality.

1.7. Participation in BRC and Technical meetings

Members of the USGS team participated in quarterly BRC meetings and monthly BRC Technical Subcommittee meetings. The USGS team participated in the BRC Open House on December 13th by making a short oral presentation and providing a booth with posters explaining the USGS role in the project and a computer monitor with access to the new public web sites described above.

2. USGS Next Steps in 2023

2.1. Operation and Maintenance of Stream Gages

The USGS stream gages will continue to be operated and maintained throughout Water Year 2023 (October 2022 – September 2023) and will continue through Water Year 2024 (October 2023 – September 2024). Flow is typically seasonal at most of the sites; no flow is expected during May to September.

2.2. Water-Quality Sampling

Water sampling of Clear Lake tributaries during Water Year 2023 will continue to be coordinated among USGS, UC Davis, Lake County, and other stakeholders.

2.3. Sediment Fingerprinting

USGS will continue sample collection efforts in the next year. In addition to the 750 samples planned from the tributaries, an additional 45 samples are planned from the lakebed. The goal is to collect the remaining streambed, streamside, soil, roadside ditch, and lakebed samples by Spring of 2023. The integrator sites will be sampled periodically until each integrator location has a total of 15 samples. Most of the sample locations on public land have been collected. The next phase will require coordinating with many private landowners in Lake County. We will continue to build a working relationship with the local landowners and private citizens as we move toward completing the field work portion of this task.

Samples will be submitted to USGS Sample Control in Denver for processing by late Spring or early Summer. We expect to work closely with our colleagues in Denver to ensure the

processed samples are received by laboratories for analysis in a timely manner. Planned analyses include: major and trace elements; nutrient species (forms of nitrogen and phosphorus); forms of carbon (organic, inorganic, and pyrogenic); stable isotopes of carbon, nitrogen, and strontium; and grain-size distribution.

We expect to receive laboratory data for all submitted samples by late 2023. Once data are received it will go through a process of QA/QC and subsequently be published in a USGS data release. The data will be used for sediment fingerprinting calculations to determine sediment sources by watershed and land use / vegetation type.

2.4. Rainfall-Runoff Modeling (HSPF)

Over the next year, USGS will develop the gridded weather inputs and calculate potential evapotranspiration to run the models. The initial HSPF model parameters for streamflow, sediment, and nutrients will be enhanced using land use, soil properties, elevation, and geology. The initial HSPF models will be calibrated in three steps: 1) streamflow will be calibrated using available stream gage data, 2) sediment will be calibrated using sediment data collected at gages and parameterized using any available data from the sediment fingerprinting task, and 3) nutrients (nitrogen and phosphorus) will be calibrated in a similar method to the sediment calibration with any available nutrient data. Model outputs will include hourly streamflow, sediment transport, and nutrient loads. As new data are collected at each of the gages and from the sediment fingerprinting task, model calibration and validation will be performed iteratively as necessary. We will work closely with the SPARROW and UCD modeling teams to ensure communication about model outputs and future climate and land-use scenarios.

2.5. Mass-balance Modeling (SPARROW)

Over the next year, the USGS will continue to develop the input data set (Data1 file) needed to run the SPARROW model on a seasonal time step for the 2022-2024 period. This data set will include updated agricultural inputs based on county and state estimates of fertilizer applied to agricultural land and from livestock manure waste from confined animal operations, and from unconfined animals on farms, pastures, and rangelands; streamflow, runoff and recharge data obtained from the HSPF model developed in task 2B; climate data (temperature, and precipitation), and land use classifications obtained from the 2016 National Land Cover Database (NLCD) (http://www.mrlc.gov/nlcd.php). We will continue to collect nutrient and suspended sediment data from all USGS and DRW gaging stations.

2.6. Enhancement of web portal

The water quality portal will be enhanced during 2023 with continuous updates on water quality collected over the time frame of the project and some historical water quality. Additional enhancements will include graphical information on when water quality samples

were collected relative to stream flow at individual sites, as well as improved coordination regarding nutrient data collected and analyzed at the UC Davis Tahoe Environmental Research Center with uploads to the USGS National Water Information System. Further enhancements will include results for the mass-balance and rainfall-runoff modeling described above.

2.7. Participation in BRC and Technical meetings

Members of the USGS team will continue to participate in quarterly BRC meetings and monthly BRC Technical Subcommittee meetings, as well as future BRC Open House meetings.

References

Wise, D.R., 2019, *Spatially referenced models of streamflow and nitrogen, phosphorus, and suspended sediment loads in streams of the Pacific region of the United States (ver. 1.1, June 2020):* U.S. Geological Survey Scientific Investigations Report 2019-5112, 64 p., https://doi.org/10.3133/sir20195112.

Appendix D: UC Davis Centers for Regional Change (CRC) and Community and Citizen Science (CCS) Updates

Appendix E: US Geological Survey (USGS) Updates

Appendix E: Big Valley Band of Pomo Indians (Big Valley) Cyanotoxin Monitoring Updates

Appendix F: Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee) 2022 Approved Project Proposals

Contents

Proposal Background and Budget Summary

This document serves as a summary of all proposals submitted in 2022 for consideration by the Committee at its May 25 and June 22, 2022 meetings. All proposals were unanimously approved by Committee members present at the May 25 and June 22 meetings, and were forwarded to the California Natural Resources Agency (CNRA) for funding in the Fiscal Year (FY) 2023/24 California State Budget. The interim period from May 25, 2022-January 2023 (when the FY 23/24 budget is released) will be used to refine approved proposals and develop new concepts for funding the following year. Please note: the amount listed below is in addition to projects approved in FY 21/22 but deferred for funding until FY 23/24.

Please review the main body of the proposals in detail, as the meeting facilitator will ask for Committee approval on May 25 after a brief presentation from project proponents.

The main body of each proposal is four pages long and divided into the following sections:

- Title
- Description
- Timeline
- Budget
- Contact Information

Additional Information (such as letters of support or technical information) is include as an attachment to each proposal where available.

A summary of budget requests per proposal is included below:

Project Title	Proposal Developer	Budget Requested
Airborne Electromagnetic Survey of Lake County Groundwater Basins	Lake County Water Resources Department	$300,000
Proposal to Characterize Aquifer Conditions in Scotts Valley	Scotts Valley Band of Pomo Indians	$80,000
Environmental Education Pathway	Mendocino College	$72,000
Connecting Fire and Water: EcoCultural Tule Restoration of Clear Lake	Tribal Ecosystem Restoration Alliance	$404,600
Integrated Pest Management for Sustainable Shorelines	Lake County Water Resources Department	$351,953
Hypolimnetic Oxygenation Pilot Project in the Oaks Arm	UC Davis Tahoe Environmental Research Center et al	$2,250,000
Adobe Creek Hydrology and Groundwater Monitoring	Big Valley Band of Pomo Indians	$150,000
GDE and Wetland Restoration Analysis/Implementation	Big Valley Band of Pomo Indians	$500,000
Big Valley HAB and Bank Erosion Project	Big Valley Band of Pomo Indians	$600,000
Web-based Clearinghouse for Data/Citizen Science App	Big Valley Band of Pomo Indians	$250,000

Clear Lake Common Carp and Goldfish Management	Robinson Rancheria	$746,900
	Total:	$5,655,453

Clear Lake Blue Ribbon Committee

May 4, 2022

Project Title:

AEM (Airborne Electromagnetic) Survey of Lake County's Groundwater Basins

Agency Sponsor:
County of Lake Watershed Protection District

Project Contact:
William Fox, Water Resources Program Coordinator, Watershed Protection District, William.Fox@lakecountyca.gov, (707)263-2344

Project Description:
Past, present, and future drought in California tests the resiliency of communities and emphasizes the need for resource planning to deal with the uncertain future. Not only have our native fish species began to dwindle as there is insufficient water to support their spawning runs, but Clear Lake which provides 60% of the County's drinking water faces record low levels requiring water purveyors to extend their intakes farther into the lake. The California Department of Water Resources (CADWR) already funded AEM flights across all California's medium and above priority groundwater basins (including Big Valley) to help learn and safeguard quite possibly the most valuable natural resource on earth, water. This project aims to utilize the same technology CADWR applied to study other at-risk groundwater basins of Lake County (Figure 3) to ensure sustainable growth and prepare for the uncertain climatic future.

Project Goal:

The purpose of this project is to develop a white paper / report discussing groundwater issues and trends across the various groundwater basins in Lake County.
Other deliverables include: Developing a list of data gaps and steps to address data gaps, increased understanding of groundwater storage and resilience, support for planning of future groundwater extraction and municipal well planning, an improved mapping of the distribution of the aquifer system and aquitards, a better spatial understanding of the potential lithologic connectivity between the aquifers, creeks, and Clear Lake, and assessing future concerns to inform decision-makers (Planning Dept, Environmental Health for well permitting, water purveyors, local ordinance changes for groundwater management).

AEM technology can enhance our understanding of surface water – groundwater interactions to help determine if groundwater pumping is lowering stream levels and, therefore contributing to the decline of the State listed threatened species of fish, the Clear Lake Hitch and other groundwater dependent species.

Additionally, geologic information will increase our competitiveness when applying for future grant funds relating to water resiliency projects, as the planning and evaluation of water supply will already be completed by conducting these AEM surveys.

Finally, this data will also greatly enhance our planning process and improve government efficiency and effectiveness if CADWR requires groundwater sustainability plans from lower priority basins in the future.

Methodology:
AEM measures the electromagnetic response of the subsurface. Data is collected using geophysical instruments on a hoop that is towed beneath a helicopter. A current is generated in the hoop, which sends a signal into the subsurface (Figure 1). The response of the subsurface materials is measured in a receiver mounted on the helicopter. Different geologic layers have varying electrical resistivity responses. The AEM method can image the subsurface to depths of up to about 1,000 feet, depending on the electrical properties of the subsurface materials (at 60mph and 100ft above the ground) (Figure 2).
An important part of the planning phase is the evaluation of the expected outcome. This is done by looking into borehole information and geophysical wireline logs to ground truth collected information. Availability of this type of information makes it possible to predict the most likely geological setting and how it will be recorded by the AEM system. Expected depth of investigation is determined as is vertical resolution. In the planning phase the flight lines are designed to minimize the number of lines too close to powerlines and other noise sources that could affect data quality. Areas where AEM technology is not possible to be flown (urban areas, metal interference, and livestock) will be interpreted using well logs (also shown on Figure 2) and possibly TEM (Towed Electromagnetic).

Previous AEM Efforts:
In the previous CADWR flight, some logistical issues resulted in flights not being conducted over the Scotts Valley Basin. These issues resulted from inadequate planning due to the survey being conducted by CADWR across all of California. These logistical issues will be avoided with the extended timeline / local control, allowing for proper public outreach, land use confirmation, tailored flights for Lake County, and pilot planning. The other advantage to flying independent to the CADWR AEM flight is that the community can decide other interest areas outside the CADWR delineated groundwater basins and have denser flight lines to increase data accumulation. Local control of survey planning as opposed to the statewide conducted surveys really gives the power back to the community to sustainably plan for their futures. For example, basins already managing their groundwater sustainably could submit an alternative to the groundwater sustainability plans all medium and above priority basins were required to complete and submit to CADWR. Without knowing much about our groundwater basins, it is impossible to justify whether or not they are at risk. Thus, we currently do not have enough information to justify an alternative if lower priority basins are later required to comply with future SGMA (Sustainable Groundwater Management Act) amendments.

Rehabilitating Clear Lake:
Seventeen drinking water systems draw raw water from Clear Lake to provide over 60% of the County's drinking water needs. To date, it is the only drinking water reservoir in California with toxin-producing freshwater cyanobacterial harmful algal blooms (FCHABs). Further, climate change is shown to exacerbate FCHABs. The treatment processes for FCHABs increase costs for capital improvements and for the operation and maintenance. The increased cost of treating FCHABs disproportionally affects Lake County partly because it is the poorest county in California.

Surface water utilities in Lake County cost an average of 3.0% of resident's gross monthly income (GMI), which is double the state recommended level of 1.5%. Figure 12 shows the distribution of results comparing Clear Lake, groundwater, other surface water treatment and their relation to the recommended GMI contribution. Comparable groundwater systems were the most stable and ranged from 1.0%-2.4% with the largest cluster below the recommended GMI contribution.

Although cyanotoxins are not currently regulated under the Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) for several species of cyanotoxins will likely be adopted in the future. After

MCLs are adopted for cyanotoxins, small water systems treating FCHABs may be unable to attain funding to comply with drinking water mandates.

Thus, a critical component to the rehabilitation of Clear Lake is strategically planning drinking water extraction to best to serve the community. Understanding the County's groundwater resources could potentially lower utility bills, decrease reliance on Clear Lake, and prepare for future drinking water mandates.

(The above drinking water / cyanobacteria information was taken from a thesis prepared by Rachel Kennard: "*Safe and Affordable Drinking Water for Sources Impaired by Harmful Algal Blooms: Clear Lake, California"*, *2021)*

Potential Partnerships / Collaboration:

It is a goal of this project, if funded to conduct community outreach to better assess areas of interest for the AEM flight. There has been very limited collaboration so far, as the project has not entered the planning stages yet. If funded, an integral portion of AEM flight planning will be the consultation with various stakeholders.

- The tribes of Lake County will be consulted both for authorization to fly over their respective territories and to gain traditional knowledge to enhance flight planning (ex: natural springs which might have dried up a long ago).
- Water purveyors will be consulted to gain a better understanding of their future planning and current groundwater extraction.
- Cities of both Lakeport and Clearlake will be consulted for dry well areas, assess current issues, help plan for strategic growth, understand current / future water demand and to better plan interest areas. Lakeport City Manager has briefly been consulted and is very supportive of the project.
- County Planning and Environmental Health Departments will be consulted for current / future planned major use / groundwater extraction and known potential issues.

Project Timeline:

Project is expected to occur over a one year period, with estimated start date of winter 2023 / 2024 (with funds approved in July 2023, and contracting occurring over the fall 2023. The project duration would be Winter 2023 – Winter 2024.

Objective	Task and Deliverable	Responsible Entity
Task 1.0 Hydrogeologic Data Compilation (0-3 months)		
1.0	1.1 Compile hydrogeologic datasets	County / Ramboll
	1.2 Compile existing hydrogeologic-related reports	Ramboll
	1.3 Review WCRs and quality screen and digitize high quality lithology and geophysics logs	Ramboll
	1.4 Compile data into GIS files and develop database of datasets	Ramboll
Task 2.0 Planning and Execution of AEM Surveys (3-5 months)		
2.0	2.1 Review areas of focus and prepare final flight lines for AEM surveys	County / Ramboll / Community Partners
	2.2 Prepare and submit information for AEM survey public outreach	County / Community Partners
	2.3 Conduct AEM Surveys	SkyTEM
Task 3.0 Datasets Assimilation, AEM Processing and Inversion (5-8 months)		

Objective	Task and Deliverable	Responsible Entity
3.0	3.1 Process and conduct AEM data inversion	Ramboll / SkyTEM
	3.2 Conduct initial interpretation of hydrogeology	Ramboll
	3.3 Conduct preliminary demand analysis	Ramboll
	3.4 Conduct preliminary natural recharge	Ramboll
	3.5 Conduct preliminary natural recharge analysis	Ramboll
	3.6 Develop preliminary basin water budget	Ramboll
	3.7 Identify any potential groundwater quality issues	Ramboll
	3.8 Construct Initial 3D HCM Framework for Areas	Ramboll
	3.9 Identify data gaps	Ramboll
Task 4.0 Prepare Report/White Paper (8-12 months)		
4.0	4.1 Summarize work completed	Ramboll
	4.2 Summarize hydrogeology and preliminary water budget for each basin area	Ramboll
	4.3 Identify preliminary issues of concern for sustainability	Ramboll
	4.4 Summarize data gaps and approximate cost to fill	Ramboll

Projected Budget:

Responsible Entity	Task	Estimated Cost
County / Ramboll	Task 1 - Hydrogeologic Data Compilation	$50,000
Ramboll / SkyTEM / County	Task 2 - Planning and Execution of AEM Surveys	$150,000
Ramboll / SkyTEM	Task 3 - Datasets Assimilation, AEM Processing	$75,000
Ramboll	Task 4 - Prepare Report/White Paper	$25,000
	Total	$300,000

Figures:

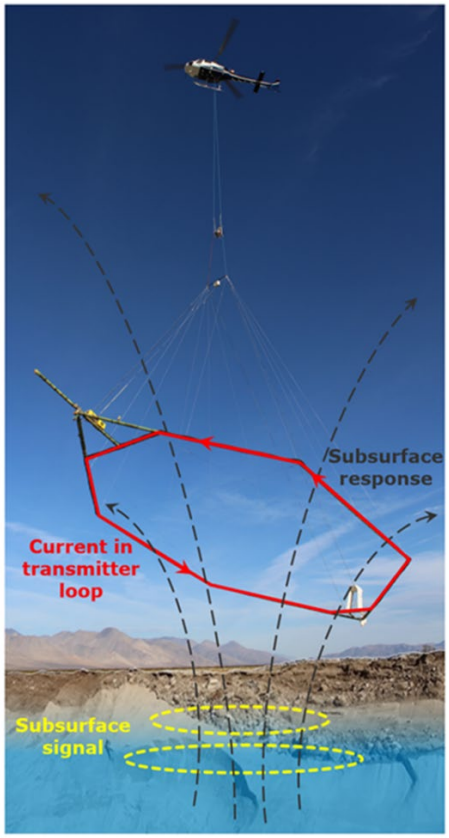


Figure 1 (AEM geophysical instrument breakdown)

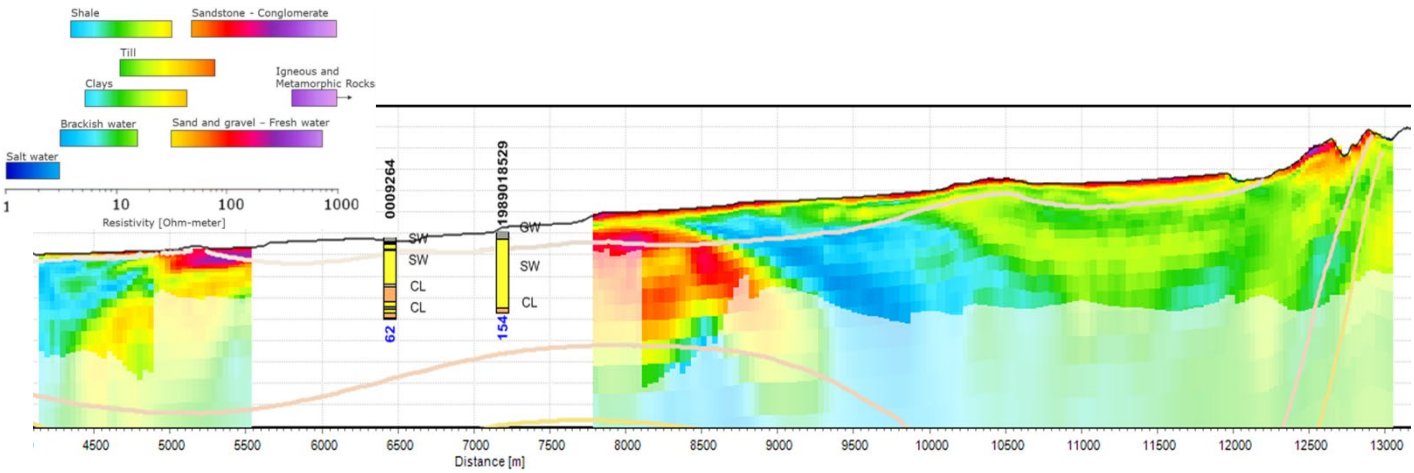


Figure 2 (AEM interpretation of a slice through the subsurface and well logs to fill data gaps)

Figure 3 (DWR Delineated Basins in Lake County)

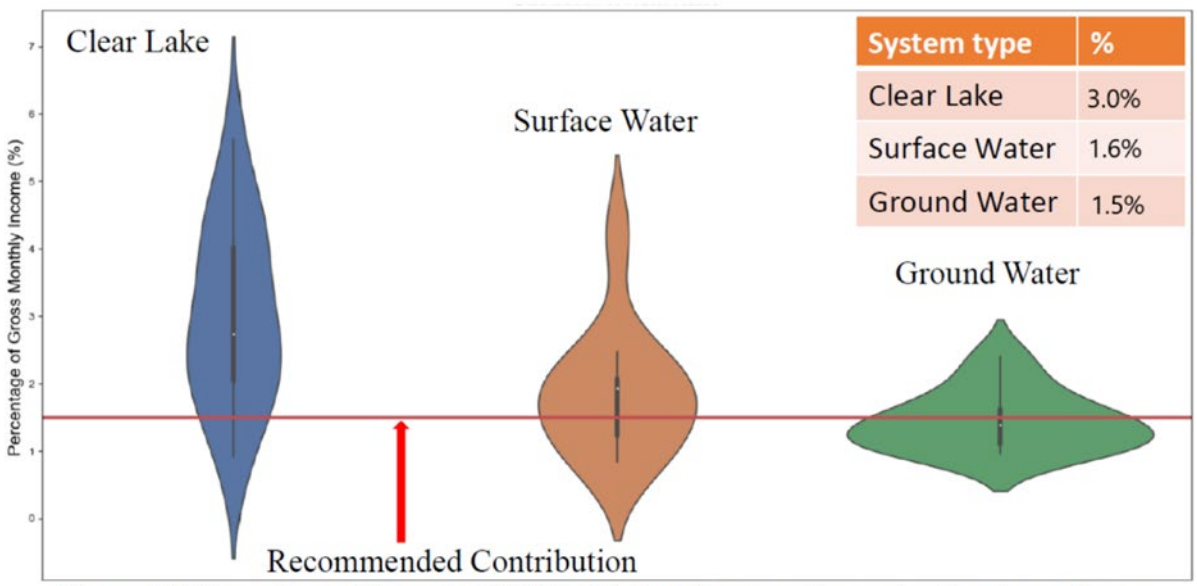


Figure 12: Percentage of household GMI distributed among three sets of water systems

(The above figure was taken from a thesis prepared by Rachel Kennard: *Safe and Affordable Drinking Water for Sources Impaired by Harmful Algal Blooms: Clear Lake, California*, 2021*)*

Contact Information:

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Clear Lake Blue Ribbon Committee

Proposal to Characterize and Evaluate Aquifer Conditions in Scotts Valley

May 5, 2022

Project Description: This proposal represents a scope of work to evaluate the local aquifer conditions and storage potential in Scotts Valley. We understand that future development of groundwater supplies may be required to provide water security for the residents of Scotts Valley. Securing groundwater resources will allow surface water to stay in Clear Lake providing additional ecosystems services and improving the overall health of the system. Potential impacts of developing local groundwater resources will be assessed in regard to the aquifer system, streams, creeks, groundwater dependent ecosystems, current groundwater pumpers and inflows into Clear Lake.

Based on our understanding:

- The Scotts Valley is approximately 7,326 acres with 1,200 irrigated acres and a population of 7,000. A map of the proposed project area is available on page 4 below.

- The current concept is to utilize the existing Big Valley Integrated Hydrologic Model (BVIHM) to assess conditions and future pumping scenarios in Scotts Valley.

- Local information will be used to refine the Scotts Valley portion of the BVIHM.

- Current conditions, including inflows, outflows, and aquifer storage will be assessed during WY 2015-2021 based on the BVIHM model outputs.

- A future scenario using no climate change assumptions and additional municipal pumping will be conducted.

- As discussed during the March 24, 2022 Technical Subcommittee meeting, there is a need to better characterize the flow from local aquifer into Clear Lake. To further characterize the groundwater flow between the shallow aquifer system and Clear Lake, three shallow (less than 50 feet deep) one or two inch monitoring wells will be installed. Depth to groundwater levels and water quality samples will be collected and analyzed. The groundwater level data will be utilized to enhance the calibration of the groundwater flow model.

This proposal, developed by Luhdorff & Scalmanini Consulting Engineers (LSCE), provides a scope of work for preparing an evaluation of the local aquifer conditions and storage potential in Scotts Valley.

SCOPE OF WORK

This scope of work described below includes five tasks developed to meet the needs of the Project:

- Task 1. Background Information Review: Review Scotts Valley specific information. The BVIHM was calibrated and assessed for Big Valley. Additional data from Scotts Valley will minimized uncertainty of storage estimates. Information requested for this task to any local agencies or stakeholders include:
    - Locally obtained groundwater elevation data
    - Aquifer test, step-drawdown test, or any other pumping information within Scotts Valley
    - Location and volumes of future extractions

- Task 2. Incorporation of Scotts Valley Specific Data: Incorporate additional information from Task 1 into the BVIHM. Updates to the model will allow for better estimates of aquifer characteristics.

- Task 3. Evaluate Aquifer Inflows, Outflows, and Storage: Water budgets specific to Scotts Valley will be developed. Recharge in natural vegetation, stream flows into the valley, and groundwater interactions with Clear Lake will be included within the water budget. The total aquifer storage will be calculated and compared against published values from DWR Bulletin 118.

- Task 4. Pumping Scenario Evaluation: With input from local agencies, a scenario will be developed that explores the impact of additional pumping for municipal demand (i.e., increase pumping in the City of Lakeport).

- Task 5. Develop Technical Memorandum and Presentation: A technical memorandum (TM) will be prepared to summarize key points relating to:
    - Outlining updates to the BVIHM
    - Detailing the water budget terms and interactions based on the BVIHM
    - Estimating the amount of water available in storage in Scotts Valley
    - Assess the impacts of additional municipal pumping
    - Cumulative impact of water uses to surrounding areas due to project operations
    - Prepare for and present at two public meetings

- Task 6. Monitoring Well Installation: LSCE will retain a licensed C-57 well drilling contractor to drill and construct up to 3 monitoring wells. The monitoring wells will be located in close proximity to Clear Lake. All work performed by the contractor will be overseen by LSCE to ensure that it is performed in accordance with project specifications. LSCE will provide onsite drilling and sampling inspection and general project oversight. LSCE will provide documentation and sampling services during the test hole drilling process, including preparation of a drilling log, collection of lithologic samples at a minimum of 10-foot intervals at each of the monitoring sites. All work will be performed by a California Professional Geologist or by experienced personnel under the direct supervision of a California Professional Geologist. LSCE will develop final monitoring well designs based on data gathered during test hole evaluation. The principal design elements will include screen, casing, and seal depths. The piezometers will be constructed of 2-inch diameter, Schedule 40 PVC blank casing. The screen sections will be of the

same material and will have machine cut 0.040-inch slots. A No. 8 gradation gravel will be placed in the annulus between the casings and the borehole wall. A sand/cement grout sanitary seal will be placed from a minimum depth of 20 feet to ground surface, pending any modifications needed due to the actual conditions encountered.

LSCE will verify that the monitoring wells are constructed as designed and according to accepted industry standards and regulatory requirements. Measures will be taken to ensure monitoring well security and public safety. LSCE will witness well development and verify completeness. LSCE will ensure that the contractor complies with all discharge, permit, and site cleanup and restoration requirements.

- Task 7. Monitoring Well Letter Summary Report: LSCE will prepare a well construction summary letter report for each monitoring well which will include an as built well profile, lithologic descriptions of the formations encountered, a California Well Drillers Completion Report.

Project Timeline:

Proposed Task Duration	
Tasks	**Duration**
Task 1. Background Information Review	2 weeks
Task 2. Incorporation of Scotts Valley Specific Data	2 weeks
Task 3. Evaluate Aquifer Inflows, Outflows and Storage	3 weeks
Task 4. Pumping Scenario Evaluation	2 weeks
Task 5. Develop Technical Memorandum and Public Presentation	5 weeks
Task 6. Monitoring Well Installation	6 weeks
Task 7. Monitoring Well Technical Memorandum	4 weeks
Total Project Duration	**24 weeks**

Projected Budget:

Provide overall budget request and breakdown by task (as needed). Example:

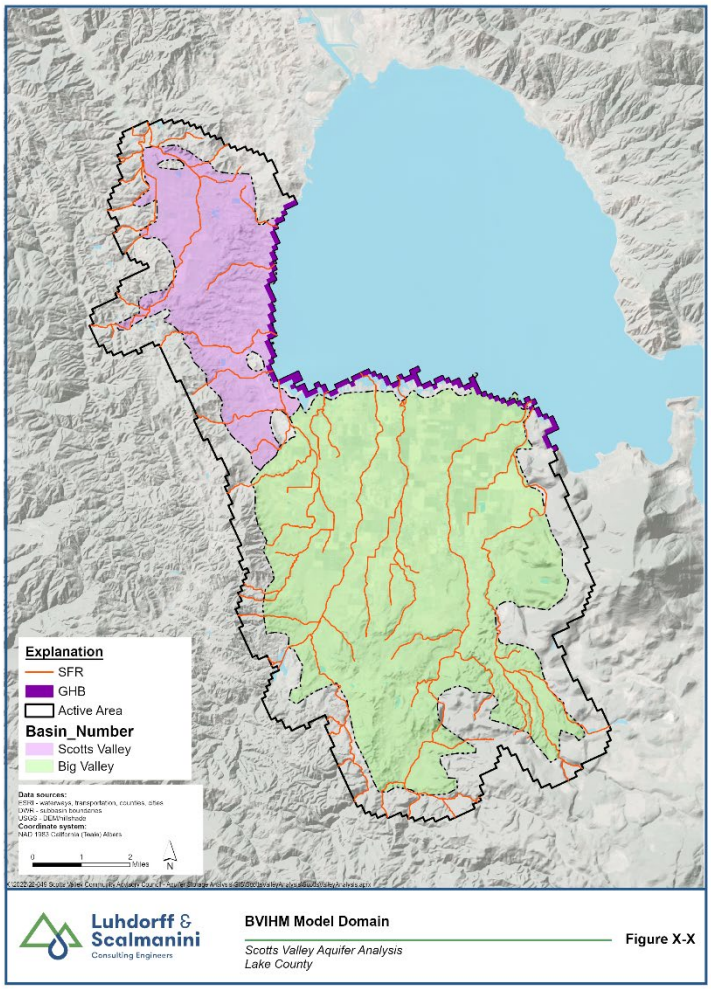
- Overall budget request: $80,000
    - Task 1: Background Information Review: $2,000
    - Task 2: Incorporation of Scotts Valley Specific Data: $5,000
    - Task 3: Evaluate Aquifer Inflows, Outflows, and Storage: $5,000

- Task 4: Pumping Scenario Evaluation: $5,000
- Task 5: Develop Technical Memo and Public Presentation: $8,000
- Task 6: Monitoring Well Installation: $50,000
- Task 7: Monitoring Well Technical Memo: $5,000

Contact Information:

- Eddy Teasedale, LSCE , eteasdale@lsce.com, 530-661-0109, 180 E 4th St Ste. 140, Chico, CA 95928

Additional Information:



Clear Lake Blue Ribbon Committee

Environmental Education Pathway- Mendocino College

April 29, 2022

Project Title: **Environmental Education Pathway- Mendocino College**

Project Description:

Purpose: To develop an applied science pathway (certificate) focused on environmental/conservation technician using the natural resources of Lake and Mendocino Counties for field/laboratory research.

Success Measure: The create a course sequence of (lecture, lab, field work) leading to workforce aligned certificate.

Who: Mendocino College faculty will writing or revise curriculum and create a certificate program.

The Clear Lake regions offers a unique environmental education opportunity. The hydrology, geology, and biological feature of the basin are unique in California. This natural asset can provide exceptional teaching and learning opportunities and connect K-12 to the higher education segments (community colleges, CSU, UC). A pathway based at the Mendocino College Lake Center, in Lakeport, provides a meaningful addition to educational opportunity in Lake County. This project aligns with the work of other Blue Ribbon Projects, such as the:

- Environmental Education Resources and Program Support for Citizen and Community Science at Clear Lake
- Promoting Citizen and Community Science through the development and piloting of a participatory environmental monitoring app
- Scientific Research and Environmental Education Capacity Building in Lake County

Mendocino College acknowledges that we are on the ancestral, traditional, and contemporary land of the First Nations of Lake County. We recognize, honor, and respect these nations as the traditional stewards of the lands and water on which the District is now present. There is a wealth of expertise and knowledge that can contribute to a richer curriculum and program. We will engage with the indigenous communities to assist in program development.

Dialog with the Clear Lake Environmental Research Center (CLERC), Tribal Nations, community organizations, K-12, universities, and local agencies would provide direction for curriculum development. Mendocino College has agreements with Upper Lake, Kelseyville, and Clear Lake High Schools to provide dual enrollment opportunities to students and we have career education pathways established with each school district. These existing partnerships can be leveraged to broaden educational opportunities leading to local workforce needs.

With Humboldt State University transition to Cal Poly Humboldt, Mendocino College has begun regular meetings between our institutions to strengthen transfer pathways between our institutions. Applied Science, Social Work, and Native American Studies have been our focus. A conservation technician certificate aligns with this emerging area of collaboration.

Within the mathematics discipline, Mendocino College has been successful in creating a new transfer level mathematics course called Math 170: Math in Native American Cultures.

There is a workforce gap in the Far North Region of the State. Below is an illustration produced by the North/Far North Center of Excellence Economic Update, November 2021 of the Top 10 occupational job openings with the agriculture, water and environmental technology sector.

Exhibit 6. AgWET jobs postings detail, Far North subregion, July 18, 2021–October 15, 2021 (n = 536 jobs postings)

Top 10 Employers	Top 10 Occupations	Top 10 Specialized Skills
• Forest Service	• Janitors and Cleaners, Except Maids and Housekeeping Cleaners	• Cleaning
• Healthcare Services Group, Inc.	• Merchandise Displayers and Window Trimmers	• Scheduling
• VCA Animal Hospitals	• Heavy and Tractor-Trailer Truck Drivers	• Customer Service
• Sysco Corporation	• Forest and Conservation Technicians	• Sales
• Bimbo Bakeries USA	• Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	• Merchandising
• Anheuser-Busch Companies, Inc.	• Veterinarians	• Repair
• Trugreen	• Maids and Housekeeping Cleaners	• Personnel Management
• Tetra Tech	• Landscaping and Groundskeeping Workers	• Lifting Ability
• Mendocino Forest Products Company	• Retail Salespersons	• Budgeting
• Crossmark	• Pest Control Workers	• Forklift Operation

Source: Burning Glass, Labor Insight. *Note:* AgWET = NAICS 11, 21, 311, 312, 321, 322, 4238, 4244, 4245, 4249, 4452, 5416, 5419, 5617, 5629, 712130, 712190.

As we have experienced the optimal means to support long-term workforce stability is a train people residing in the county to qualify for jobs. Relying on attracting and retaining workers from outside the area proves challenging for many industries.

This project will place the kernel for the college to begin offering applied science courses in environmental/conservation studies. This can lead to growth in other areas, such as, lake systems, watershed management, water quality, etc.

Project Timeline:

- **Year 1:** Initiate curriculum inventory; Begin revision/create of curriculum

  The initial year would be used to complete a curriculum inventory of courses available at Mendocino College in disciplines such as Biology, Chemistry, Earth Science, Geography, Geology,

and Natural Science. After the inventory is completed, existing courses would be identified to be included in the environmental education pathways. As needed, courses would be updated, or new courses would be created.

- **Year 2:** Form advisory committee; complete curriculum work; begin offering courses

  Based on the curriculum a certificate program would be created for conservation technicians. This program development would require the formation of an advisory community. The advisory committees, which can include community members, industry, local agency, tribal nations, purpose is to feedback, advice, and guidance to career education programs.

  Pathway expansion to adult education (non- credit) course would be explored through partnership with the Mendocino-Lake Adult Education Collaborative (MLACE).

Projected Budget:

Provide overall budget request and breakdown by task (as needed). Example:

- Overall budget request: $72,000
  - Task 1: Initiate curriculum inventory; Begin revision/create of curriculum: $36,000
  - Task 2: Form advisory committee; complete curriculum work; begin offering courses: $36,000

Contact Information:

- Dr. Tim Karas, Superintendent/President

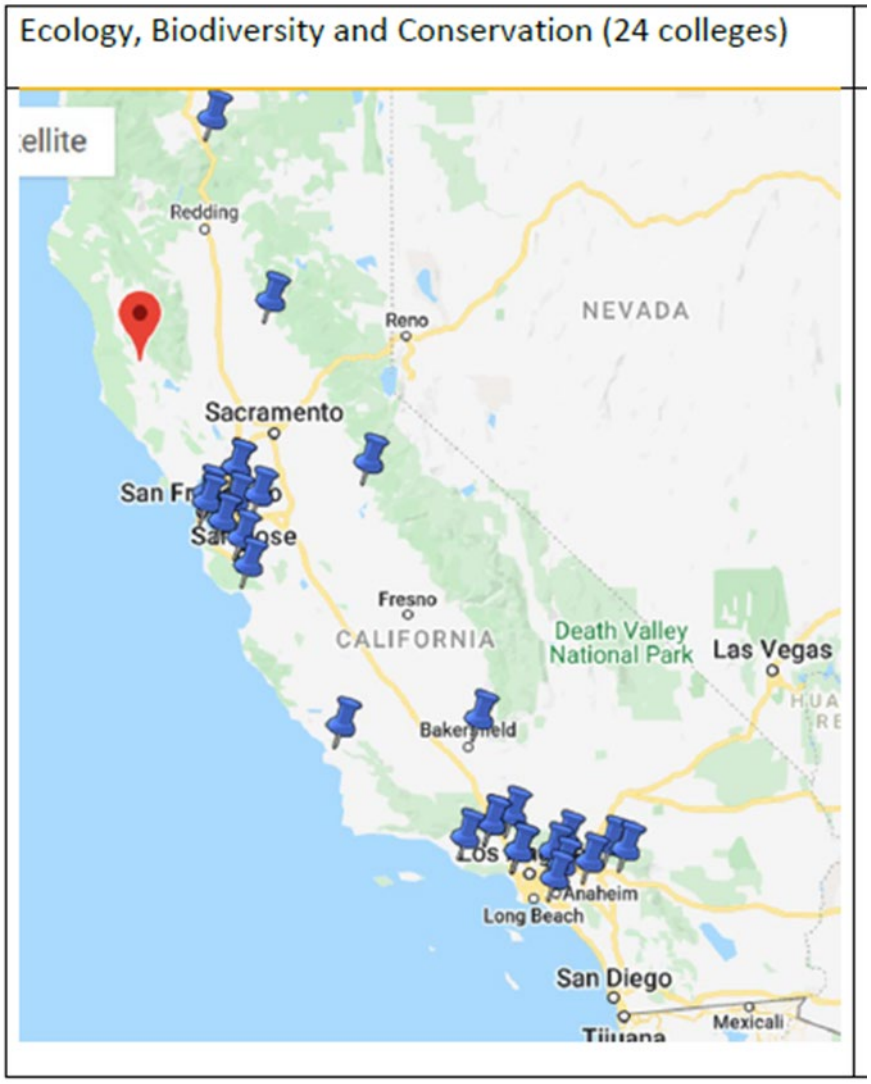
  Mendocino College

  tkaras@mendocino.edu; 707-468-3071

  1000 Hensley Creek Road. Ukiah, CA 95482

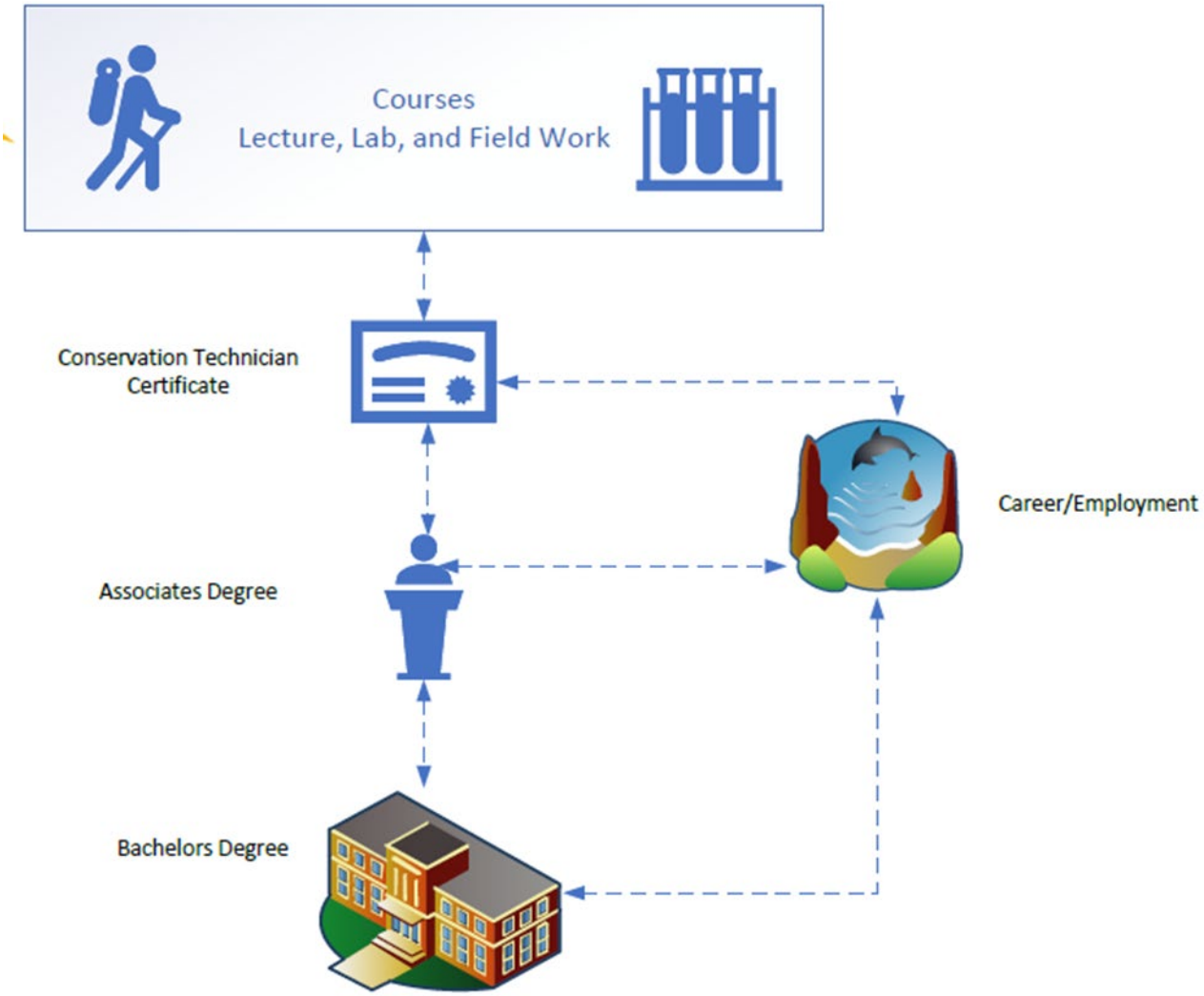
Additional Information

Within the California Community College System (115 colleges), there is a gap in programs related to conservation in the far north region. The map below shows the 24 community college in California offering programs aligned to ecology, biodiversity, and conservation. Two urban areas (San Francisco Bay Area and Los Angeles basin) account for the preponderance of programs.



Project Timeline

The project is intended to be implemented over a 2-year period. In the infographic below, the focus of the project is the top to elements of the flow chart. Curriculum revision or creation to develop a pathway leading to a new certificate. From this milestone, student would have the option to join the workforce or continue to an associate degree in science. Upon completion of the associates degree student could transfer to a four-year university or join the workforce.


Courses
Lecture, Lab, and Field Work
Conservation Technician Certificate
Associates Degree
Bachelors Degree
Career/Employment

Clear Lake Blue Ribbon Committee

Connecting Fire & Water: EcoCultural Tule Restoration of Clear Lake

May 4, 2022

Project Title: Connecting Fire & Water: EcoCultural Tule Restoration of Clear Lake

Project Description:

Tule is an eco-cultural keystone species in the Clear Lake Basin, whose health impacts water quality, hitch habitat, and overall lake health, as well as supports the cultural vitality of Lake County tribes by providing food, clothing, shelter, and ceremonial material.

Cultural burning of tule has been used by the indigenous inhabitants of the Clear Lake basin for millennia to maintain the health of tule on the lakeshore by removing dead tule plant material, cycling nutrients, and allowing light to reach the new growth on young plants. Reintroducing cultural burning to revitalize tule along the lakeshore has been identified as a high priority to multiple Lake County tribes.

This project proposes to build collaborative intertribal capacity to revitalize the health of Clear Lake through supporting traditional ecological management of Clear Lake via cultural burning. The funds will support the planning, implementation and monitoring of 10 cultural burns of tule on the lakeshore and gather data that reveals how traditional ecological knowledge and management support the revitalization of tule health and improve water quality and hitch habitat.

The work will be conducted collaboratively by the following partners:

<u>Tribal EcoRestoration Alliance:</u>

- Lead applicant; project management, administration, and coordination
- Provide technical expertise and professional services to plan and implement cultural burns with intertribal crews
- Work with Big Valley Rancheria and Robinson Rancheria to develop water quality monitoring protocols
- Lead vegetation and bird surveys / monitoring

- Identify ways through the duration of the project to collaborate with other Clear Lake restoration projects (such as Big Valley Rancheria's tule planting project)

Big Valley Rancheria:

- Provide input and guidance on cultural burning goals and techniques
- Project lead for managing water quality monitoring
- Partner on implementing cultural burning on their tule / wetland on tribal trust land

Robinson Rancheria Pomo Indians of California:

- Provide input and guidance on cultural burning goals and techniques
- Provide technical support with water quality monitoring and hitch habitat assessment
- Partner on implementing cultural burning on their tule / wetland on tribal land

Scotts Valley Band of Pomo Indians:

- Provide input and guidance on cultural burning goals
- Provide technical support with water quality monitoring

Other Potential Contributors:

- Lake County Land Trust (provide land for cultural burning)
- County of Lake Water Resources Department (provide input on monitoring, identify County and privately owned land to include in the project)

Project Timeline:

- YEAR 1
    - Develop project workplan and schedule
    - Develop monitoring protocols
    - Work with consultant to submit CEQA documents and filing fees
    - Collect baseline data
    - Write burn plans for different lakeshore land ownerships
    - Assemble intertribal cultural fire hand crew and acquire necessary equipment
    - Implement first year of cultural fire on various burn units

- YEAR 2
    - Continue monitoring

- Implement second year of cultural fire on various burn units with an intention to complete burn units (dependent on weather conditions)

- YEAR 3
  - Continue monitoring
  - Implement final year of cultural fire if needed
  - Synthesize data and author report

Projected Budget:

- Overall budget request: **$404,578.80**

  - **Task 1. Project Management & Burn Planning**

    - TERA Executive Director (project development, site visits, burn planning, etc.)

      - $55 / hour x 400 hours = $22,000

    - TERA Project Coordinator (coordinating partners, scheduling monitoring, logistics, working with CEQA consultant, etc.)

      - $45 / hour x 400 hours = $18,000

    - Big Valley Rancheria Partner Participation

      - 360 total hours over 3 years x $45 / hour = $16,200

    - Robinson Rancheria Partner Participation

      - 360 total hours over 3 years x $45 / hour = $16,200

  - **Task 2. Permitting**

    - CEQA Consultant & Filing Fees

      - $8,000 per site x 10 sites = $80,000

  - **Task 3. Implementing Burns**

    - 10 full sets of Fireline Personal Protective Equipment (PPE) including full Nomex, backpack, helmet, eye protection, and gloves

      - 10 x $1,000 each = $10,000

    - CARX (California Certified Burn Boss; may be provided by TERA or subcontracted out)

      - $2,500 x 10 burns = $25,000

        - National Wildlife Coordinating Group certified cultural fire practitioners
            - 2400 People hours @ $38 / hour = $91,200
    - **Task 4. Pre & Post-Burn Monitoring & Reporting**
        - Tools & Materials
            - TERA: 1 computer, flagging, stakes, binoculars, general office supplies = $4,540
            - Big Valley Rancheria: Water quality monitoring supplies and materials = $4,000
        - TERA Bird Point Count Monitoring
            - 540 hours @ $38 / hour = $20,520
        - Big Valley Rancheria Water Quality & Hitch Habitat Assessment
            - 720 hours @ $35 / hour = $25,200
        - Labs for water quality monitoring
            - Pre burn benthic (1), pre-burn water monitoring (1), post fire water quality (3)
            - $47,625
        - Consultant to Author White Paper
            - $10,000
    - ***Grant Subtotal: $374,610***
    - **8% Administrative Indirect Fee: $29,968.80**
    - **Grant Total Request: $404,578.80**

Contact Information:

Lindsay Dailey
Executive Director, Tribal EcoRestoration Alliance
lindsay@tribalecorestoration.org
(707) 889-3744
PO Box 1058 Upper Lake CA 95485

Additional Information: Attached you will find letters of commitment from various partners.

Big Valley Band of Pomo Indians

To: Clear Lake Blue Ribbon Committee Grants Team
RE: Letter of Support "Connecting Water & Fire: EcoCultural Tule Restoration of Clear Lake"

May 3, 2022

The Big Valley Band of Pomo Indians is writing to support "Connecting Water & Fire: EcoCultural Tule Restoration of Clear Lake (Fire & Water)," Tribal EcoRestoration Alliance's (TERA's) application for the Clear Lake Blue Ribbon Committee Grant opportunity.

Big Valley has participated with TERA in resource management projects including participating in a training on tule replanting, and our members and staff have attended their Burn Planning workshops and prescribed burning trainings. We are aware of their good work and support their efforts. Most recently, we worked together to plan and implement a prescribed tule burn on the shore of Clear Lake and conduct post-burn monitoring. This was a very positive experience for the Tribal community and we see the benefits already; what was previously an

The Fire & Water Project will build the capacity of tribes to revitalize the health of Clear Lake through traditional ecological management techniques. The funds will support the planning, implementation and monitoring of cultural burns of tule on the lakeshore and gather data that reveals how traditional ecological knowledge and management support the revitalization of tule health and improve water quality and hitch habitat.

Traditionally tule and other riparian vegetation was managed by the Big Valley Band of Pomo Indians and other local Tribes with cultural burning, to stimulate healthy regrowth, and to keep fuels down and communities safe. Bringing cultural burning back is a gift and our community supports these efforts and they know the benefits that will come from these traditional cultural activities. We have been active on natural resource management for many years, and know the importance of using traditional ecological knowledge. We look forward to working with TERA on this grant. This work builds our capacity to continue to manage our lakeshore vegetation in a way that aligns with our cultural and traditional values and safeguards the ecological health of Clear Lake.

As a partner in this project, Big Valley will take the lead on water quality monitoring, which will include developing monitoring protocols and providing technicians to carry out sampling. Big Valley will also collaborate with TERA and other partners to develop cultural burning goals and conduct hitch habitat assessments for each of the proposed burns. Finally, Big Valley plans to implement a cultural burn on our own lakeshore.

On behalf of Big Valley, we fully and wholeheartedly support the proposed project and strongly recommend that the Blue Ribbon Committee fund this important effort. We are especially interested in restoring a healthy tule population in the watershed using Tribal traditional knowledge, and the

2726 Mission Rancheria Road • Lakeport, CA. 95453 • Phone: (707) 263-3924 • Fax: (707) 264-6556

subsequent water quality benefits. If you have any questions about our commitment to the project, please contact me as shown below.

Sincerely,

Sarah Ryan
Environmental Director/Emergency Management Director
2726 Mission Rancheria Road
Lakeport, CA 95453
707-263-3924 x132

COUNTY OF LAKE

WATER RESOURCES DEPARTMENT
255 N. Forbes Street
Lakeport, California 95453
Telephone 707-263-2344
Fax 707-263-1965

Angela De Palma-Dow
Invasive Species Program Coordinator

May 3, 2022

To: Clear Lake Blue Ribbon Committee Grants Team

RE: Letter of Support for "Connecting Water & Fire: EcoCultural Tule Restoration of Clear Lake"

The County of Lake Water Resources Department is writing to support "Connecting Water & Fire: EcoCultural Tule Restoration of Clear Lake (Fire & Water)," Tribal EcoRestoration Alliance's (TERA's) application for the Clear Lake Blue Ribbon Committee Grant Opportunity.

The Fire & Water Project will build the capacity of tribes to revitalize the health of Clear Lake through traditional ecological management techniques. The funds will support the planning, implementation and monitoring of cultural burns of tule (i.e. emergent hard-stem bulrush) on the lakeshore and gather data that reveals how traditional ecological knowledge and management support the revitalization of tule health and improve water quality and hitch habitat.

The Water Resources Department has a history of collaboration with TERA to care for Clear Lake, its shoreline, and its watershed. To continue this collaboration, we are particularly interested in the cultural management of native tule on the lakeshore with prescribed fire. Prescribed burn on tule will have multiple benefits, including removing diseased plant materials, reducing invasive species that threaten native shoreline communities, and promoting the regrowth of stronger, healthier, and more abundant tule stands that provide bird, wildlife, and fish habitat and serve as an important cultural resource. The Water Resources Department is committed to assisting TERA, and their partner tribes, with permit requirements to comply with State and County Laws.

On behalf of the County of Lake Water Resources Department we wholeheartedly support the proposed project and strongly recommend that the Blue Ribbon Committee fund this important effort. We are especially interested in the littoral zone habitat improvements that this project will provide, and the knowledge gained through this process will help Water Resources, as the designated Clear Lake Managers, better plan and implement sound management. If you have any questions about our commitment to the project, please contact us via email, as provided below.

Sincerely,

Angela De Palma-Dow
County of Lake Water Resources Department
255 N. Forbes St. Lakeport, CA 95453
Angela.DePalma-Dow@lakecountyca.gov

ROBINSON RANCHERIA

CITIZENS BUSINESS COUNCIL

Beniakem Cromwell
Tribal Chairman, Robinson Rancheria
1545 E. Hwy 20
Nice, CA, 95464

5/4/2022

To: Clear Lake Blue Ribbon Committee Grants Team

RE: Letter of Support for "Connecting Water & Fire: EcoCultural Tule Restoration of Clear Lake"

The Robinson Rancheria Band of Pomo Indians is writing to support "Connecting Water & Fire: EcoCultural Tule Restoration of Clear Lake (Fire & Water)," Tribal EcoRestoration Alliance's (TERA's) application for the Clear Lake Blue Ribbon Committee.

Robinson Rancheria has partnered with TERA since its inception to implement multiple resource management projects over the years including vegetation management, prescribed burn planning, cultural activities, and ongoing collaboration on local projects. Most recently, we worked together to plan and implement a prescribed tule burn on the shore of Clear Lake and conduct post-burn monitoring.

The Fire & Water Project will build the capacity of tribes to revitalize the health of Clear Lake through traditional ecological management techniques. The funds will support the planning, implementation and monitoring of cultural burns of tule on the lakeshore and gather data that reveals how traditional ecological knowledge and management support the revitalization of tule health and improve water quality and hitch habitat.

Traditionally tule and other riparian vegetation was managed by our Tribe with cultural burning, to stimulate healthy regrowth, and to keep fuels down and communities safe. We look forward to working with TERA on this grant to build our capacity to ongoingly manage our lakeshore vegetation in a way that aligns with our cultural and traditional values.

As a partner in this project, Robinson Rancheria is committed to working with TERA to develop cultural burning goals and provide technical support through conducting water quality monitoring and hitch habitat assessments for each of the proposed burns.

On behalf of Robinson Rancheria, we fully support the proposed project and strongly recommend that the Blue Ribbon Committee fund this important effort. If you have any questions, please contact me as shown below.

Sincerely,

Beniakem Cromwell
Tribal Chairman, Robinson Rancheria
E: brcomwell@rrcbc-nsn.gov
P: 707-275-8735

Clear Lake Blue Ribbon Committee

May 4, 2022

Project Title:

Using Integrated Pest Management methods to create strong and sustainable shorelines on Clear Lake, CA.[4]

Agency Sponsor: County of Lake Watershed Protection District

Project Contact: Angela De Palma-Dow, Invasive Species Program Coordinator, Watershed Protection District, Angela.DePalma-Dow@lakecountyca.gov, (707)263-2344

Project Description:

Major Project Tasks (Goals) Using Integrated Pest Management methods to create strong and sustainable shorelines on Clear Lake, CA.

1. ***General Project administration and coordination***
2. ***Primrose removal and native species replanting at four public access shoreline sites along Clear Lake***
3. ***Private Property incentives for manual primrose removal in lieu of herbicide use***
4. ***Implementation of a Natural Shoreline Stewards Program for Clear Lake***

Lake County Watershed Protection District ("The District"), with local cooperative and collaborative partners (i.e. the Alliance Team), will strengthen and restore 4-5 acres of Clear Lake wetland shoreline habitat through the implementation of Integrated Pest Management (IPM) techniques. The District will protect human health and the environment by reducing the reliance on chemical pesticides to manage and control the invasive aquatic plant called creeping water primrose (also known as yellow water primrose, *Ludwigia peploides*) while simultaneous creating stronger natural shorelines through strategic native plant restoration. Clear Lake is located in rural Lake County, CA, and serves as a drinking water source, recreation and fishing economic driver, and provides local tribes with essential cultural and subsistence resources.

Specifically, IPM techniques will be used to remove, manage, and prevent future spread of a destructive, invasive aquatic plant called creeping yellow water primrose. Dense biomass of primrose can pose a serious nuisance for human activities such as impeding navigation, reduced recreational capacity, restrict fish habitat, and primrose reduces flow in channels, contributing to localized flooding. Abundant primrose and infrastructure damage and can clog drinking water intakes, reducing needed water quality and quantity for treatment systems to function properly (Grewell et al. 2016). Due to its efficient growth rate and productivity, primrose has globally been show to demonstrate problems socially and economically (Thouvenot et al. 2013). The aggressive nature of Primrose allows it to displace and disrupt native riparian and wetland plant communities of Clear Lake, including those comprised of culturally and ecologically significant tule (*Schoenoplectus acutus*), smartweed (*Polygonium amphibium*), and water spikerush (*Eloacharis palustris)*.

[4] **PLEASE NOTE: This proposal was withdrawn after receiving funding through a Department of Pesticide Regulation grant.**

The human communities depending on a healthy and resilient Clear Lake are broad, from rural and unincorporated areas of the County that rely in pumped irrigated water for commercial agriculture orhousehold gardens, to disadvantaged and low-income communities that already pay the highest rates for drinking water in the state (Kennard et al. 2021). According to 2019 County Health Ranking Database,

Lake County median income ($46,900) is approximately $33,500 less than the state's overall median income ($80,400), indicating that the locally generated resources available for community services, such as invasive species management, is extremely limited. Although further primrose expansion threatens to degrade Clear Lake, the County's number one economic driver, there is little to no local available funds to start and maintain an effective IPM program for primrose.

This project has four main goals and objectives that will provide for a more sustainable and stronger Clear Lake Shoreline that that will be more resilient to future invasive species introductions, adapt to climate change, and require less dependence on aquatic herbicide applications. Objective 1 will include all project coordination, administration, and reporting. Objective 2 will include the direct implementation of IPM strategies through the target manual removal of primrose from four high-priority public access locations around the lake, followed by native plant restoration. Monitoring will be conducted after removal and planting tasks to ensure project is achieving target goals. Objective 3 will focus on an incentive program for private property owners to utilize manual primrose removal on their individual shorefront parcel as opposed to used aquatic herbicides or no management. Clear Lake is located in a severely disadvantaged community and many property owners face financial hardships that create barriers to participating in low-risk and sustainable pest management, or any type of management at all.

Lastly, Objective 4 implements a recently developed Clear Lake Natural Shoreline Stewardship Program Plan. This program has roots in IPM as natural shorelines are more resilient to changes to climate, water level, introduction and establishment to invasive species. Natural Shorelines provide valuable and essential habitat and ecosystem services to people and wildlife. To date, there has not been a comprehensive shoreline stewards program in place on Clear Lake, although this IPM strategy has been shown to be extremely beneficial in other locations such as Michigan, Vancouver, and Vermont. Our Natural Shoreline Stewards Program, like others around the Country, which is based on many IPM strategies, for preventing aquatic and wetland invasive shorelines from degrading this valuable niche habitat.

This last objective will utilize an AmeriCorps partnership to provide education, outreach, and awareness of the Natural Shoreline Stewardship Program. This task will be accomplished through development of a user-friendly website, participation and presentation of trainings and workshops within the community, and the creation and production of relevant outreach and education materials like native plant factsheets and Natural Shoreline Stewards Manual. The goal of this objective is to get shoreline property owners engaged and participate in transforming their shore land space into a Natural Shoreline that both improves water quality, reduces erosion, and relies less on pesticides in the terrestrial, aquatic and transition zones. Through this project, the implementation of IPM strategies and the transformation to natural shorelines will improve water quality, protect fish habitat, and enhance flood protection and prevention as well as create strong and sustainable natural vegetative wetland communities around the shores of Clear Lake and serve as an exemplar for other freshwater systems, and aquatic resource managers, in California.

Project Timeline:

Project is expected to occur over a three year period, with estimated start date of winter 2023 / 2024 (with funds approved in July 2023, and contracting occurring over the fall 2023. The project duration would be Winter 2023 – Winter 2026.

Objective	Task and Deliverable	Target Completion Date
Task 1.0 General Project administration and outreach plan		
1.0	1.1 Initial project meeting	30 days from grant execution
	1.2 Outreach and project plan	60 days from grant execution
	1.3 Invoices	As needed by Natural Resources Agency
	1.4 Quarterly project update meetings	Every quarter through December, 2026
	1.5 Annual reports	Every December through 2026
	1.6 Final report	December 31, 2024
	1.7 Final Project presentation	Within 90 days of project completion
Task 2.0 Primrose removal and native species replanting at public access shoreline sites along Clear Lake		
2.0	2.1 Task Coordination and Supervision	December 31, 2026
	2.2 Project / Alliance Team Member Planning Meetings	Every quarter through September 30, 2024
	2.3 TERA Agreements or MOUs	60 days from grant execution
	2.4 Purchase any materials, equipment needed for task	Ongoing throughout December 15, 2026
	2.5 Seasonal Primrose Removal Training	Annually by April 30th throughout project
	2.6 Primrose Removal at Public Sites	During growing season until Dec, 2026
	2.7 Primrose Removal site monitoring	During growing season until Dec, 2026
	2.8 Native Replanting at Public Sites	Cool, wet season until Dec, 2026
2	2.9 Native Replanting monitoring	Cool, wet season until Dec, 2026
Task 3.0 Incentive Program for manual primrose removal in lieu of herbicide use		
3.0	3.1 Task Coordination & Admin	December 2026
	3.2 BullFrog Agreement / MOU	60 days from grant execution
	3.3 Purchase any needed supplies and materials	Ongoing throughout December 2026
	3.4 Private Property Incentive Program Execution & monitoring	November 15, 2026
	3.5 Task Outreach and Advertisement	November 15, 2026
Task 4.0 Implementation of a Natural Shoreline Stewards Program for Clear Lake		
4.0	4.1 Task Coordination and Admin	December 2026
	4.2 AmeriCorps Agreements	September 30, 2024
	4.3 AmeriCorps Fellow Onboarding, Training, Executing project, Evaluation, Support	August 30, 2025
	4.4 Natural Shoreline Website Agreements	December 30, 2024
	4.5 Natural Shoreline Website Development, review, and Maintenance	September 30, 2025
	4.6 Purchase materials, outreach products, signs	December 30, 2025

Objective	Task and Deliverable	Target Completion Date
	4.7 Travel to conduct training, education, outreach	December 2026
	4.8 Digital marketing, boosts, PSAs	December 2026
	4.9 Information Sharing at workshops or symposia	December 2024

Projected Budget: Please see attached budget Sheet.

COMPOSITE BUDGET FOR ENTIRE PROPOSED PROJECT PERIOD: Winter 2023/2024 - Winter 2026/2027						
			2024	**2025**	**2026**	
BUDGET CATEGORY			**Year 1**	**Year 2**	**Year 3**	**TOTAL**
PERSONNEL: *County Salary and fringe benefits.*			$44,110	$43,110	$42,110	$129,330
TRAVEL			$2,500	$3,500	$3,500	$9,500
MATERIALS & SUPPLIES			$11,250	$12,500	$10,000	$33,750
EQUIPMENT			$5,400	$5,000	$5,000	$15,400
RENT			$0	$0	$0	$0
SUBCONTRACTOR #1 (TERA)			$28,000	$27,000	$18,000	$73,000
SUBCONTRACTOR #2 (BullFrog Diving)			$2,500	$2,500	$2,250	$7,250
SUBCONTRACTOR #3 (AmeriCorps)			$0	$15,000	$14,000	$29,000
OTHER DIRECT COSTS (ODC)						
	ODC #1 Alliance Team Member Participation Support		$3,000	$3,000	$1,500	$7,500
	ODC #2 Shoreline Stewards Website Development		$0	$12,000	$2,000	$14,000
	ODC #3 Digital Marketing		$1,000	$2,000	$500	$3,500
TOTAL DIRECT COSTS			**$97,760**	**$125,610**	**$98,860**	**$322,230**
Indirect Costs		**Not Applicable to ODC**				
	Rate					
	10%		*$9,376*	*$10,861*	*$9,486*	**$29,723**
TOTAL COSTS PER YEAR			**$107,136**	**$114,963**	**$131,013**	
TOTAL BRC COSTS FOR PROPOSED PROJECT PERIOD						**$351,953**

Sources Cited:

Grewell, B.J. Netherland, M.D., Thomason M.J. (2016). Establishing Research and Management Priorities for Invasive Water Primroses (*Ludwigia* spp.) US Army Corps of Engineers, Engineer Research and Development Center. ERDC/EL TR-16-2

Kennard, R. 2021. Safe and Afforable Drinking Water for Sources Impaired by Harmful Algal Blooms: Clear Lake, California. Thesis Submitted to Hydrological Sciences Office of Graduate Studies of the

University of California. Available at:
http://watermanagement.ucdavis.edu/files/3816/3364/0833/Kennard_Thesis.pdf

Thouvenot, L., Haury,J., Thiebaut, G. (2013) A success story: water primrose, aquatic plant pests. Aquatic *Conservation: Marine and Freshwater Ecosystems* 23:790-803.

Clear Lake Blue Ribbon Committee

HYPOLIMNETIC OXYGENATION PILOT PROJECT IN THE OAKS ARM

May 5th, 2022

Project Title: Hypolimnetic Oxygenation Pilot Project in the Oaks Arm

Project Description:

1. *Background of the Project*: Historical monitoring data and more recent monitoring, experiments, and modeling by UC Davis TERC have shown that periods of low dissolved oxygen (hypoxia) next to the lake bed sediments are a major factor in the poor water quality and ecological health of Clear Lake (Fig. 1, App. 1). These periods of depleted dissolved oxygen (DO) occur when the lake thermally stratifies in summer. The absence of DO during the summer months (typically June to September, but occasionally May to November) leads to:

- *Release of sediment-bound phosphorus (internal loading).* Field and laboratory studies confirm that internal loading is responsible for over 80% of the phosphorus in the lake water (Fig. 2, App. 1).
- *Phosphorus (P) is a major driving factor in the formation of harmful algal blooms (HABs).* HABs are an issue that threatens public health and many beneficial uses of the lake. Recent measurements have shown that neurotoxins produced during Clear Lake's intensive HABs travel through treatment plants and are present in human drinking water at levels in exceedance of state and federal standards.
- *Facilitation of methylmercury release (MeHg)*. MeHg accumulates in fish tissue and produces nervous system effects in humans. The linkage between low DO and high MeHg release rates has been established in numerous systems around the country, and the USGS and US EPA have been studying this at Clear Lake in the decadal long remediation program of the Sulphur Bank Mercury Mine (Fig. 3, App. 1).
- *Release of other metals*. Metal ions (e.g. iron) also result from episodic periods of hypoxia that impose expensive water treatment costs on water purveyors.
- *Loss of fish habitat with the potential for summer fish kills*. Extended hypoxic events stress fish populations and negatively impact the lake ecology and the economic viability of the sports fishery.

Hypolimnetic Oxygenation (HO) (Fig. 4, App. 1) is a technique that has been used nationwide (and in California) to ameliorate such conditions. It entails the direct injection of pure oxygen to the lake's hypolimnion (the lower stratum of the lake). Appendix 2 provides background details.

While many reservoirs are successfully utilizing this technique, Clear Lake has a large surface area (150 km^2) and is naturally highly productive (hypereutrophic), which results in a very high oxygen demand at the sediment-water interface (approx. 0.9 g O_2/m^2/day). For these reasons, we propose a pilot project on the Oaks Arm (14.1 km^2) to fine-tune the technology for Clear Lake before a whole-lake implementation

is designed. **An important advantage that Clear Lake possesses over smaller lakes is that it has high water current velocities resulting from longer distances winds can blow across the lake.** This feature will be utilized through the model-based design to help distribute the oxygen over a larger area both in the Oaks Arm and into the other two Arms.

Importantly, although internal loading accounts for a majority of the lake P-budget, watershed inputs are important, especially at longer time scales (e.g. decadal and centennial), and activities to reduce external nutrients are still critical to the long term health of the lake.

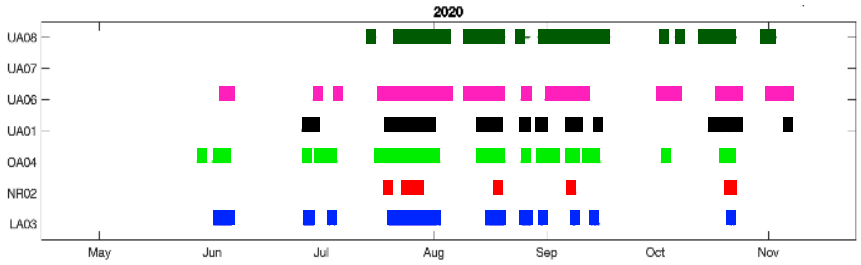
2. *Project Purpose:* This pilot **research** project consists of the design, construction, implementation, monitoring, water testing, and scenario testing of Hypolimnetic Oxygenation (HO) in the Oaks Arm of Clear Lake, CA. The **Oaks Arm** was selected as it is the smallest basin (14.1 km^2, 0.125 km^3), is affected by long-term mercury issues, and is the site of many of the largest HAB blooms. Preliminary results from our 3D lake model suggest that the added oxygen will be readily transported throughout the Oaks Arm within days of injection at the site, depending on current velocities and sediment uptake rates.

The HO will occur through the direct injection of oxygen via a set of diffusers installed at the bottom of the lake from an external oxygen supply onshore during the summer months (see further details about timing in the section below). Pure oxygen (five times more effective than air) is injected at low flow rates through a porous diffuser line that is elevated a short distance above the sediments (Fig. 5, App. 1). The released fine bubbles dissolve rapidly in the hypolimnion, without significant lake mixing. Sediment disturbance will also be minimal given the low oxygen flow rates and the suspension of the diffuser slightly above the sediments. This design is largely self-cleaning, and the whole system need only be floated to the surface in the unlikely event of a line break. This operation can be simply performed on-site if needed.

3. *What does "Success" Look Like?* Our objectives are to 1) quantify rates at which oxygen is dispersed and taken up after injection; 2) quantify the impact of oxygenation on P-release from sediments; and, 3) monitor the effect of oxygenation on water quality. Success of the pilot project is necessarily more targeted than the eventual lake-wide implementation goal of reducing HABs. Here, success will be defined as quantifiably increasing DO in bottom waters and having such oxygenation result in a measurable reduction in P-release from sediments, and validating predictions made using our 3D lake model.

The pilot project will target maintaining daily average hypolimnetic DO concentrations above 3.5 mg/L, and maintaining hypolimnetic orthophosphate concentrations below 0.05 mg/L. As a point of reference, DO can currently be at zero for 2-3 weeks at a time, and orthophosphate can be in excess of 0.6 mg/L. Monitoring of methyl mercury concentrations in the Oaks Arm (by USGS) will also be made and compared to measurements taken in previous years and other Arms.

Success also includes optimizing the HO to deliver the precise amounts of oxygen only when they are needed. The figure below shows the periods in 2020 when anoxia existed at our monitoring stations. At OA-04 in the Oaks Arm (OA04 - light green) anoxia occurred for less than 3 months. Using a hypoxia prediction model already developed for Clear Lake (Cortés et al. 2021), we can modify it and test the system's ability to efficiently start and stop the oxygenation as needed.



This technology, combined with the operational experience from the pilot project and the 3-D lake model, **will allow for the design of a future whole-lake system** and its efficient local operation.

4. *Project Tasks*

Task 1 - Permitting: We will contract with an experienced local consultant to conduct the CEQA environmental review, planning, and construction permits. This will be for the pilot project, but the knowledge gained will streamline the future permitting process.

Task 2 - Design: We will contract with an experienced HO designer for the pilot HO system. TERC staff will assist by the running of the 3-D lake model (see Appendix 3) under separate funding. The siting of the land-based part of the system is included in the design. Preliminary design calculations call for two oxygen diffuser lines, each 4,400 feet long. The assumed sediment oxygen demand is 0.9 g/m^2/day, and with a factor of safety of two, the design capacity of the system should be ~33 tons of oxygen per day. Deliveries to a liquid oxygen storage tank can come from a number of suppliers in Sacramento or the Bay Area.

Task 3 – Outreach: The TERC project manager will be responsible for conducting community outreach for the project. Working collaboratively with all community stakeholders from around the lake and with guidance from the BRC Socio-Economic Sub-Committee, the outreach will be conducted during both the planning, design, and construction phases (Year 1) and the operational phase (Year 2). Workshops, school visits, public meetings, attendance at local events, and social media will be part of the approaches to be used. Special emphasis will be given to Oaks Arm stakeholders initially. Real-time data access from the monitoring buoys will be used as part of the outreach.

Task 4 - Construction: An RFP for HO construction and installation of the designed system will be developed. The Contracting process and the award will be managed by UC Davis Purchasing.

Task 5 - Operation: The system will be operated by the Construction contractor under guidance from TERC. Three specific goals will guide the operation:

1. Achievement of the performance standards detailed above and based on the ongoing monitoring;
2. Testing of the high efficiency model-guided operating system; and,
3. Testing of the system response to “worst-case scenarios” such as wildfire evacuations, or anchor dragging breaking a diffuser line. The system requires no power, so power failure is not a concern.

Tasks 6A and 6B – Monitoring: This program will be a partnership between TERC and the USGS.

TERC Monitoring: Three real-time monitoring buoys will be deployed in the Oaks Arm to gather continuous real-time DO and temperature data every 5 minutes at multiple depths above the lake bottom. Operation will commence in Year 1 when permitting, design and construction are taking place, to provide background data, and continue in Year 2 to monitor the impacts of hypolimnetic oxygenation. The data will be telemetered in real-time and a web portal created to allow the public access to the high-frequency data. With these data, the immediate response of the system will be available to the HO operator,

researchers, and stakeholders. Water samples will be taken every 2 weeks at 4 depths at all three stations. The full suite of phytoplankton identification/abundance and nitrogen and phosphorus forms (as currently being measured in the lake) will be analyzed. On up to 10 occasions surface samples for cyanobacteria will be sampled (if bloom conditions are present) and analyzed for total anatoxin-a, total microcystin/nodularin, and total saxitoxin. Comparisons will be made with historical data and other Arms and with the existing shoreline cyanobacterial detection program conducted by the Big Valley Band of Pomo Indians. An acoustic Doppler current profiler will be deployed for the pilot HO operation in Year 2 to better understand the movement of oxygenated water in the Oaks Arm and to assist with model calibration. An autonomous underwater vehicle (AUV) will be deployed to map the distribution of dissolved oxygen in the hypolimnion prior to the commencement of oxygenation and on two occasions during oxygenation to show the spatial distribution of oxygen and other variables. Sediment cores, that are being analyzed on behalf of Lake County, will continue to be collected and used to help determine the impacts of oxygenation on phosphorus partitioning. We do not expect measurable changes at higher trophic levels (fish) because of the short duration of the oxygenation in the Pilot Project.

USGS Monitoring: Water samples for Methyl mercury analysis will be taken on six occasions (before, during, and after HO). One profiling sonde will be incorporated into one of the real-time buoys, and a second sonde will be used for distributed profiling. The development of the sondes will be separately funded by the US EPA.

Task 7 - Final Report: A final report detailing the project outcomes, access to the data, and recommendations for the use of hypolimnetic oxygenation will be provided. The report will also include the details of the system design, construction, and operation.

5. The Longer-Term Vision

Assuming that the pilot project achieves its scientific, water quality, and ecological goals, it will be a relatively straightforward task to quantify the **capital cost and running cost** of a full-scale system. We are optimistic that with the experience gained, efficiencies in operation will translate into reduced oxygen consumption, and will allow for long-term reductions in costs.

What we would recommend to parallel this very large effort would be a quantitative assessment of the **long-term benefits** that an improvement in water quality and ecological health will provide to the entire community. This should take into account the economic benefits across all sectors, and include human health benefits and the opportunities for building human capacity. This is a task that would benefit from the leadership and inclusiveness of the Blue Ribbon Committee.

It is only when the true costs and benefits have been determined that a long-term, sustainable financing model can be developed.

Project Timeline:

- **Year 1:** Permitting, design, outreach, construction, monitoring
- **Year 2:** summer oxygen injection), monitoring, final report

Projected Budget:

		Performed By	Year 1	Year 2	Total	Percentage of Budget
Task 1	Permitting	Consultant	$200,000		$200,000	9.1%
Task 2	Design	Contractor	$150,000		$150,000	6.8%
Task 3	Outreach	TERC	$30,000	$20,000	$50,000	2.3%
Task 4	Construction	Contractor	$850,000		$850,000	38.6%
Task 5	Operation	Contractor		$300,000	$300,000	13.6%
Task 6 - A	Monitoring	TERC	$330,000	$180,000	$510,000	23.2%
Task 6 - B	Monitoring	USGS		$120,000	$120,000	5.5%
Task 7	Final Report	TERC		$20,000	$20,000	0.9%
All Tasks			$1,560,000	$640,000	$2,200,000	100%

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- Alicia Cortes, UC Davis TERC, alicortes@ucdavis.edu, (805) 895-7449, University of California, Davis, One Shields Avenue, Davis, CA 95616
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Additional Information:

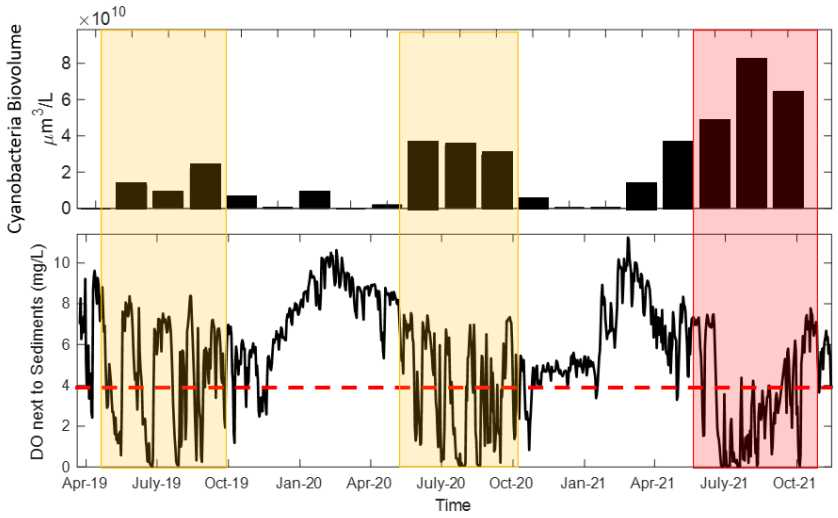

Fig. 1. (Top) Cyanobacteria biovolume from our in-lake sampling every 6-8 weeks in the Oaks Arm. (Bottom) Continuous-time series of benthic dissolved oxygen in the Oaks Arm. The red dashed line marks one of the possible DO thresholds to define hypoxia. The squares mark the summer periods when the cyanobacteria biovolume increases and the DO decreases

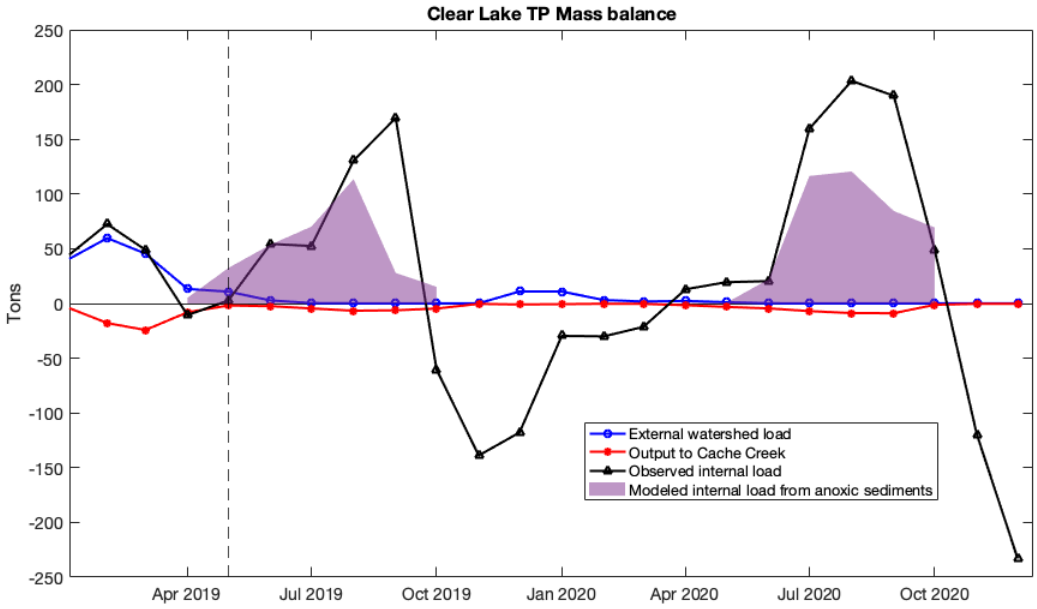

Fig.2. Total phosphorus mass balance for Clear Lake (2019-2020) with external input and output loads, and observed and modeled internal load from anoxic sediments using laboratory P-release rates. Dashed vertical line indicates the start of the UC Davis Lake monitoring program

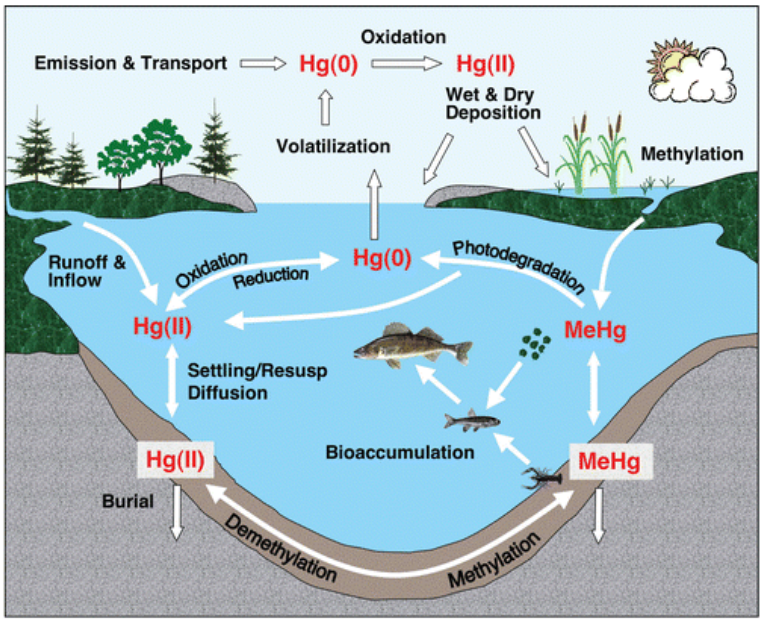

Fig. 3. Diagram of mercury (Hg) cycle in a water body. A small portion of Hg(II) is converted to the more toxic form of methylmercury (MeHg). Methylation of mercury is a biologically mediated process known to be facilitated by some strains of sulfate- and iron-reducing bacteria (anaerobic conditions). Wetlands and lake sediments are important environments where methylation occurs. Methylation can also occur in anoxic bottom water. If we keep the overlying water oxygenated, concentrations of MeHg are likely to be lower in sediment, bottom water, and the food web.

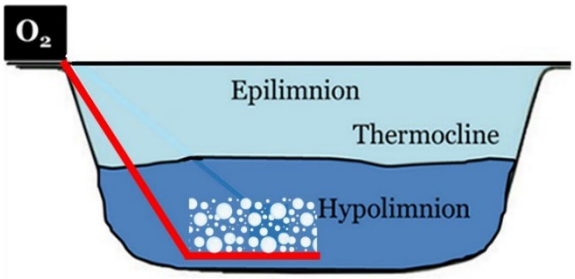

Fig. 4. Hypolimnetic oxygenation (HO) system schematic. The red line represents the pipe that transports the pure oxygen from the shore supply to the bottom of the lake

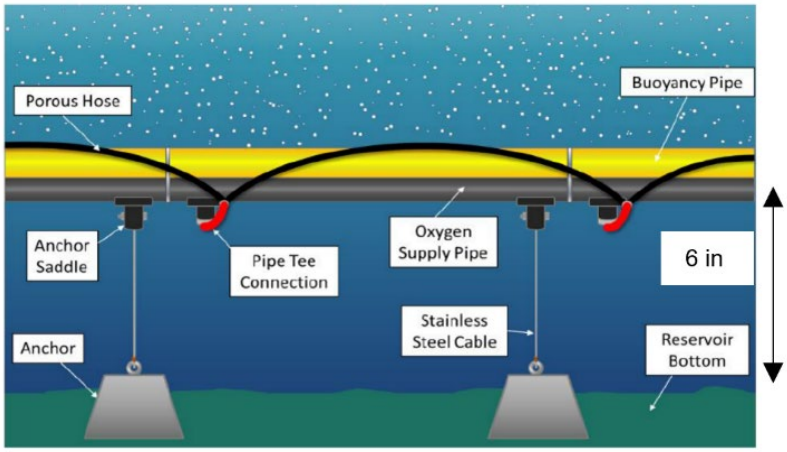

Fig. 5. Oxygen diffusers diagram. The yellow pipeline is very porous and it releases fine bubbles creating a crater that removes the sediments that may be covering it. The black pipe transports the oxygen and it is designed to float and keep the diffuser above the sediments

***Appendix 2**: Background of Hypolimnetic Oxygenation*

The foundation for use of oxygen as a restoration strategy of eutrophic lakes and reservoirs traces back to Mortimer (1942). The first application of artificially raising hypolimnetic oxygen to counter anoxia occurred in an Austrian aeration system. In the early years of HO, results were often variable, in part due to the availability of pure oxygen, design and performance issues, and oxygen storage logistics. As research on HO systems continued, technology improved, and pure oxygen became more readily available, HO has proven to be an effective technique with more predictive results. To date, more than 30 HO systems have been deployed in lakes and reservoirs worldwide (Gerling et al. 2014, Singleton and Little 2006).

Modern HO systems rely on oxygen either produced or stored adjacent to the lake. An on-site oxygen generator can be used to produce oxygen. These have a higher initial capital cost but lower operating costs in the long run. Liquid oxygen (LOX) can be delivered by a gas supplier. Such an arrangement has little or no maintenance expense but can result in a higher oxygen cost. Pure oxygen is preferred over the addition of air, as air is comprised of only 20% oxygen. It was envisaged for the Pilot Project that LOX be delivered, as the limited duration of the pilot project (less than 4 months) did not appear to warrant the extra capital costs. As part of the pilot project, a more detailed cost-benefit analysis of the oxygen supply could be conducted.

There are various systems used to transfer the oxygen from the storage or generation site into the lake and hypolimnion. HO transfer systems are generally categorized into three types: (1) direct injection via bubble plume diffusers (see for example Singleton et al. 2007) – in these systems a small bubble size ensures the oxygen quickly dissolves into the hypolimnion within a short distance from the injection depth; (2) in situ contact chambers such as the Speece Cone (see for example McGinnis and Little 1998) where oxygen dissolution occurs within a specially designed dissolution chamber housed at the bottom of the lake before releasing to the hypolimnion; and (3) side-stream saturation, for which water is withdrawn from the hypolimnion, oxygenated, and then returned (see for example Beutel and Horne 1999). Such systems have all operated for many years at a time, with a Speece cone system in Camanche Reservoir having been used for over twenty years. CA Waterboard currently has a hypolimnetic oxygenation study ongoing on Lake Hodges in San Diego. None of these systems have been found to cause

the sustained disturbance of the sediments. A pilot study conducted by Dr. Horne in the 70s in the Oaks Arm used the aeration technique, and the goal was to mix the full water column instead of directly adding oxygen at the sediment-water interface.

In 1999, the first review on HO was compiled, focusing on the first two decades of HO (Beutel and Horne 1999). A 2006 review summarized the state of system design (Singleton and Little 2006). A comprehensive review of HO in 2016 summarized HO applications to reduce cyanobacterial blooms (Bormans et al. 2016). A more recent review of HO was conducted in 2019, which concluded that HO was largely successful in improving water quality in the studies reviewed, although the conclusions must be tempered with the fact that other in-lake and watershed nutrient restoration efforts have often been implemented in conjunction with HO (Preece et al. 2019). The impacts of hypolimnetic oxygenation in three reservoirs in northern California specifically on mercury methylation are described in McCord (2016).

***Appendix 3**: In-lake Model Description and Progress*

During the past three years, the TERC team has been building, calibrating, and validating a three-dimensional (3-D) hydrodynamic lake model. A numerical lake model is a computer model that uses sets of mathematical equations to reproduce the different processes which are occurring in the lake (warming, mixing, stratification, inter-basin transport). The model is 3-D because it considers changes both in the horizontal and vertical directions. The processes the model simulates are organized into two groups: those that characterize how the water moves (i.e. *hydrodynamic*) and those that modify nutrients and algae in the lake (i.e. *water quality*). We have successfully completed the calibration/validation of the hydrodynamic model. The *calibration* process is a trial-and-error process in which we adjust the parameters of the mathematical equations to reduce the error between field observations and lake model results. During the *validation*, we use a different set of field data without changing any parameters, and we expect a good agreement between observations and model results.

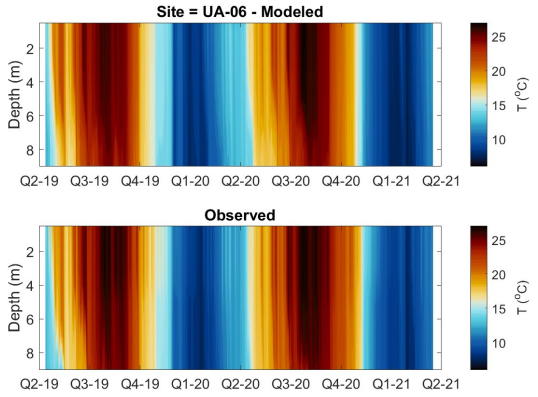

Fig. 6. Comparison of modeled (top) and observed (bottom) lake water temperatures between spring 2019 and spring 2021 in the

Root mean square errors for temperature are less than 1°C between modeled and observed lake temperatures for a two-year simulation in all Clear Lake basins (Fig. 6).

This lake model can also help us to better understand the transport of particles and dissolved constituents in the lake. The particles could be algae, phosphorus-rich sediment, or particulate mercury. Figure 7 shows the lake model results of the paths of three particles released in the Upper Arm. Each particle followed a completely different pathway, which highlights the complexity of the hydrodynamics or water movement in this system. Our field sampling plan is focused on improving our understanding of what are the factors affecting the different pathways.

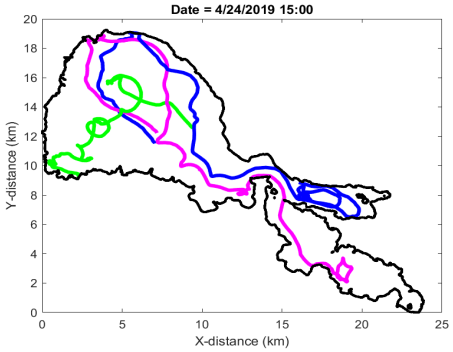

Fig. 7. Three-dimensional lake model results of possible pathways for particles. We used a different

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. Once the validation is completed, we are expecting to use the model to explore different questions regarding lake water quality (e.g. dissolved oxygen enhancement techniques, the fate of streams, and culvert loads). We have produced preliminary results of the dissolved oxygen changes in the water column without and with the hypolimnetic oxygen system (Fig. 8). These results suggest that dissolved oxygen next to the sediments can increase up to 80% when using hypolimnetic oxygenation.

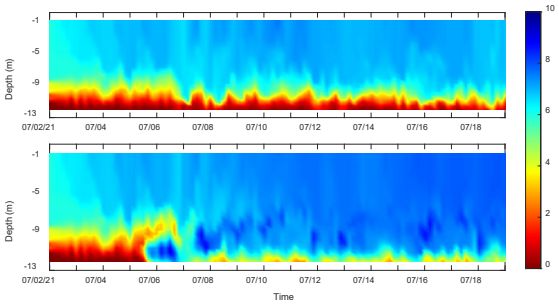

Fig. 8. Three-dimensional lake model results of dissolved oxygen without hypolimnetic oxygenation (top) and with

The large-scale manipulation that hypolimnetic oxygenation introduces, and the changes that it will set in motion, combined with the intensive monitoring that will track these changes, is an ideal scenario for a very robust calibration and validation of the biogeochemical model.

Appendix 4: References

Beutel MW, Horne AJ. 1999. A review of the effects of hypolimnetic oxygenation on lake and reservoir water quality. Lake Reserv Manage. 15(4):285–297. doi:10.1080/07438149909354124

Bormans M, Marsalek B, Jancula D. 2016. Controlling internal phosphorus loading in lakes by physical methods to reduce cyanobacterial blooms: a review. Aquat Ecol. 50(3):407–422. doi:10.1007/s10452-015-9564-x.

Cortés A, Forrest AL, Sadro S, Stang AJ, Swann M, Framsted NT, Thirkill R, Sharp SL, Schladow SG. 2021. Prediction of hypoxia in eutrophic polymictic lakes. Wat Resour. Res. 6: e2020WR028693. Doi: 10.1029/2020WR028693

Gerling AB, Browne RG, Gantzer PA, Mobley MH, Little JC, Carey CC. 2014. First report of the successful operation of a side stream supersaturation hypolimnetic oxygenation system in a eutrophic, shallow reservoir. Wat Res. 67:129–143. doi:10.1016/j.watres.2014.09.002.

McCord SA, Beutel MW, Dent SR, Schladow SG. 2016. Evaluation of mercury cycling and hypolimnetic oxygenation in mercury-impacted seasonally stratified reservoirs in the Guadalupe River watershed, California. Water Resour Res. 52(10):7726–7743. doi:10.1002/2016WR019061

McGinnis DF, Little JC. 1998. Bubble dynamics and oxygen transfer in a Speece cone. Water Science and Technology. 37:285-292, url: https://iwaponline.com/wst/article/37/2/285/7538/Bubble-dynamics-and-oxygen-transfer-in-a-speece

Mortimer CH. 1942. The exchange of dissolved substances between mud and water in lakes. Part III. The relation of seasonal variables in redox conditions in the mud to the distribution of dissolved substances in Esthwaite Water and Windermere, North Basin. Part IV. General discussion. J. Ecology. 30:147–201. doi:10.2307/2256691.

Preece, E. P., B. C. Moore, M. M. Skinner, A. Child & S.Dent. 2019. A review of the biological and chemical effects of hypolimnetic oxygenation. Lake and Reservoir Management. 35:3. 229-246, doi: 10.1080/10402381.2019.1580325

Singleton VL, Gantzer P, Little JC. 2007. Linear bubble plume model for hypolimnetic oxygenation: full-scale validation and sensitivity analysis. Water Resour Res. 43:W02405. doi:10.1029/2005WR004836.

Singleton VL, Little JC. 2006. Designing hypolimnetic aeration and oxygenation systems: a review. Environ Sci Technol. 40(24):7512–7520.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 9
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San Francisco, CA 94105-3901

S. Geoffrey Schladow, PhD
Professor of Water Resources and Environmental Engineering
Director, Tahoe Environmental Research Center
University of California, Davis

Alicia Cortes
Assistant Project Scientist
Civil and Environmental Engineering
University of California, Davis

Via Electronic Mail

RE: Hypolimnetic Oxygenation for the Reduction of Mercury Methylation

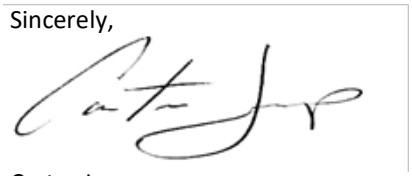
Dear Dr. Schladow and Ms. Cortes:

Thank you for inviting USEPA to participate in your informational session regarding UC Davis Tahoe Environmental Research Center's proposal for a hypolimnetic oxygenation pilot project in Clear Lake. As clearly outlined in your proposal summary, the hypoxic and anoxic conditions that contribute to harmful algal blooms in Clear Lake are also understood to contribute to the methylation of mercury in the lake. Hypolimnetic oxygenation studies in other waterbodies have shown that by improving low oxygen conditions, methylmercury generation can be reduced.

As I know you are aware, the Sulphur Bank Mercury Mine Superfund Site (SBMM) sits on the shoreline of Clear Lake and extends out to include Clear Lake itself. Prior evaluation by the Central Valley Regional Waterboard has concluded that a majority of the mercury in Clear Lake was introduced by SBMM. Due to the complexities inherent in both the Clear Lake system and the dynamics of mercury in the aquatic environment, EPA is still investigating both the nature and extent of SBMM-related contamination in Clear Lake and what future cleanup options might be available. EPA's principal goal at any Superfund site is to control the risks that the site poses to human health and the environment. Based on a 2021 Human Health Risk Assessment, we find that eating methylmercury-contaminated fish from Clear Lake poses serious health risks for community members who eat fish from the lake regularly. From information gathered to date and existing scientific literature, it appears that hypolimnion oxygenation warrants study as a possible tool for managing methylmercury generation. Such tools, if they prove viable, may help curb public exposure to this serious health risk. For these reasons, we would be very interested in the data produced by any hypolimnetic oxygenation project in Clear Lake.

Whenever possible, EPA will be participating in future technical subcommittee meetings of the Blue Ribbon Committee for the Rehabilitation of Clear Lake. We hope to continue to receive updates about your pilot project proposal through that participation. In the meantime, please feel free to contact me at (628) 223-3524 or jessop.carter@epa.gov if there is any clarification you need about this letter.

Sincerely,



Carter Jessop
Superfund Remedial Project Manager

Clear Lake Blue Ribbon Committee

Adobe Creek Hydrology & Groundwater Monitoring
May 4th, 2022

Project Title: Adobe Creek Hydrology & Groundwater Monitoring

Project Description:

The purpose of this project is to better understand discharge in Adobe Creek, which contributes nutrients and sediment that decreases water quality in Clear Lake and provides habitat for Clear Lake hitch, which are an important component of the Clear Lake ecosystem and are on the verge of collapse. The Big Valley Band of Pomo Indians (BV) is currently developing a 2D hydraulic model of Adobe Creek to better understand discharge and habitat availability but require more streamflow and groundwater data–which is extremely limited on Adobe Creek–to calibrate the model and to gain a better understanding of groundwater recharge. The additional data from developing rating curves for the Big Valley Band of Pomo Indians stage gages in Adobe Creek will improve the data input in larger water quality modeling efforts that will be completed by USGS. Specifically, USGS will build a SPARROW (SPAtially Referenced Regression On Watershed attributes) model for the Clear Lake Watershed that will relate water-quality measurements made at a network of monitoring stations to attributes of the upstream watersheds. Additionally, the flow data from this project could be used to help calibrate the Hydrological Simulation Program - FORTRAN (HSPF) USGS will build to describe runoff, sediment transport, and nutrient transport. This proposal builds off projects Big Valley Band of Pomo Indians has completed with funding from the Bureau of Indian Affairs, but there is no additional funding for this work starting Jan 2023 to continue surface water and groundwater monitoring. Better understanding of discharge in Adobe Creek will contribute to larger modeling efforts that will quantify the impacts of sediment and nutrients in Clear Lake from the Big Valley tributaries, which will prioritize sediment and nutrient reduction actions to improve water quality in Clear Lake.

There are pressure transducers installed in three locations along Adobe Creek: 1) Bell Hill Road crossing, 2) Argonaut Road bridge, and 3) Soda Bay Road bridge. In addition to these three existing gages, two more will be installed, downstream of both the Highland Springs Reservoir and the Adobe Reservoir (Figure 1). Big Valley Rancheria staff regularly downloads data from the three existing pressure transducers, as well as the barometric pressure. Stage is calculated by merging the barometric data with the pressure data. The Tribe has been working with consultants to perform in-channel discharge monitoring using a Hach FH950 Flowmeter at each of the three locations and will continue to develop rating curves at the two additional sites near Highland Springs and Adobe reservoirs.

This project will include the purchase of equipment to conduct discharge measurements at higher flows when Adobe Creek cannot be safely waded and the labor to conduct discharge measurements and develop rating curves. High flow measurements will be conducted at the Soda Bay, Argonaut, and Bell Hill sites.

With the additional flow data, the Tribe will be able to better quantify minimum flows to inundate the channel for Hitch habitat and better understand sediment and nutrient transport (Figure 2), data which will be useful to other restoration efforts in the watershed.

Task 1: Purchase of discharge monitoring equipment to be used from bridges over the creek - flowmeter, bridge board, and cable

Discharge measurement is currently limited to wadeable flows. Purchasing additional discharge monitoring equipment to be used from the bridges over the creek will enable measurement at higher flow levels. This will include a flowmeter, bridge board, cable, and weighted fish.

Task 2: Conduct discharge measurements at a range of flows during 10 flow events

We will conduct a total of 10 discharge measurements at a range of flows, including those too deep for wading at the Soda Bay, Argonaut, and Bell Hill sites. Measurements will be taken at all three locations, adjacent to the installed pressure transducers. Discharge measurements will also be collected at the Highland Springs Reservoir and Adobe Reservoir sites if flows allow for wading in the creek.

Task 3: Analyze data and compose report

The Tribe will use the stage data and discharge data to build a rating curve for determining a range of flows in Adobe Creek. This flow data will be used for hydraulic model calibration. The 2D hydraulic model is being built with funding from the BIA using HEC-RAS and will provide water surface elevations for a given discharge, as well as additional data on velocity, flow vectors, sediment transport, and losses to groundwater.

All data will be analyzed, and a report composed. Analysis will include filling in data gaps as feasible. The current monitoring capabilities of flow data is limited, so new flow monitoring equipment will aid in filling those gaps in data.

Task 4: Purchase and install groundwater monitoring equipment and manage data

Groundwater monitoring equipment will be purchased and installed in the watershed and the data will be managed by the Tribe and shared with restoration and water management practitioners. Two groundwater monitoring wells will be installed adjacent to Adobe Creek.

Project Timeline:

- **Years 1:** Task 1, 2, & 4
- **Year 2:** Task 2
- **Year 3:** Task 2 & 3

Projected Budget:

The total budget request for the project is $150,000. The breakdown between tasks is:

Task	Description	Budget
1	Purchase of discharge monitoring equipment to be used from bridges over the creek - flowmeter, bridge board, and cable	$30,000
2	Conducting discharge measurements at a range of flows during 10 flow events	$50,000
3	Data analysis and report composition	$30,000
4	Purchase and installation of groundwater monitoring equipment and data management. Two groundwater monitoring wells will be installed adjacent to Adobe Creek.	$40,000
TOTAL		**$150,000**

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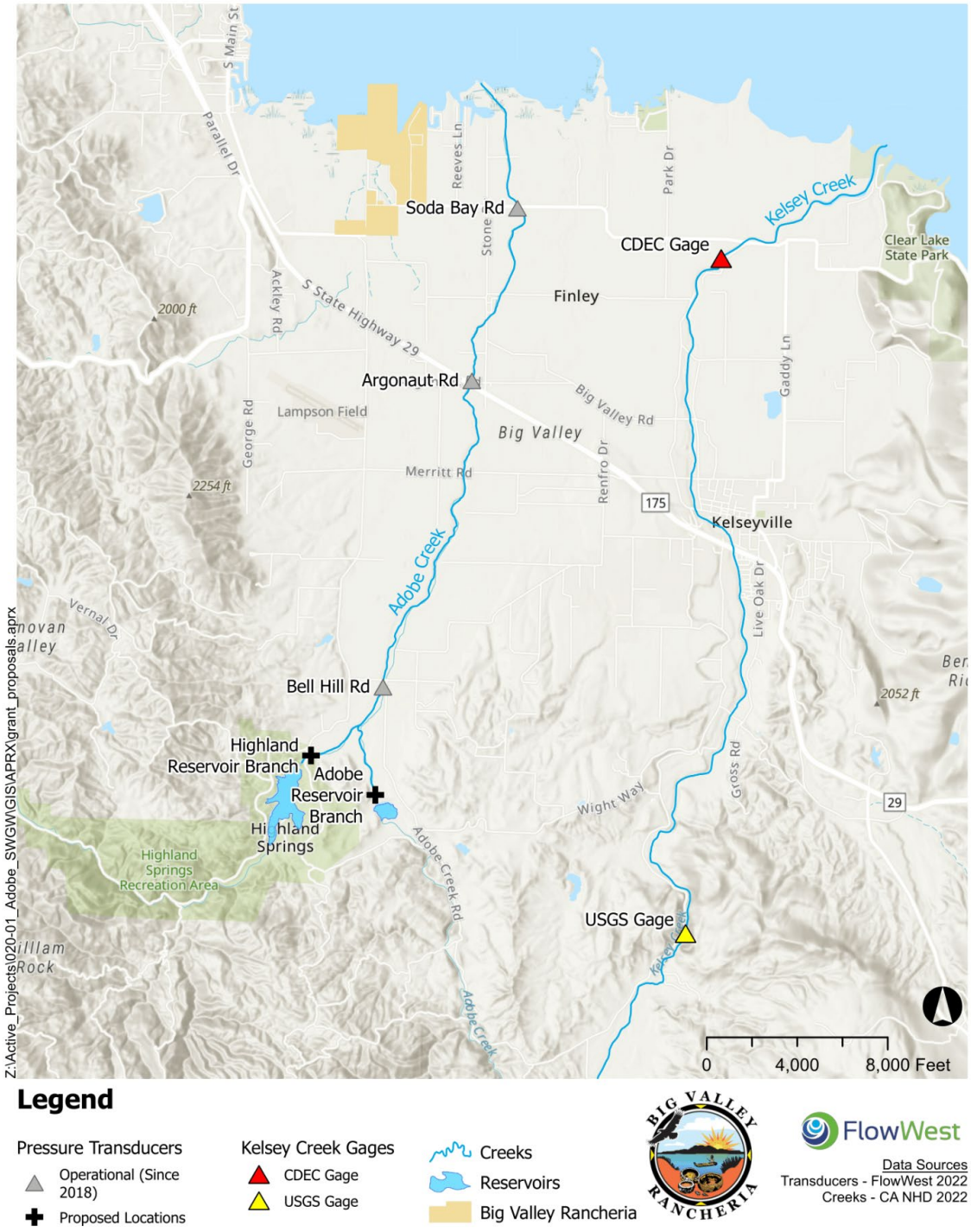
sryan@big-valley.net

707-263-3924 x132

Leverage Existing Funding

This project builds off projects funded by the Bureau of Indian Affairs (BIA) Climate Resilience Grant Program that funded the installation of the existing pressure transducers and will fund the two additional pressure transducers. Additionally, groundwater monitoring will continue efforts started under the BIA grant that installed groundwater monitoring equipment in existing residential and agricultural wells. The Blue Ribbon Committee funding will allow for the installation of two dedicated groundwater monitoring wells that will record groundwater elevations every 15-minutes. The combination of the surface water and groundwater monitoring will significantly increase the available data to help manage water resources that benefit water quality in Clear Lake and the hitch.


Soda Bay Rd
CDEC Gage
Kelsey Creek
Clear Lake State Park
Finley
Argonaut Rd
Lampson Field
Big Valley
Big Valley Rd
Merritt Rd
Kelseyville
Adobe Creek
Bell Hill Rd
Highland Reservoir Branch
Adobe Reservoir Branch
Highland Springs
Highland Springs Recreation Area
USGS Gage
Wight Way
Adobe Creek Rd
Parallel Dr
S Main St
Reeves Ln
Park Dr
Stone
Ackley Rd
S State Highway 29
2000 ft
George Rd
2254 ft
Renfro Dr
175
Live Oak Dr
Gross Rd
Gaddy Ln
2052 ft
29
Vernal Dr
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0
4,000
8,000 Feet
Legend
Pressure Transducers
Operational (Since 2018)
Proposed Locations
Kelsey Creek Gages
CDEC Gage
USGS Gage
Creeks
Reservoirs
Big Valley Rancheria
FlowWest
Data Sources
Transducers - FlowWest 2022
Creeks - CA NHD 2022

Figure 1 Existing USGS and CDEC discharge gages on Kelsey Creek and pressure transducers installed along Adobe Creek. High flow discharge monitoring will be conducted at the Big Valley pressure transducers (gray triangles) and low flow discharge monitoring will be conducted at the gray triangles and plus signs.

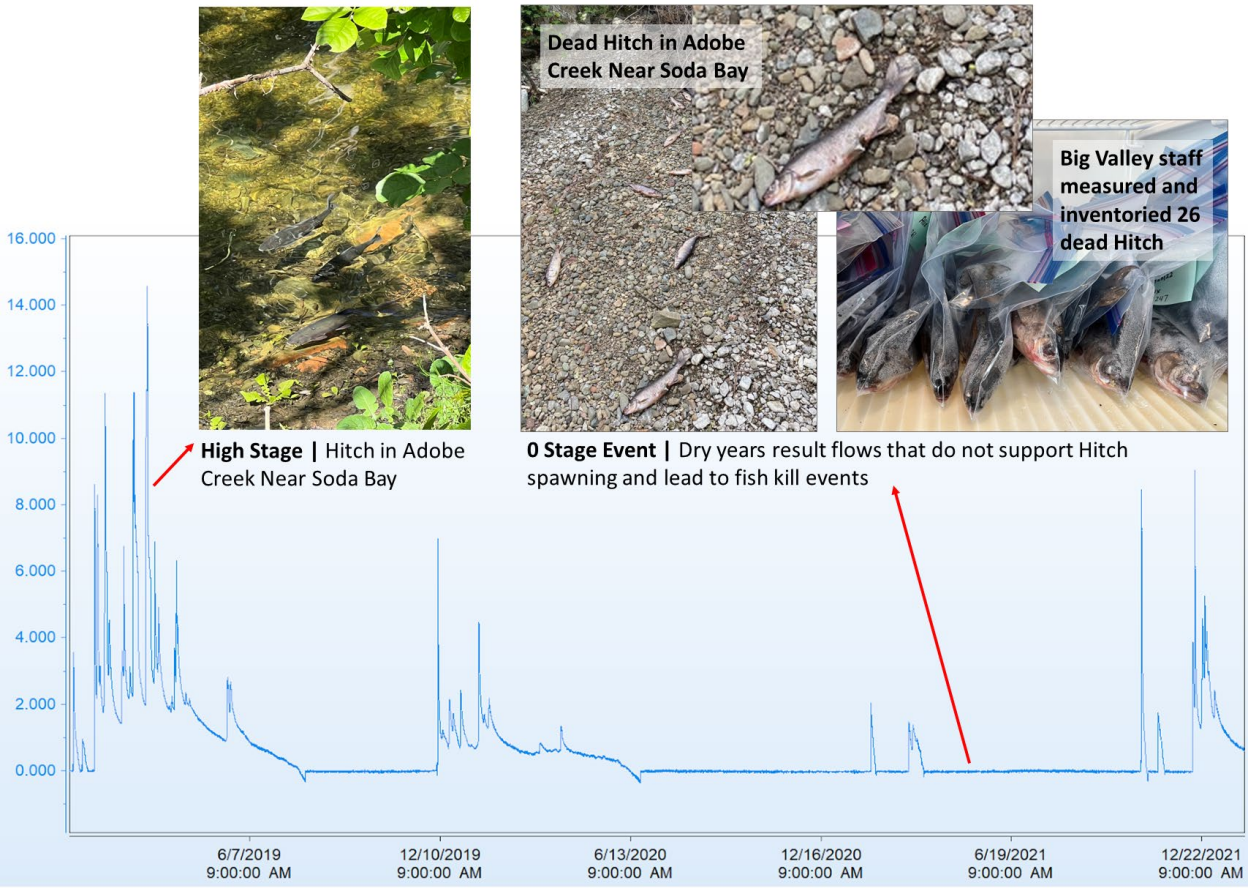

Figure 2 Flows in Adobe Creek are critical for hitch spawning. When flows drop quickly during the spawning period, hitch become stranded in dry creek pools and must be removed downstream or to the lake to survive. Hitch rescues and deaths have occurred during March through May in 2014, 2016, 2018 and 2022 according to CDFW documents.

Clear Lake Blue Ribbon Committee

Groundwater Dependent Ecosystems (GDE) and Wetland Restoration Analysis and Implementation

May 4th, 2022

Project Title: Groundwater Dependent Ecosystems (GDE) and Wetland Restoration Analysis and Implementation

Project Description:

The purpose of the project is to restore groundwater-dependent ecosystems (GDE) in the Big Valley Subbasin (see Figure 1). Success for the project is a constructed wetland providing GDE habitat. Success also involves improving data related to GDE in the subbasin to ensure the implementation project achieved through this effort is readily reproducible and scalable in the Clear Lake watershed. Constructed wetlands based on GDE evaluations will improve water quality and provide critical habitat in the watershed. Big Valley Band of Pomo Indians EPA (BV EPA) will conduct the project work with support from FlowWest, a restoration engineering and science consulting firm. A TBD contractor will be engaged for construction.

Task 1: Evaluation of existing GDE data and assessments and refinement of spatial GDE data

This task would involve reviewing the existing GDE data developed by The Nature Conservancy (TNC), and incorporating TNC's recommendations for best use of the data in the Big Valley subbasin per their input

on the Big Valley subbasin GSP. Updating the GDE data as soon as possible is critical to moving forward with implementation of GDE habitat restoration project. Although these data will likely be updated through the GSP process, the Tribe would like to act more quickly. The recent hitch fish kill on Adobe Creek has highlighted the need to improve habitat in the subbasin as soon as possible. The project team will review the Natural Communities (NC) dataset, including areas that are adjacent to irrigated fields or surface water; and compile likely irrigated areas in the subbasin based on available landcover data and select ground-truthing. TNC's plant rooting depth database will also be reviewed and integrated into spatial data as applicable. Groundwater trends in the subbasin using TNC's Shallow Groundwater Estimation Tool will be evaluated and integrated into spatial data.

Task 1 Deliverables: Compiled spatial dataset of GDEs in the Big Valley subbasin

Task 2: Document potential wetland restoration areas and select pilot project site in collaboration with local Tribes

Based on the assessments completed in Task 1, the Project team will develop a draft map of up to 10 potential sites for restoration. The Project team will also review land ownership data and assess constraints related to coordinating with public and private landowners. BV EPA will engage local Tribes to provide insights on the potential sites based on Tribal traditional uses and knowledge, to aid in prioritization of projects. Based on assessments and outreach, a pilot wetland restoration project will be selected. The Project team will consolidate analysis and findings from Tasks 1 and 2 in a technical memo; the memo will explain the rationale behind the prioritization of the selected pilot project.

Task 2 Deliverables: Big Valley subbasin GDE assessment and prioritization memo

Task 3: Pilot project development, design, and environmental compliance

FlowWest will lead the development of site access agreements; environmental compliance documentation, and engineering designs including planset, basis of design report, specifications and bid package. FlowWest will also prepare a monitoring protocol to assess the wetland performance and gather baseline data necessary prior to construction.

Task 3 Deliverables:

- *Site access agreements*
- *Final engineering design package*
- *CEQA environmental compliance documentation and associated permits*

Task 4: Pilot project construction and post-project monitoring

The Project team will select a contractor to construct the wetland, and FlowWest will provide engineering oversight during construction. FlowWest will conduct an as-built survey; the survey will document the constructed project and be a resource for monitoring and can be used as a reference for additional projects in the watershed. The Project team will conduct post-project monitoring in accordance with the protocols developed in Task 3.

Task 4 Deliverables:

- *As-built survey*
- *Post-project monitoring summary assessing first year after construction*

Project Timeline:

We assume contracting is in place by September of 2022 and construction (Task 4) occurs in the summer of 2023, following by one year of monitoring.

Task	Sept – Dec 2022	Jan- March 2023	April -June 2023	July 2023- Sept 2024
1				
2				
3				
4				

Projected Budget:

The total budget request for the project is $500,000. The breakdown between tasks is:

Task	**Description**	**Budget**
1	Evaluation of existing GDE data and assessments and refinement of spatial GDE data	$30,000
2	Document potential wetland restoration areas, TEK integration, prioritization and selection of pilot project site in collaboration with tribal partners	$60,000
3	Pilot project development, CEQA, site access agreements, design, and environmental compliance	$185,000
4	Pilot project construction and post-project monitoring	$225,000
TOTAL		**$500,000**

Contact Information:

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The Nature Conservancy
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May 5, 2022

SUBJECT: Letter of Support for "Groundwater Dependent Ecosystems (GDE) and Wetland Restoration Analysis and Implementation".

Dear Blue Ribbon Committee for the Rehabilitation of Clear Lake,

This is a letter of support for the Big Valley Band of Pomo Indians' proposal to restore groundwater dependent ecosystems in the Big Valley subbasin. I have reviewed the proposal and believe it to be well thought out and critical for rehabilitating ecosystems in the Big Valley subbasin. I encourage you to consider providing funds for this proposal.

Groundwater dependent ecosystems are biological hotspots that support ecological functioning and important refugia during drought. Due to widespread groundwater depletion, many groundwater dependent ecosystems are losing access to groundwater which results in habitat loss and affects many species' ability to carry out key life processes such as spawning and migration. Due to a long history of land use conversion, water diversions (including groundwater pumping), and climate change, many groundwater dependent ecosystems host many threatened and endangered species, such as the Clear Lake hitch (*Lavinia exilicauda chi*) - a threatened species under California Endangered Species Act and culturally important to the Xa-Ben-Na-Po Band of Pomo people.

Successfully restoring groundwater dependent ecosystems in the Big Valley subbasins will require selecting suitable project sites that can access groundwater and be resilient to drought. While The Nature Conservancy has developed a suite of groundwater dependent ecosystem mapping tools, there is a need to locally validate where these ecosystems are located, and the groundwater levels needs to restore habitat. This work is outlined in this proposal, which I happily and enthusiastically endorse.

Please feel free to contact me if you have further questions.

Best regards,

Melissa M Rohde

Melissa M. Rohde
Groundwater Scientist
California Water
Program

Clear Lake Blue Ribbon Committee

Big Valley Tributary Harmful Algal Bloom (HAB) and Bank Erosion Project
May 4th, 2022

Project Title: Big Valley Tributary Harmful Algal Bloom (HAB) and Bank Erosion Project

Project Description:

Clear Lake is impaired by nutrients because of decades of sediment loading from the watershed. Due to impairment of the beneficial uses of the lake, Clear Lake was added to the Clean Water Act 303(d) List of Impaired Waterbodies for nutrients and mercury with TMDLs being developed in 2007 and 2003 respectively. Clear Lake was listed for microcystin on the 2022 303(d) list. The creeks feeding Clear Lake are also contributors of nutrients and mercury through sediment loading. Monitoring has been conducted on Middle and Scotts Creeks by the USGS, but systematic monitoring and assessment has not been conducted on the Big Valley Tributaries that are critically important for the Clear Lake hitch and the health of Clear Lake. USGS will be conducting watershed wide nutrient and sediment modeling through Blue Ribbon Committee funding. This project adds HAB monitoring in the four primary tributaries to Clear Lake in the Big Valley Basin. Harmful algal blooms are overgrowths of cyanobacteria (formerly known as "blue green algae") and can produce cyanotoxins that are harmful to humans and animals. The blooms themselves impair the many beneficial uses of Clear Lake including surface drinking water treatment and recreation by filling the water with noxious organic matter.

This project will also assess the four primary tributaries to the Clear Lake in the Big Valley Basin for bank erosion and develop bio-engineering designs to reduce chronic sources of sediment and nutrients to Clear Lake. The hitch population is on the verge of collapse and is an important indicator for the health of Clear Lake. Hitch rescues are becoming common as water resources decrease even as recently as May 2022 (https://www.sfchronicle.com/bayarea/article/Clear-Lake-hitch-17152310.php). Harmful algal blooms (HAB) driven by high nutrient loads and warm water temperatures have become more prevalent and violate state and federal standards. Understanding HAB and bank erosion will improve understanding of HAB, sediment, and nutrient discharge into Clear Lake. This project will build off work conducted in the Middle Creek watershed and complements studies and modeling to be completed by USGS. This project implements a pilot project to reduce chronic sources of nutrients and sediment from bank erosion. In the Summer 2021, Big Valley Rancheria EPA discovered, during routine water quality sampling in Clear Lake, anatoxins – a potent neurotoxin produced by certain cyanobacteria species – were found in multiple locations on the Lake; while microcystin levels from a September 7, 2021, monitoring event were the highest ever measured at 160,378 micrograms/liter (200,000 times higher than State water recreational standards). While previous years' sampling showed anatoxins in single locations, it had never been identified in multiple locations in the same sampling event.

This project will address HAB and delivery of nutrients and sediment from bank erosion by:

1) conducting HAB monitoring through grab samples as well as using Solid Phase Adsorption Toxin Tracking (SPATT) bags along the four primary tributaries to Clear Lake from the Big Valley Basin, and

2) conducting systematic bank erosion assessment along the four primary tributaries and implement a pilot project to reduce the chronic source of nutrients and sediment from bank erosion

Big Valley Rancheria (BVR) EPA has been conducting water quality monitoring in and around Clear Lake for over 20 years and has developed a rich dataset that documents the decline in water quality. All BVR-EPA's water quality sampling results are submitted to the USEPA Water Quality Exchange, and the datasets are utilized by the Central Valley Regional Water Quality Control Board to assess Clear Lake in regular Integrated Reports for impairment. Big Valley Rancheria's cyanobacteria, cyanotoxin, and tissue-testing data is ultimately shared with the State Water Resources Control Water Board, the Regional Water Board, and the Office of Environmental Health Hazard Assessment (OEHHA).

The Big Valley Rancheria EPA Water Quality Monitoring Program includes the following:

1. Monthly lake sampling (since 1999), both below the surface and at various depths, in the vicinity of the Big Valley Rancheria shoreline. BVR EPA measures phycocyanin, chlorophyll-a, pH, water temp, dissolved oxygen, turbidity, specific conductivity, salinity, and total dissolved solids.

2. Groundwater monitoring program (since 2004) for the Tribe's production wells ensures ongoing sustainable management of groundwater resources. In 2021, the Tribe began collaborating with local well owners to measure groundwater levels by installing water level monitoring equipment measuring depth and temperature. This 15-minute interval data readings will help groundwater managers better understand seasonal variability of groundwater resources.

3. Stormwater monitoring (since 2008) occurs during winter months to determine pathogen, nutrient, and petroleum product contaminants.

4. Weekly creek monitoring (since 2009) during the rainy season in the Big Valley Basin of five Hitch bearing streams, for water chemistry and field observations. In 2018, the Tribe also installed pressure transducers on Adobe Creek to measure stream stage at three locations. This data is downloaded quarterly. This data has resulted in a Hitch Climate Adaptation Plan shared with local and state stakeholders https://bit.ly/HitchClimateAdaptationPlan .

5. Biweekly cyanotoxin monitoring (since 2014) of Clear Lake shoreline for cyanotoxins. This collaborative program begun with Elem Indian Colony determines bloom presence using site conditions, field toxin kits, microscopy, field measurements for water chemistry and algal pigmentation. Samples are sent off for lab confirmation of hepatotoxins and neurotoxins. The Tribes developed and lead the Clear Lake Cyanobacteria Task Force, meeting biannually with local, regional, and state staff and leadership on Clear Lake water quality issues which have led to climate action plans and projects focusing on nutrient management and drinking water protection.

6. Lake real-time water quality stations (as of 2021) off docks in the Oaks and Lower Arms capturing water temperature, dissolved oxygen, phycocyanin, chlorophyll-a, and specific conductivity.

Funding from this project will allow Big Valley Rancheria to expand HAB monitoring in the four primary tributaries to Clear Lake in the Big Valley Basin. Monitoring in tributaries is needed to document the expansion of microcystin upstream of Clear Lake. As climate change stressors such as heightened water temperatures, lowered lake levels (due to drought) and heightened sediment loads (from chronic and increased erosion following multiple wildfires), Clear Lake water quality is continuing to deteriorate and threatening the health and livelihood of people living in the region.

Project Timeline:

Given the critical need for the sediment and nutrient reduction into Clear Lake, data analysis and design will be streamlined to implement the pilot project quickly.

- **Year 1:** Install HAB monitoring equipment (SPATT bags), map bank erosion on Adobe, Cole, Manning, and Kelsey Creeks, conduct bedload and suspended load sediment baseline sampling, and lab analysis of HAB and sediment samples
- **Year 2:** Develop bank enhancement design using bio-engineering techniques and complete environmental compliance at a high-priority site, maintain HAB monitoring equipment, and lab analysis of HAB samples
- **Year 3:** Implement pilot bank enhancement project, conduct bedload and suspended load sediment sampling, analyze data and compose report, maintain HAB monitoring equipment, and lab analysis of HAB and sediment samples

Projected Budget:

- Overall budget request: $600,000
    - Install HAB monitoring equipment (SPATT bags) on Adobe, Manning, Cole and Kelsey Creeks ($30,000)
    - Maintain HAB monitoring equipment for 3 years ($30,000)
    - Lab analysis of HAB samples ($30,000)
    - Map bank erosion on Adobe, Manning, Cole, and Kelsey Creeks ($50,000)
    - Develop shovel ready bank enhancement design using bio-engineering techniques and complete environmental compliance at high-priority sites ($150,000)
    - Implement pilot bank enhancement project ($200,000)
    - Conduct bedload and suspended load sediment sampling ($30,000)
    - Analyze data and compose report ($80,000)

Contact Information:

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Additional Information:

Leveraging existing grants

This project leverages grants that the Big Valley Band of Pomo Indians has obtained from the Bay Area Council Resiliency Challenge, the EPA Exchange Network program, and the Bureau of Indian Affairs (BIA) Climate Resilience Grant Program.

Funding from the Bay Area Council Resilience Challenge (https://www.bayareacouncil.org/press-releases/california-resilience-challenge-announces-statewide-request-for-proposals-for-climate-adaptation-projects/) enabled the initial development and outreach for the iNaturalist Fish Kill App. Funding from BRC will be used to expand the functionality of the app and continue outreach.

The Big Valley Band of Pomo Indians has also obtained funding from the EPA Exchange Network program (https://www.epa.gov/exchangenetwork) to upload water quality data to the EPA Water Quality Portal (https://www.waterqualitydata.us/). Work completed under the EPA project will be included in the Clearinghouse developed for the BRC project.

This project also builds off projects funded by the BIA Climate Resilience Grant Program that (https://www.bia.gov/bia/ots/tribal-climate-resilience-program) that funded the installation of the pressure transducer in Adobe Creek to measure temperature and stage. Additionally, groundwater monitoring equipment was installed in existing residential and agricultural wells. The combination of the surface water and groundwater monitoring will significantly increase the available data to help manage water resources that benefit water quality in Clear Lake and the hitch.

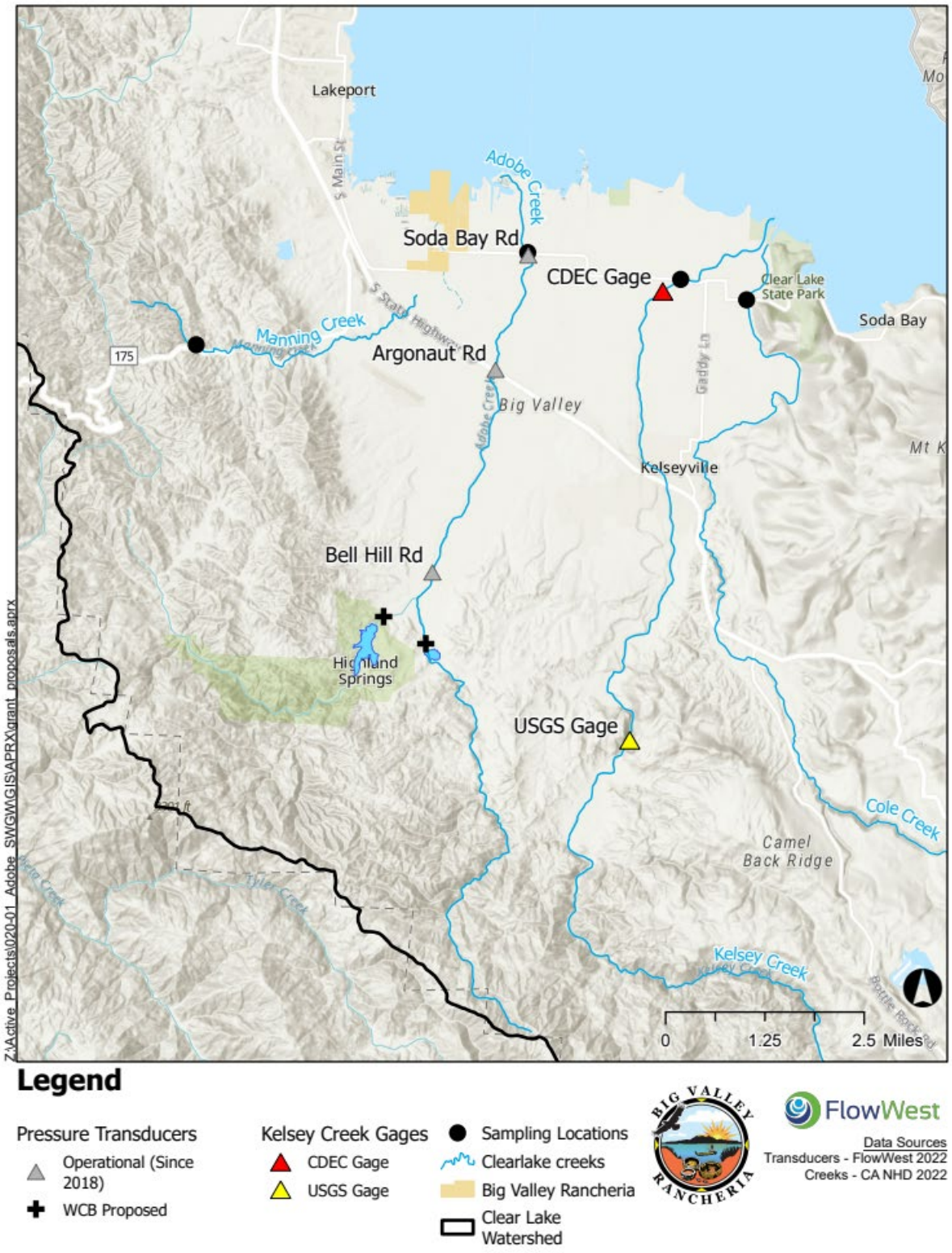

Figure 1 Proposed HAB monitoring locations (black circles) and the four primary tributaries to Clear Lake from the Big Valley Basin.

Clear Lake Blue Ribbon Committee

Web Based Clearinghouse for Data and Reports and Expansion of the Bay Area Council Citizen Science App and Dashboard

May 4th, 2022

Project Title: Web Based Clearinghouse for Data and Reports and Expansion of the Bay Area Council Citizen Science App and Dashboard

Project Description:

Multiple federal, state, local, and tribal entities have been collecting water quality and hitch related data on Clear Lake and tributaries for decades, but there is no central location to disseminate information collected by these different institutions. Information that is shared is in federal and state databases that are challenging to navigate and discover information. This difficulty in obtaining information related to Clear Lake water quality is a barrier to collaboration and public engagement. Public engagement is critical because water quality monitoring requires reporting from community members to augment tribal and agency personnel to accurately and timely report and respond to fish kills and harmful algal blooms (HABs). Clear Lake is the state's largest natural lake that covers 70 square miles and exceeds the capacity of the local entities to monitor. Centralizing the great monitoring data collected in the watershed by local Tribes, Lake County, USGS, EPA, CDFW, UC Davis, University of Southern California, and other entities will enhance the impact of the investment in data collection and help realize the potential of improved resource management through access to the best available information for all stakeholders. Additionally, high quality data that has been through a QA/QC process that is shared with federal and state agencies will help allocate funding resources to Clear Lake to increase monitoring and water quality actions.

This project will address both problems by:

1) creating a web-based clearinghouse for reports and links to data sets that spans all entities collecting water quality and hitch data on Clear Lake and tributaries and

2) building off of the existing Big Valley Band of Pomo Indians citizen science monitoring program for fish kills (https://flowwest.shinyapps.io/bvr-water-quality/) to include HABs and expand outreach, manage data, and share data with other state and federal agencies.

As the diverse and dedicated entities working on Clear Lake continue to expand, a clearinghouse is needed for centralized dissemination of documents and links related to water quality and hitch data sets. Some stakeholders include Clear Lake research on websites, but publications are not separated from other research or organized to easily find data on water quality topics (https://regionalchange.ucdavis.edu/publications). We will engage with agencies, tribes, NGOs, and

academic institutions to obtain reports and documents. We will catalog and tag documents for easy searching and display on a webpage. We will also provide links to water quality and hitch data sets maintained by various entities to create one location on the web to easily obtain and share Clear Lake water quality and hitch data. Reports and documents will be obtained, cataloged, and made available for download from local tribes, Lake County, USGS, EPA, CDFW, UC Davis, University of Southern California, Chi Council, CLERC, and other entities. The Klamath Tribes of Southern Oregon have developed a similar clearinghouse for water quality and sucker related information that provides a guide for the Clear Lake clearinghouse webpage (https://klamathtribeswaterquality.com/).

Community monitoring of hitch spawning by the Chi Council and CLERC illustrates the success of and potential for citizen science in Clear Lake. As of Summer 2021, over 3,300 people follow Big Valley Rancheria-EPA's Clear Lake Water Quality Facebook website (https://www.facebook.com/ClearLakeWaterQuality/) where the latest water quality monitoring results are announced, and where the tribe builds community capacity by conducting public education and outreach. Posts regarding cyanotoxin results usually garner over 6,000 reaches and hundred of engagements, according to web analytics. The Big Valley Band of Pomo Indians recently implemented a citizen science monitoring program for fish kills including an online dashboard that was funded through the Bay Area Council's California Resilience Challenge (https://flowwest.shinyapps.io/bvr-water-quality/). This project will build on the existing iNaturalist app for fish kills to include HAB mapping and reporting. iNaturalist was developed by the California Academy of Sciences and has over 5,133,000 people signed up and has logged over 97,430,000 observations of over 343,000 species (https://www.inaturalist.org/). The iNaturalist app is easily downloaded on mobile devices and can be used by people on the lake fishing or recreating; homeowners; partner entity staff; and concerned community members. Outreach will include signage, discussion during a radio show on public radio broadcast once a month, and social media. In addition to fish kills and HABs, the app will also include tools for community building for citizen mobilization during critical times, such as the recent hitch rescue.

Project Timeline:

Given the critical need for the central location of Clear Lake water quality related documents this component of the project will be completed within the first year. The citizen science component will be developed during the first year of the project and supported for the remaining two years of the project.

- **Year 1:** Create web-based clearinghouse for Clear Lake water quality and hitch data, expand iNaturalist app to include HAB monitoring, expand dashboard to visualize monitoring, outreach and training for iNaturalist app for fish kill and HAB monitoring
- **Year 2:** Citizen science app outreach and engagement, manage and disseminate data, and improve dashboard
- **Year 3:** Citizen science app outreach and engagement, manage and disseminate data, and improve dashboard

Projected Budget:

- Overall budget request: $250,000
    - Create Web-based Clearinghouse for Clear Lake water quality and hitch data and key documents ($100,000)
    - Expand iNaturalist app to include HAB monitoring ($20,000)
    - Expand dashboard to visualize monitoring ($40,000)
    - Outreach to increase training and adoption of iNaturalist app for fish kill and HAB monitoring that will include flyers and handouts at marinas and lake related recreational supply vendors, social media, and public radio discussion ($50,000)
    - Manage data (QA/QC) and automate transfer of data to state water quality portals ($40,000)

Contact Information:

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Additional Information:

Leveraging existing grants

This project leverages grants that the Big Valley Band of Pomo Indians has obtained from the Bay Area Council California Resilience Challenge and the EPA Exchange Network program.

Funding from the Bay Area Council Resilience Challenge (https://www.bayareacouncil.org/press-releases/california-resilience-challenge-announces-statewide-request-for-proposals-for-climate-adaptation-projects/) enabled the initial development and outreach for the iNaturalist Fish Kill App. Funding from BRC will be used to expand the functionality of the app and continue outreach.

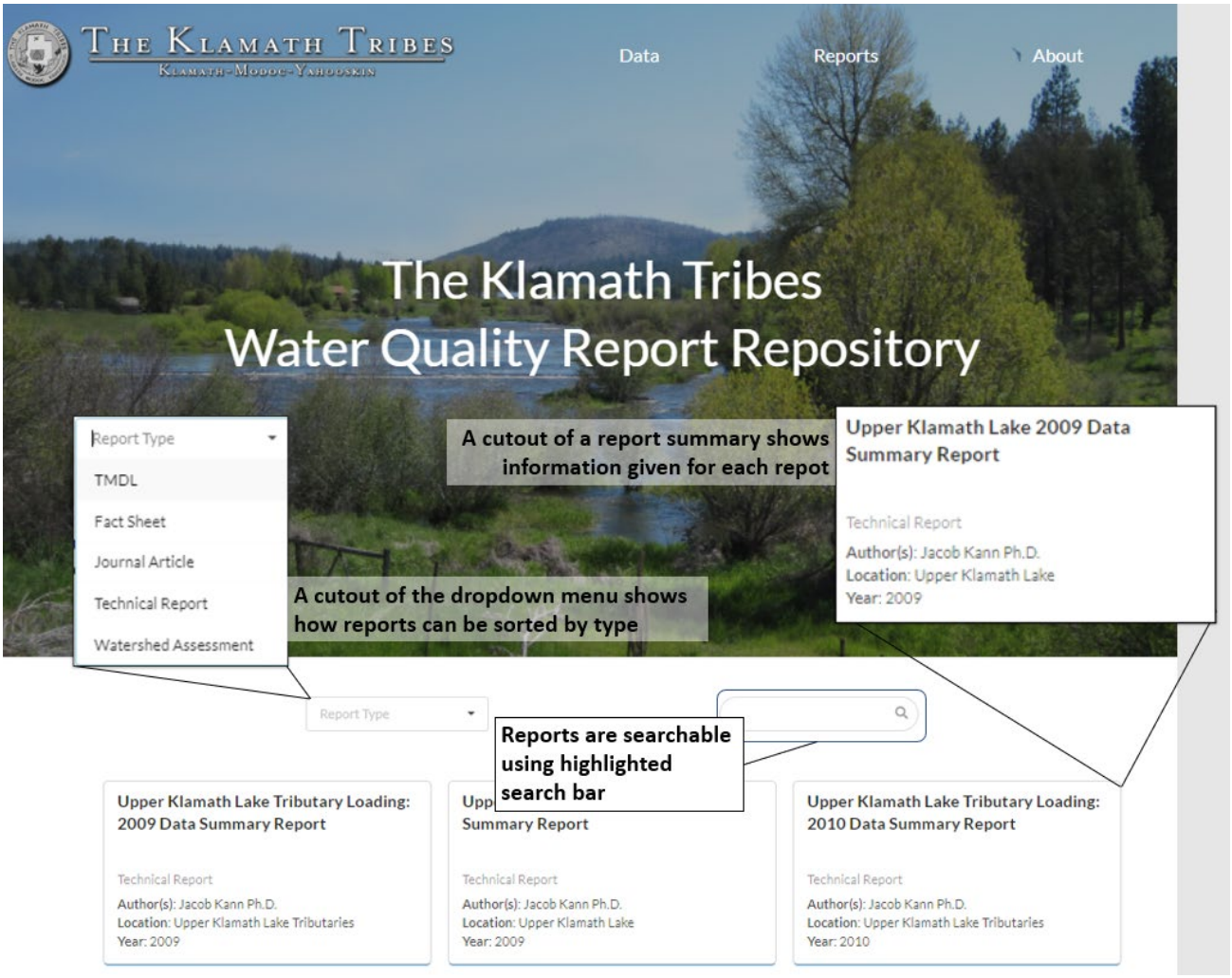
The Big Valley Band of Pomo Indians has also obtained funding from the EPA Exchange Network program (https://www.epa.gov/exchangenetwork) to upload water quality data to the EPA Water Quality Portal (https://www.waterqualitydata.us/). Work completed under the EPA project will be included in the Clearinghouse developed for the BRC project.

Projects Examples

The Klamath Tribes Upper Klamath Lake Water Quality Clearing House Website homepage:

The Upper Klamath Lake Water Quality Clearing House Website homepage gives easy links to download from the National Water Quality Monitoring Council Water Quality Portal or to view reports.

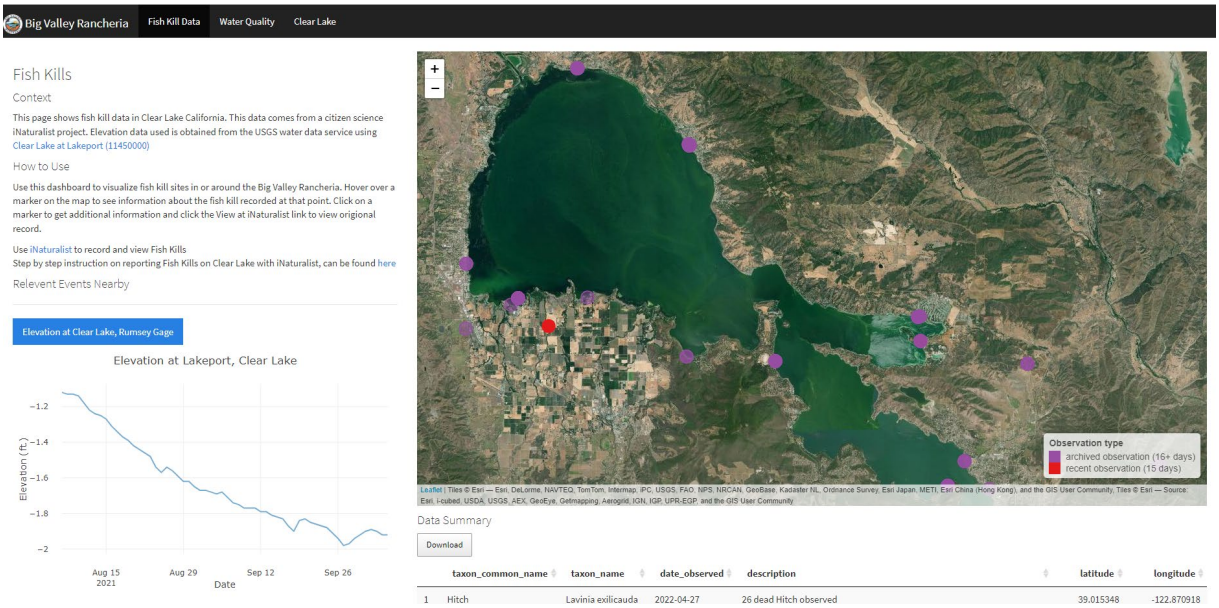
The Klamath Tribes Upper Klamath Lake Water Quality Clearing House Website reports page:



The Water Quality Reports Page is a PDF database of key reports related to water quality and endangered species. It is searchable and sortable by document type (TMDL, Technical Report, Watershed Assessment, Journal Article, and Fact Sheet) using the Report Type dropdown menu.

View the website at: https://klamathtribeswaterquality.com/

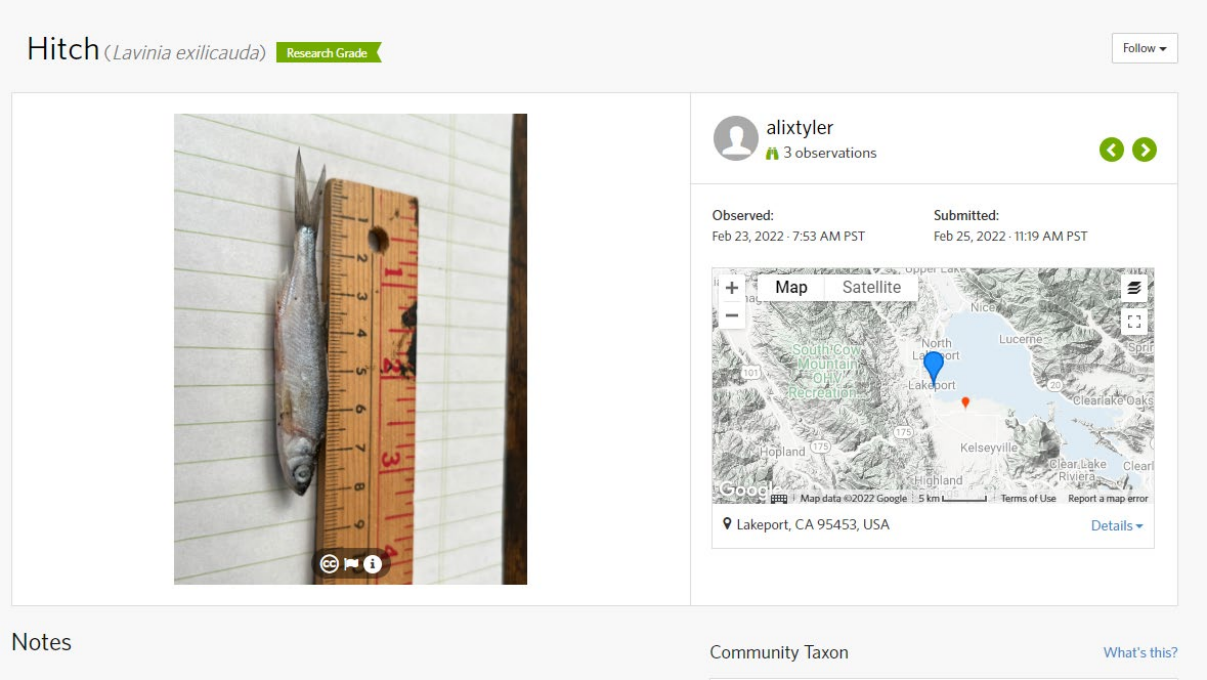
The Bay Area Council Resilience Challenge Citizen Science App - Fish Kill



FlowWest developed a dashboard that displays fish kill observations near Clear Lake, lake elevation, and water quality measures (still in development). Each fish kill observation is recorded in iNaturalist and then automatically updated on the dashboard for easy exploration. Easy user interface within iNaturalist allows users to mark the location of an event, add a photo, and give a description. iNaturalist is a web and mobile site that is used around the world to record biological observations and is supported by the California Academy of Science.

View the shiny application at: https://flowwest.shinyapps.io/bvr-water-quality/

The shiny application links directly to the iNaturalist Clear Lake Fish Kill Monitoring Project (shown below).



Example Data Sources to Include in the Clearinghouse

USGS Reports: various locations

UC Davis https://regionalchange.ucdavis.edu/publications

Lake County CLAMP https://clear-lake-ambient-water-quality-lakecountywrd.hub.arcgis.com/

Big Valley Rancheria https://www.bvrancheria.com/water-quality-dashboard

Clear Lake Environmental Research Center https://www.clerc.co/

Chi Council https://lakelive.info/chicouncil/

Watershed Assessments

https://www.lakecountyca.gov/Assets/Departments/WaterResources/Scotts+Cr+Watershed+Assessment+Documents/03+Scotts+Creek+Watershed+Assessment.pdf

https://www.lakecountyca.gov/Assets/Departments/WaterResources/Middle+Cr+Watershed+Assessment+Documents/03+Middle+Creek+Watershed+Assessment.pdf

https://www.lakecountyca.gov/Assets/Departments/WaterResources/Kelsey+Cr+Watershed+Assessment+Documents/03+Kelsey+Creek+Watershed+Assessment.pdf

TMDL
https://www.waterboards.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/clear_lake_nutrients/