2019 Report to the Governor of California and California State Legislature

AB 707
Blue Ribbon Committee for the Rehabilitation of Clear Lake

December 23, 2019

The Blue Ribbon Committee for the Rehabilitation of Clear Lake (Committee) is pleased to submit the attached 2019 Annual Report (Report) to the Legislature and Governor of California in compliance with AB 707 (2017). The Committee is comprised of the following individuals and organizations. Their hard work and support of the recommendations is invaluable for the Committee.

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The California Natural Resources Agency and its contracted facilitator for the Committee, California State University, Sacramento (Sacramento State), in completing this report, also reached out to leadership and staff at Tribal, local, State, and Federal agencies, departments, and offices that may play a role in enacting the recommendations. Their critical thinking and input is appreciated.

For more information on these recommendations, the Committee, and its Technical Subcommittee, please contact the Sacramento State facilitation staff by emailing Sam Magill at s.magill@csus.edu.

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Section 1: Background

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

Clear Lake is the oldest species-rich, warm water, natural lake in North America. It supports the surrounding ecosystems of native plants and animals, as well as species introduced by the Department of Fish and Wildlife (CDFW). Clear Lake and the surrounding environment are also home to endangered and rare animal species. However, the lake also experiences environmental challenges such as harmful algal blooms (HABs) 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. The full text of AB 707 is included as Appendix F.

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 document represents the first annual report to Governor Gavin Newsom and appropriate committees within 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 includes recommendations on solutions to these issues, cost estimates, and a plan for involving the local, State, and Federal governments in funding for and implementation of lake restoration activities.

As a multi-year process, the Committee will continue to refine recommendations and develop on-the-ground actions to improve the conditions noted above. This report outlines five introductory recommendations designed to address these challenges, beginning with a robust data collection effort to ensure future environmental recommendations are based on the most up-to-date analysis possible. The report also acknowledges that in addition to the physical and natural environment, the communities impacted by Clear Lake play an important role in the long-term environmental and socioeconomic health of the region. The Committee understands that recommendations designed to improve

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

infrastructure and socioeconomic conditions in Lake County will be a critical future component of its work and expects to address these issues beginning in 2020.

Section 2: Committee Process and Progress to Date

This section provides a brief overview of the process used to develop the five recommendations described in detail in Section 4 below, including background on project initiation, a summary of Committee and subcommittee discussions to date, and a description of parallel efforts conducted by partner efforts at the University of California, Davis.

Committee Launch

Resources launched the Committee effort in June 2018 by requesting applications from local County and Tribal representatives in accordance with AB 707 and appointing members, including:
- A representative from the University of California (UC), appointed by the Chancellor of UC Davis
- One member of the Board of Supervisors from Lake County or their designee
- Representatives from Tribes impacted by Clear Lake, appointed by their respective Tribal councils
- The Resources Secretary or their designee
- A representative of the Central Valley Regional Water Quality Control Board (Regional Water Board), appointed by its Board
- An expert from each of the following areas, appointed by the Lake County Board of Supervisors:
  o Local economic development
  o Agriculture
  o Environment
  o 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.

Resources contracted with the California State University, Sacramento (Sacramento State) 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 meetings, carry out routine negotiations between members over recommendations, and ensure all outreach meets the requirements of the Bagley Keene Open Meetings Act.

Resources formally convened the Committee process at a public meeting on October 10, 2018. This meeting was used to provide background on AB 707, explain the charge of the Committee, and discuss parallel research processes intended to develop up-to-date environmental and social science information on Clear Lake and the surrounding area.

Finally, the UC Davis Tahoe Environmental Research Center (TERC) was selected to lead the 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 the socioeconomic research effort. These efforts run in parallel to, but are separate from, the Committee effort. Research from both entities will inform the Committee's work in the future. Additional information on both research projects is described below.

<u>TERC Information</u>

TERC is charged with researching the dominant physical and environmental processes in the Clear Lake basin and in the lake itself that are negatively impacting the rehabilitation of the lake water quality and ecosystem health. The data acquisition will form the basis of a long-term monitoring strategy to measure status and trends in the future. A set of numerical models, calibrated and validated with these data, will be developed to inform local and State decision-making. The Committee's recommendations in Section 4 below are intended to compliment and build upon TERC's research, and to fill in data gaps not captured in its existing scope.

Final research outcomes are expected at the end of 2020; an overview of TERC's progress to date, known data deficiencies, and next steps are summarized in Appendix B. *This is a standalone work product developed outside of the Committee process.*

<u>CRC Information</u>

CRC is charged with conducting research to investigate barriers to socioeconomic improvement in Lake County. Through economic analysis, Tribal engagement, and a series of community workshops and other outreach activities, CRC will provide recommendations for improving the Lake County economy, including broadband internet investments and vocational training. A summary of CRC's progress to date and next steps is included in Appendix C. *This is a standalone work product developed outside of the Committee process.*

<u>Committee Process to Date</u>

Beginning with the project launch meeting, the full Committee met a total of eight times in 2018 and 2019. The table below includes the meeting schedule and a brief summary statement of topics discussed at each session. Complete summaries and materials from each meeting are available online at www.resources.ca.gov/clear-lake.

Meeting Date	Summary
October 10, 2018	Resources, Assemblymember Aguiar-Curry, and CCP reviewed the Committee purpose and formally convened the Committee process. A full summary is available here.
December 20, 2018	Committee received local land management updates, reviewed an assessment of critical issues for future deliberation, and discussed project logistics. A full summary is available here.
February 12, 2019	Committee discussed the formation of a Technical Subcommittee and other logistical items. A full summary is available here.

March 13, 2019	Committee discussed its Charter and decision making protocols, finalized membership for the Technical Subcommittee, and received local updates on water quality issues for consideration. A full summary is available here.
June 5, 2019	Committee received local updates on the Sulphur Bank Mercury Mine Superfund project and discussed initial recommendations from the Technical Subcommittee for the 2019 Annual Report. A full summary is available here.
August 15, 2019	Committee formally ratified its charter, received updates on 2019 recommendations, and reviewed the format for the 2019 Annual Report. A full summary is available here.
September 26, 2019	Committee reviewed recommendations, provided conditional approval on five recommendations, and agreed to submit a letter of support for the Middle Creek Restoration Project. Other proposed recommendations were deferred to 2020. A full summary is available online here.
December 11, 2019	Committee reviewed this report and provided consensus approval of all recommendations in Section 4. A full summary will be posted to the Committee website in January 2020.

Table 1: 2018/19 Committee Schedule and Outcomes

Technical Subcommittee Process to Date

In February 2019, the Committee directed CCP to convene a Technical Subcommittee (Subcommittee) made up of local and regional scientific experts to provide a menu of recommendations for Committee consideration. A roster of current Subcommittee members is included in Appendix E. The Committee determined focusing on technical, environmental recommendations was an appropriate starting point to meet the charge of AB 707 in 2019. Future subcommittees, including a Socioeconomic Subcommittee and a Cultural Resources/Traditional Ecological Knowledge (TEK) Subcommittee, will be convened to review these environmental recommendations, and ensure all recommendations have a positive impact on communities dependent on Clear Lake for economic, cultural, or public health purposes.

The Subcommittee met a total of six times in 2019. The table below includes a meeting schedule and brief summary of topics discussed during each session. Complete summaries of each meeting are available online at www.resources.ca.gov/clear-lake.

Meeting Date	Summary
April 19, 2019	Participants reviewed the purpose of the Subcommittee and received informational presentations on existing water quality programs. A full summary of the meeting is available online here.
May 17, 2019	Participants received informational presentations on public water systems, cyanotoxin sampling results, and satellite imagery of algal blooms/sediment plumes. Participants also began identifying information gaps for recommendation development. All meeting materials are available online here.
July 9, 2019	Participants continued development of recommendations for this report and received informational presentations on 2019 monitoring results from UC Davis. A summary of the meeting is available online here.

August 27, 2019	Participants refined recommendations based on Committee feedback. A summary of the meeting is available online [here]().
November 6, 2019	Participants began development of the 2020 monitoring plan/strategy, including potential sites for new monitoring and sampling locations. This meeting was held via webinar/conference call. A full summary of the meeting is available online [here]().
December 5, 2019	Participants continued refinement of a 2020 monitoring strategy. This meeting was held via webinar/conference call. A full summary will be posted to the Committee website in January 2020.

Table 2: 2019 Subcommittee Schedule and Outcomes

Section 3: Barriers to Improving Water Quality and Threats to Wildlife

For 2019, the Committee and Technical Subcommittee opted to focus on the causes of HABs from cyanobacteria, as well as elevated methyl mercury levels as prominent water quality issues in Clear Lake. This section lays out key water quality issues, barriers to improving the physical condition of Clear Lake, and threats to wildlife caused by these issues and identified by Committee, Technical Subcommittee, and the parallel efforts at UC Davis.

Initial recommendations to further understand these challenges are presented in Section 4 below, and are expected to result in a suite of management activities after 2020.

Water Quality Issues: Harmful Algal Blooms

HABs resulting in detectable levels of cyanotoxins in Clear Lake have been directly linked to documented pet and livestock deaths, and human exposure leads to a variety of health problems including gastrointestinal issues, skin issues, and neurological impacts. The most common pathway for human and pet exposure is through direct contact with untreated lake water (i.e., swimming in or drinking untreated water). However, cyanotoxins generally and microcystins more specifically, are on the contaminant candidate list (CCL) as a currently unregulated contaminant of concern for public water systems by the US Environmental Protection Agency (US EPA).[2] California has developed recreational trigger levels for human and animal health for three cyanotoxins including microcystins. US EPA has developed recreational water quality criteria, swimming advisories, and drinking water health advisories for cyanotoxins.[3] Additionally, HABs impact lake aesthetics and produce strong odors which may dissuade recreation and other uses.

Current scientific understanding of HABs shows blooms are caused by several key factors such as nutrient availability (particularly phosphorus and nitrogen), duration of sunlight, water temperature,

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[2] https://www.epa.gov/sites/production/files/2014-08/documents/cyanobacteria_factsheet.pdf
https://www.epa.gov/cyanohabs/epa-drinking-water-health-advisories-cyanotoxins
https://www.epa.gov/wqc/recommended-human-health-recreational-ambient-water-quality-criteria-or-swimming-advisories
[3] https://mywaterquality.ca.gov/habs/resources/habs_response.html#trigger_levels

and stability of the water column. Nutrient availability appears to be a primary driver of HABs in Clear Lake, which occur most often in mid/late summer but may be present at other times of the year. In response to nutrient issues, the Regional Water Board issued a Total Maximum Daily Load (TMDL) restriction to address the issue in 2006.[4] This TMDL is currently the primary regulatory mechanism to address nutrient issues throughout the Clear Lake basin, and requires responsible parties to meet specified point and nonpoint load allocations to limit the loads of phosphorus entering the lake. The Board does not specify the manner of compliance with the TMDL. It is up to the responsible parties to determine how they will meet their load allocations and demonstrate compliance.

Water Quality Issues: Mercury and Methylmercury

Mercury is naturally present throughout California and may leech into Clear Lake from a variety of sources. However, the former Sulphur Bank Mercury Mine site, located near the City of Clearlake and adjacent to the Elem Indian Colony Reservation, is a known, significant source of human-caused infiltration. Sulphur Bank is an active US EPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site, commonly known as "Superfund."[5]

High mercury levels are due to the watershed inputs, the existing sediment load, and ongoing input from the Sulphur Bank Mine Superfund site. Understanding the mercury cycle in the lake is currently an active area of research at Clear Lake by the US Geological Survey (USGS). There are a range of engineering options for controlling mercury release to the water and the food web.

Once mercury becomes biologically available through a process known as methylation, it collects in fish tissue, may be ingested by humans and animals alike, and increases in concentration as it moves up the food chain. In the vast majority of exposure cases, methylmercury is ingested by eating contaminated fish and shellfish. Methylmercury poses a range of significant neurological health impacts, particularly for sensitive groups including young and elderly individuals, and in pregnant women.[6]

On December 6, 2002, the Regional Water Board adopted a TMDL for the control of mercury in Clear Lake. The Clear Lake Mercury TMDL outlines a process to reduce mercury impacts on the lake through remediation and erosion control activities on the Sulphur Bank mine site, the development of monitoring activities, coordination with the Tribes in the Clear Lake basin, public outreach and education, and a review of progress toward meeting fish tissue objectives for Clear Lake every five years. Load allocations for the Clear Lake Mercury TMDL apply to tributaries and surface water runoff and to the Sulphur Bank Mine Superfund site.

In the context of these overarching water quality issues, the Committee, Technical Subcommittee, and TERC identified specific barriers to water quality improvement and threats to wildlife, including institutional challenges, lack of quantitative data, and physical/environmental barriers. These items are discussed in detail below.

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[4] https://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/clear_lake_nutrients/2018_0627_tech_memo_final.pdf

[5] https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.cleanup&id=0902228

[6] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3514465/

Water Quality Issue: Native Vegetation Dominance vs. Turbid Phytoplankton-Dominated State

Native aquatic vegetation (such as tules, cattails, and other so-called "macrophytes") stabilize clear-water conditions by reducing resuspension, increasing sedimentation, providing habitat for fish, and suppressing phytoplankton growth (nutrient competition). When the nutrient concentrations in the water are very high, the submerged and emergent native vegetation can be lost and the turbidity of the water increases. As a result, the buffering capacity of the ecosystem to external stressors is reduced. The current state of Clear Lake waters based on the limnological parameters is being assessed by TERC.

Barriers to Water Quality Improvement: Institutional Barriers

Nearly all of Lake County (including all population centers in the County) is designated as a disadvantaged community by the California Department of Water Resources (DWR). Over 20% of the County is at or below the poverty line according to US Census Bureau estimates.[7] Funding from the County level for lake restoration activities has often been limited, resulting in limited implementation of the TMDL and other, locally led regulatory efforts. Initial suggestions for resolving institutional barriers to water quality improvement include:

- Stronger coordination between Lake County Water Resources Department (WRD), Environmental Health, and Community Development Departments and oversight by the Board of Supervisors and/or County Administrative Officer. Local regulatory programs are in place, but there is not a mechanism to ensure compliance and that follow-up is conducted. One example of this is on-site project monitoring during and after construction projects.
- Increased revenue streams through permitting fees to support the programs directly responsible for regulatory compliance.
- Stable, long-term funding for water quality improvement projects. Three minimal, local sales tax measures were narrowly defeated in recent years. A lack of trust that funding will be utilized correctly and limited understanding of the importance of special sales tax to fund water quality improvements is a major barrier to long-term environmental restoration.
- Include older septic systems in the Land Agency Management Plan (LAMP) mapping process. This is particularly important for septic systems along the shoreline. Documentation is not currently digitized and easily shared between key departments.

Barriers to Water Quality Improvement: Lack of Quantitative Data

While lists of water quality challenges can be readily compiled, the greatest barrier to improving the water quality issues and other physical challenges facing Clear Lake is the absence of quantitative data on the response of the Lake to specific restoration projects. Acquiring quantitative data requires completing four fundamental tasks:

1) Quantifying the processes that contribute to poor water quality, i.e. data collection;

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[7] https://www.census.gov/quickfacts/lakecountycalifornia

2) Accurately predicting the lake response to environmental forces, including quantifying the extent of the current water quality challenges, i.e. model development;

3) Quantitatively evaluating the impacts, the costs, and unintended consequences of implementing particular projects and strategies, i.e. scenario development; and,

4) Quantitatively evaluating the consequences and costs of "no action" to improve water quality

Barriers to Water Quality Improvement: Physical and Environmental Challenges

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

- *Changes in land use and alteration of the natural shoreline* are a major driver of water quality issues in Clear Lake. Land use changes over many years have virtually eliminated natural wetlands, and modifications to slopes/cover appear to increase nutrient discharge (particularly phosphorus) into Clear Lake. Additionally, native tules have been removed from the shorezone, further reducing natural nutrient filtration.

- *Lake water temperatures* are increasing globally, and Clear Lake is no exception. Aside from the direct effect of higher temperatures on metabolic and reaction rates, the most important consequence of this is expected to be an increase in the duration of periods of thermal stratification. Mixing or turnover events may be less effective and frequent. This trend cannot be prevented by local action as it is happening on a global scale, but all planning needs to explicitly take this into account. Management actions can be designed to account for rising temperatures, and any future projects should take potential climate change impacts into account during design.

- *Episodic low dissolved oxygen* (DO) events in the deep water are known to occur, producing fish kills, release of nutrients through a phenomenon known as "internal loading," release of heavy metals including mercury to the food web, and the formation of noxious odors. With climate warming, there are likely to be more extended periods of low DO, with a corresponding increase in water quality degradation. There are engineering solutions to addressing low DO, but the extent of the problem needs to be quantified in order to make these solutions feasible and cost-effective.

- *The relative contribution of nutrient inputs* (both phosphorus and nitrogen) through both external and internal loading likely drives cyanobacteria production but is not well understood. External loading can be increased by agricultural fertilizer addition, grazing, airborne dust, erosion due to poor land management or wildfire, increases in impervious land cover due to population growth, destruction of wetlands, etc. Internal loading is caused by low DO in the lake. Quantifying the sources of nutrients, their seasonal variability, and partitioning the loading rates (both internal and external) are key to selecting the most appropriate solutions to excessive nutrient build up (also known as eutrophication).

- *Increasing frequency, biomass, duration and distribution of both algal blooms and cyanobacterial blooms* drives many of the water quality issues in Clear Lake. Although algal

blooms in general are a natural phenomenon in freshwater lakes, the frequency and toxicity of harmful cyanobacteria specifically appear to be increasing in Clear Lake. Cyanobacterial blooms create risks to human and animal health, increase the costs for water treatment, contribute to a negative perception of the region leading to losses in tourism, property values, and business. Factors that may favor the cyanobacterial dominance include:

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

<u>Impacts to Wildlife</u>

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

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

Section 4: 2019 Committee Recommendations

As discussed in Section 3, a lack of quantitative data is a major contributing factor to addressing barriers to water quality improvement and threats to wildlife. To being addressing this issue, the Committee and Technical Subcommittee developed a series of recommendations designed to provide the most up-to-date water quality information for Clear Lake and its surrounding basin and to take preliminary steps to improve management strategies. All recommendations listed below received unanimous support from Committee members, but will require additional Tribal, local, State, or Federal partnership to be implemented.

The current list of 2019 Committee recommendations includes:
1. Develop a distributed model of the upper watershed
2. Implement a comprehensive basin-wide monitoring strategy
3. Conduct a bathymetric survey of Clear Lake
4. Review the implementation of existing Tribal, local, State, and Federal programs, Best Management Practices (BMPs), and other management requirements in the Clear Lake Basin
5. Assess the public's perceptions, attitudes, and knowledge gaps towards water quality in order to improve education and ultimately human impacts on Clear Lake

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

Recommendations 4 and 5 include activities to address institutional barriers to water quality improvement and expedite planned restoration projects. The list above is displayed in order of relative priority based on Committee member surveys and meeting outcomes. A complete list of recommendations developed during brainstorming sessions with the Technical Subcommittee, but not vetted by the Committee, is provided in Appendix D. The approved recommendations are described in more detail below. The Committee also supports the Middle Creek Flood Damage Reduction and Ecosystem Restoration Project (Middle Creek Restoration Project), an undertaking already underway which is expected to significantly improve water quality in Clear Lake; a Committee letter of support for the project has been drafted and is described below in the 2020 workplan.

1. <u>Develop a distributed model of the upper watershed:</u> Models are a mathematical approximation of physical hydrologic and hydrodynamic processes. They are powerful software tools that integrate both measured *and* observed hydrologic data and provide estimates within data gap areas. These models are highly organized and synthesize multiple related activities and hydrologic processes such as rainfall, sheet flows/runoff, surface water flows, and sediment discharges. In the case of Clear Lake, an upper watershed model can be developed to show where flows lead to significant sediment discharge, and how management activities can alter sediment or nutrient sources entering the lake. The 2001 TERC Lake Tahoe model is an example of testing assumptions against observed and modeled sedimentation sources and resulted in shifting management activities from forested to urban areas. This has resulted in a significant net water quality improvement and reversed a decades-long trend of worsening clarity in the lake. It should be noted that to properly calibrate this type of model, a unified monitoring strategy (as described in Recommendation 2 below) is required to ground truth all modeling runs with actual observed data. For the purposes of this recommendation, "upper watershed" is defined as areas upstream of Clear Lake, generally represented by the tributaries and drainages of major creeks and streams draining into the lake such as (but not limited to) Middle, Kelsey, Scotts, and Adobe Creeks.

Numerous other examples of watershed models exist; the Technical Subcommittee will be essential for further defining the specific type of model in early 2020. Cost estimates and timelines are based on the 2001 Tahoe model.

- Cost Estimate: A cost estimate for the model will be developed in early 2020 through discussions with the Technical Subcommittee.
- Recommended Timeline: 2020-2023 including model calibration
- Funding or Partnership Recommendations: Partnership recommendations will be developed through discussion with the Committee and its subcommittees in early 2020.

2. Implement a comprehensive basin-wide monitoring strategy: Consistent monitoring and sampling of stream flows, turbidity, sediment, and other constituents of concern is important for understanding nutrient and sediment sources. Although a number of weather stations and stream gauges are used throughout the Clear Lake basin, a lack of monitoring and sampling results for key areas in the Clear Lake basin result in data gaps around Clear Lake and in the upper watershed, particularly at stream confluences. Additionally, more robust monitoring and sampling will help ground truth remote sensing technology and calibrate the upper watershed model discussed in Recommendation 1.

For the purposes of this recommendation, "monitoring" may include weather stations, nutrient and chemical sampling, flow stage and sediment gauges, or biological monitoring similar to the State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Freshwater HAB assessment.

Before new modeling stations or sampling strategies can be deployed in the field, a monitoring plan should be developed in two stages. In the first stage, Committee members, with assistance from the Technical Subcommittee, will identify all existing monitoring sites and known areas of sediment discharge which do not currently have stream gauges or other sampling activities in place. Likely areas include the confluence of tributaries with major streams or areas with significant known erosion issues. This information will be used to identify specific monitoring and sampling points for watershed model development and will be compiled into a comprehensive monitoring strategy. In the second stage, the Committee and model developer from Recommendation 1 will work together to implement a long-term monitoring plan to specify the type of equipment needed and duration of sampling.

- Cost Estimate: Estimates from WRD and Big Valley Rancheria include an annual amount of approximately $100,000 for the installation, maintenance, and data collection analysis for one fixed stream gauge measuring flow and turbidity, and $250-350 for the collection and analysis of one "grab sample".   Phase 1 will determine the required number of new gauges and grab samples.
- Recommended Timeline: Stage 1 should take place as soon as possible (2020). The Stage 2, long-term monitoring plan, should be developed in parallel with the model, and updated based on model runs when completed.
- Funding or Partnership Recommendations: Senate Bill (SB) 19 (Dodd, 2019) was recently chaptered to provide increased use of stream gauges and monitoring throughout California

and may be a vehicle for securing Clear Lake-specific funding for monitoring. Numerous agencies and organizations including Tribes, WRD, DWR, the Regional Water Board, UC Davis, and others already operate monitoring/sampling networks in and around Clear Lake. Continued partnership with these groups is essential to the long term success of a comprehensive Clear Lake monitoring plan.

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

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

   - Cost Estimate: $400,000
   - Recommended Timeline: 2020-2021
   - Funding or Partnership Recommendation: Cost sharing with Federal partner agencies, such as US EPA and USGS, may provide attractive funding opportunities.

4. <u>Review the implementation of existing Tribal, local, State, and Federal programs, BMPs, and other management requirements in the Clear Lake Basin:</u> According to the Big Valley Band of Pomo Indians, management of sediment and nutrient loading areas throughout the Clear Lake basin is varied, with Federal, State, County, and Tribal authority over land use planning and decisions. Small amounts of environmental monitoring occur to determine the success of the policies and BMPs, but there is a need to coordinate the monitoring that exists and create an effective feedback loop in which the results drive improvements in the management policies to better control sediment and nutrient pollution loading in the watershed. The Regional Water Board has started a review of the Nutrient TMDL but given the multi-jurisdictional nature of water management activities in Clear Lake, the Committee recommends a more comprehensive review of various jurisdictions' ordinances impacting water quality to date.

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

   - Cost Estimate: $60,000 for an independent review by an outside consultant according to estimates by the Big Valley Band of Pomo Indians.

- Recommended Timeline: 2020-2021
- Funding or Partnership Recommendations: The Regional Water Board is already carrying out an inventory and assessment of management practices associated with the Nutrient TMDL and should be engaged as a partner. Lake County and represented Tribes have expressed a willingness to support this effort.

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

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

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

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

   - Cost Estimate: Lake County WRD estimates a total budget of $120,000 for the assessment.
   - Recommended Timeline: 2020-2025, including post-survey activities

- Funding or Partnership Recommendations: The UC Davis CRC is conducting topic-specific community workshops on a range of socioeconomic issues and may provide useful venues for survey distribution and outreach. Lake County and the Cities of Clearlake and Lakeport are required to conduct assessment surveys as part of their Phase 2 municipal separate storm sewer systems (MS4) permit pursuant to the Federal Water Pollution Control Act (Clean Water Act) section 402(p); a cohesive joint effort could broaden the breadth, depth, and quality of results. Furthermore, the Socioeconomic and Cultural Resources/TEK subcommittees discussed in Section 5 below may be important venues to broaden outreach and engage a larger cross section of the County.

Section 5: Proposed 2020 Workplan

In calendar year 2020 the Committee will continue to refine the approved recommendations described in Section 4 by developing specific scopes of work and cost estimates.

The Committee and Technical Subcommittee will continue development of four additional proposed recommendations:

- Develop letter of support from the Committee for the Middle Creek Restoration Project
- Conduct remote sensing analysis of nutrients and algal blooms throughout the watershed
- Compile Clear Lake data in an accessible unified database, with database management staff
- Analyze existing Clear Lake data

These recommendations are discussed in more detail below.

Along with continued development of recommendations to the governor and legislature, 2020 will see the establishment of two new Subcommittees, intended to be discussion venues to address the potential socioeconomic and cultural resource impacts of the Committee's technical recommendations.

Develop a letter of support from the Committee for the Middle Creek Restoration Project

The Committee supports the Middle Creek Flood Damage Reduction and Ecosystem Restoration Project (Middle Creek Restoration Project)and will transmit an official letter of support to the California Governor and the Legislature. The Middle Creek Restoration Project is a large, long-term, and complex effort to reestablish historic wetlands at the mouth of Middle Creek, the largest watercourse entering Clear Lake. Its implementation is expected to restore damaged habitat and improve the water quality of the Clear Lake watershed by reducing nutrient loading to the lake.

A multi-jurisdictional project team is assembled, and land acquisition of the project is underway. The agencies and organizations the Committee members represent see the Middle Creek Restoration Project as a significant, worthwhile activity, already in progress and clearly in line with the directives of the Committee. The letter will urge the Governor and the California State Legislature to expedite this project through their continued financial support of the Middle Creek Restoration Project's non-Federal

sponsor, the County of Lake; Committee members will transmit a draft letter of support to their governing bodies for consideration and approval in early 2020.

<u>Conduct remote sensing analysis of nutrients and algal blooms throughout the watershed</u>

Committee members recommended the development of a basin-wide analysis of satellite imagery and other remote sensing such as spectral analysis from aerial drone imaging to determine nutrient loading and sediment inputs.

There are several remote telemetry options available that could provide a breadth of valuable information on the health indicators and inputs to Clear Lake. For example, the Landsat and Sentinel 2 satellites currently provide general observations of Clear Lake, but the data must be processed to provide useful information. Further discussion of this recommendation is required to understand goals and capabilities of such an analysis. The Center for Spatial Technologies and Remote Sensing (CSTARS) at UC Davis has volunteered to present to the Subcommittee on the available and appropriate remote sensing technologies.

In 2020 the Technical Subcommittee will further define the goals they intend to meet with a satellite study and then design a set of questions to be answered about nutrients that might be answered with satellite data. The Subcommittee will invite CSTARS to present on the different remote sensing technologies available to meet the goals and answer the questions identified to determine if satellite data will be an effective tool for the rehabilitation of Clear Lake. The Committee recognizes that the cost estimates for any remote sensing recommendation will need to include the cost of ground-truthing of the results, likely through on-the-ground monitoring.

<u>Compile Clear Lake data in an accessible unified database, with database management staff</u>

Clear Lake has been the subject of study and data collection for decades. A wealth of data already exists from many entities, in many different locations, and many different formats. The Big Valley Band of Pomo Indians hosts the largest publicly available collection of data on their Environmental Protection Department website, but still more data exists with public, private, State, and academic researchers. Access to this data has the potential to inform various research efforts, identify contributing factors to poor water quality in the lake, and ultimately lend to capital improvement projects.

While the Committee supports creating a unified and publicly accessible database, compiling data across multiple agencies and jurisdictions poses significant challenges, and a large database can be costly and cumbersome. The Committee and Subcommittee posed a number of refining questions for this recommendation to be addressed in 2020, including the following:

- Who would own the database and be responsible for its upkeep?
- Where would the database staff position be housed?
- Can a watershed modeling tool be combined with the unified database?
- The data outputs from the lake model and the potential watershed model will be massive and should be publicly accessible. What resources are available to manage large datasets?

- Would creating an inventory of all Clear Lake data be more appropriate than creating an entire database?
- How will this relate to the Open and Transparent Water Data portal created by AB 1755?
- How could this database incorporate health data to correlate it with water quality data?

It was proposed that the Committee convene a data management workgroup made up of Clear Lake stakeholders and staff from certain agencies to refine the database needs. This proposal will be addressed in 2020, as well.

<u>Analyze existing Clear Lake data</u>

Much of the existing Clear Lake data to be included in the accessible unified database has not been analyzed. As new data is collected, it will be prudent to make the previously collected data usable in order to build on existing information and to not duplicate past efforts. While the Committee is supportive of analyzing existing data, they recognize that this effort may prove time consuming and expensive, and that data can be analyzed in different ways for different purposes. In 2020 the Committee will explore what data exists unanalyzed as well as the potential costs and needs for analyzing existing Clear Lake data, and how that will feed into the proposed database.

<u>Socioeconomic & Cultural Resources Subcommittees</u>

In additional to the ongoing work of the Technical Subcommittee, Committee members approved the formation of additional Socioeconomic and Cultural Resources/Traditional Ecological Knowledge (TEK) Subcommittees.

Similar to the existing Technical Subcommittee, the new subcommittees are expected to develop recommendations where appropriate specific to their subject areas to alleviate the conditions identified in AB 707. Each subcommittee will also review work products developed by its counterparts to ensure those recommendations do not adversely impact socioeconomic, cultural/TEK, or environmental conditions. All materials developed during subcommittee review periods will be compiled for the full Committee's consideration; no single subcommittee can "override" recommendations from other groups, nor are they expected to reach consensus or approve any work products.

In addition to the primary purpose discussed above, these subcommittees will also:

- Provide a venue for academics, local business leaders, and stakeholders with economic, social science, and cultural/traditional usage expertise to hold in-depth discussions on socioeconomic and cultural resources issues affecting Clear Lake. Example issues include (but are not limited to) zoning changes, infrastructure modifications, or traditional Tribal resources such as ancient village sites and willow stands.
- Review technical recommendations at a greater level of detail than may be possible during formal quarterly Committee meetings.
- Coordinate existing research efforts throughout the Basin to minimize study overlap.

- Answer specific, socioeconomic or cultural resource questions as they arise at the direction of Committee members and develop action-oriented recommendations for consideration by the full Committee.

These meetings will be convened at the discretion of Committee volunteer leads . Membership for each subcommittee will be determined by the Committee but will likely include local and academic experts .

Appendix A: Committee Member Roster and Biographies

NAME	INTEREST AREA	ORGANIZATION OR AGENCY
Thomas Gibson	Committee Chair	California Natural Resources Agency
Sarah Ryan	Tribal Representative	Big Valley Band of Pomo Indians
Jennifer LaBay	Regional Water Board	Central Valley Regional Water Quality Control Board
Alix Tyler	Tribal Representative	Elem Indian Colony
Linda Rosas-Bill	Tribal Representative	Habematolel Pomo of Upper Lake
Karola Kennedy	Tribal Representative	Koi Nation of Northern California
Eddie "EJ" Crandell	Lake County Board of Supervisors	Lake County
Jan Coppinger	Public Water Supply	Lake County
Harry Lyons	Environmental	Lake County
Wilda Shock	Local Economy	Lake County
Brenna Sullivan	Agriculture	Lake County
Mike Shaver	Tribal Representative	Middletown Rancheria of Pomo Indians
Terre Logsdon	Tribal Representative	Scotts Valley Band of Pomo Indians
Paul Dodd	UC Davis	UC Davis

Thomas Gibson was appointed deputy secretary and special counsel for water at the California Natural Resources Agency in May of 2019, where he previously served as undersecretary beginning in 2016 and as general counsel from 2014 to 2016. Gibson was general counsel at the California Department of Fish and Wildlife from 2008 to 2014. He was a partner at Best, Best, & Krieger from 2002 to 2008. Gibson was an associate at Hyman, Phelps & McNamara from 1999 to 2002 and at Kronick, Moskovitz, Tiedemann & Girard from 1997 to 1999. He earned a Juris Doctor degree from the Northwestern School of Law at Lewis and Clark College.

Sarah Ryan, the Environmental Director of the Big Valley Band of Pomo Indians, works closely with Tribal members, the Central Valley Regional Water Quality Board and US EPA Region 9 on water quality and natural resource protection, including on: algal toxin testing; pesticide, nutrient and mercury monitoring in Clear Lake and its tributaries; storm water management; shoreline restoration; and other crucial water and environmental tasks. Ms. Ryan is a founder of the Clear Lake Cyanobacteria Task Force. Ms. Ryan is also a Deputy Tribal Administrator.

Jennifer LaBay is the Nonpoint Source Program Manager for the Central Valley Regional Water Quality Control Board. Jennifer oversees the implementation of the Clear Lake Nutrient TMDL, Regional Harmful Algal Bloom Response, and the Clean Water Act Integrated Report. She has worked for the State of California for 14 years in environmental science positions with California Department of Fish and Wildlife, State Water Resources Control Board, and her current position at the Regional Board.

Alix Tyler is the Environmental Director for Elem Indian Colony. She works out of six different grants to continue funding her department, two of the more significant grants are the CWA-106 grant, which allows Elem Indian Colony to partner with Big Valley Rancheria to monitor sites around Clear Lake's shoreline for cyanobacteria blooms and associated toxins. The Superfund Cooperative Agreement grant allows Elem the opportunity to partner with Federal and State agencies to decide on a clean-up remedy for the Colony. She previously worked as the Environmental Director for Scotts Valley Band of Pomo Indians and is a recent graduate of Humboldt State with an Environmental Science Degree and an emphasis on Ecological Restoration.

Linda Rosas-Bill has been the Environmental Director for the Habematolel Pomo of Upper Lake (HPUL), since November of 2015. She has dedicated her efforts to protecting the environment and educating on the importance of be a "good steward to the land." She is focused on building a strong foundation for HPUL Environmental Programs, which include Water, Air, Pesticides, Solid Waste and Geographical Information System (GIS) and Geographical Positioning System (GPS). She Is also involved in protecting Tribal Cultural Resources and is a Tribal Monitor. She oversees the Utilities, Emergency Response and Cemetery Maintenance for the HPUL Tribe.

Karola Kennedy has been deeply involved in Clear Lake watershed protection activities for six years. She previously served for five years as a Tribal Environmental Director on Clear Lake and is a co-founder of the Clear Lake Cyanobacteria Task Force. Ms. Kennedy is certified by the State of California as a Treatment Level 2-Distribution Level 2 (T2-D2) Drinking Water Operator and created the Public Water System Cyanotoxin Monitoring Program on Clear Lake, which is still active through her nonprofit, Kennedy Environmental. Ms. Kennedy earned an Environmental Engineering Degree from the University of Nevada at Reno in 2011.

Eddie "EJ" Crandell was elected to the Lake County Board of Supervisors and seated as the District 3 Supervisor on January 8, 2019. All five County Districts encompass Clear Lake; however, Highway 20 in District 3 is the only shoreline highway along the lake. Mr. Crandell is also the Tribal Chairman for the Robinson Rancheria of Pomo Indians, which is one of three Tribes located in District 3 of Lake County. From 2016–2018 he served as a Planning Commissioner for Lake County and has served as the Chair and Vice Chair on that committee. Mr. Crandell currently serves on the Eel Russian River Commission, Middle Creek Restoration Coalition, and the Lake County Watershed Protection District Board of Directors.

Jan Coppinger graduated from Colorado Mesa State College in Grand Junction, Colorado with a Bachelor of Science Degree in Business Administration. She has over 25 years of experience in government operations involving public water and sanitation. Ms. Coppinger has been employed with Lake County Special Districts for 12 years. She was appointed as the Administrator in 2016. Prior to being appointed

as the Administrator, she held the positions of Deputy Administrator- Fiscal and Compliance Coordinator for Lake County Special Districts.

Dr. Harry Lyons has lived in Lake County for over 40 years, for much of that time conveying scientific information on Clear Lake to two generations of college students. The Emeritus Professor of Biology/Ecology from Yuba College grew up in Brooklyn, attended Rutgers College and Stanford University, and was awarded a doctorate in Oceanography as a National Science Fellow from the Scripps Institution of the University of California. He currently pursues his interest in water by serving as a director of the Lake County Resource Conservation District and as a founding member of the Middle Creek Restoration Coalition.

Wilda Shock is the Economic Development Specialist for the City of Lakeport, past president of the Lake County Economic Development Corporation (Lake EDC), the Lake County Chapter of California Women for Agriculture and the Mendocino College Foundation, former Marketing Director for the County of Lake, and former administrator and instructor in higher education, local government and nonprofit arts and cultural organizations. She is a fifth generation resident of Lake County and a graduate of Sacramento State University with degrees in Government/International Relations and Business Administration.

Brenna Sullivan is the Executive Director of the Lake County Farm Bureau. She grew up in Kelseyville and graduated from UC Santa Cruz with a B.S. in Geology and Earth Sciences. She worked with California State Parks for 10 years before returning to Lake County. She has a passion for agriculture and the rural lifestyle and is dedicated to preserving Lake County's agricultural heritage.

Mike Shaver started as the Environmental Director for the Middletown Rancheria of Pomo Indians in 2018 and has extensive experience in building Tribal capacity in environmental management working with Tribal Governments since 1998. Mike is from western New York and his father is from the Tuscarora Tribe (Niagara Falls, NY) of the Iroquois Confederacy. Mike obtained a BS in Environmental Studies with a Water Resources emphasis at the SUNY College of Environmental Science and Forestry, Syracuse, NY; and a Master of Science in Biology/Aquatic Ecology at Northern Arizona University, Flagstaff, AZ. His work experience includes positions with the U.S. Fish and Wildlife Service, Northern Arizona University Department of Biology, Arizona Department of Fish and Game, Lake County Air Quality Management District, and three neighboring Tribes of the Clear Lake watershed.

Terre Logsdon has served as the Environmental Director for the Scotts Valley Band of Pomo Indians since 2018. With a BA in Liberal Studies focusing on Science and Values, an MA in Managerial Leadership from the John F. Kennedy School of Management, she also holds an Agroecology Design certificate from UC Berkeley, and is a certified Master Composter through Cal State East Bay. Her focus as the Environmental Director is on protecting and enhancing the water, land, air, and natural resources, as well as assisting in ensuring safety during emergencies for Tribal Members wherever they live in Lake County and beyond. Ms. Logsdon also was appointed by the Lake County Board of Supervisors in 2019 to the Scotts Valley Advisory Committee and by the Lakeport City Council to the Lakeport Economic Development Advisory Committee in 2016.

Dr. Paul Dodd has served in the role of Associate Vice Chancellor, Office of Research at University of California, Davis since May 2012. Dr. Dodd is responsible for establishing and supporting interdisciplinary research activities across all faculties at UC Davis. He has direct administrative responsibility for a portfolio of 20 research centers and units involving over 1000 faculty, graduate students, and researchers.

UC Davis (TERC) Lake Monitoring and Modeling Progress

3.1. Project Objectives – Following the fundament tasks required to improving the water quality in Clear Lake, we aim to understand the dominant processes in the lake watershed and in the lake itself that are negatively impacting lake water quality and ecosystem health. In addition, we will be developing the modeling tools to allow for the evaluation of the effectiveness of specific restoration strategies.

      The data acquisition that we are conducting will form the basis of a long-term monitoring strategy to measure status and trends in the future (https://ucdclearlake.wixsite.com/cldashboard). A set of numerical models, calibrated and validated with these data, will be developed to inform local and state decision-making.

3.2. Data Acquisition – We are currently measuring meteorological conditions, stream properties, and lake physio-biogeochemical properties at Clear Lake (Fig. 1).

3.2.1. <u>*Meteorology*</u> – Seven meteorological stations have been installed around the shoreline of Clear Lake on private docks and buildings to characterize the spatially and temporally varying meteorology around the lake (Fig. 1). We are measuring air temperature, relative humidity, solar radiation, rain, wind speed and direction every 15 minutes with Davis Instruments Wireless Vantage Pro2 Plus meteorological stations. Data are accessible in real-time. As an example, wind roses from the seven stations are shown in Fig. 1, which confirm the across lake variability of the wind field. Meteorological data are a fundamental driver of lake motions and warming.

3.2.2. <u>*Stream properties*</u> - Turbidity sensors and Campbell Scientific data loggers have been co-located with Department of Water Resources (DWR) gauging stations at three locations on inflowing creeks (Kelsey, Middle, and Scotts, Fig. 1). Data are recorded and transmitted to the Cloud every 10 min, providing real-time stream properties. Our continuous stream turbidity measurements captured the large sediment loads occurring during the rainy season early in 2019 (Fig. 2).
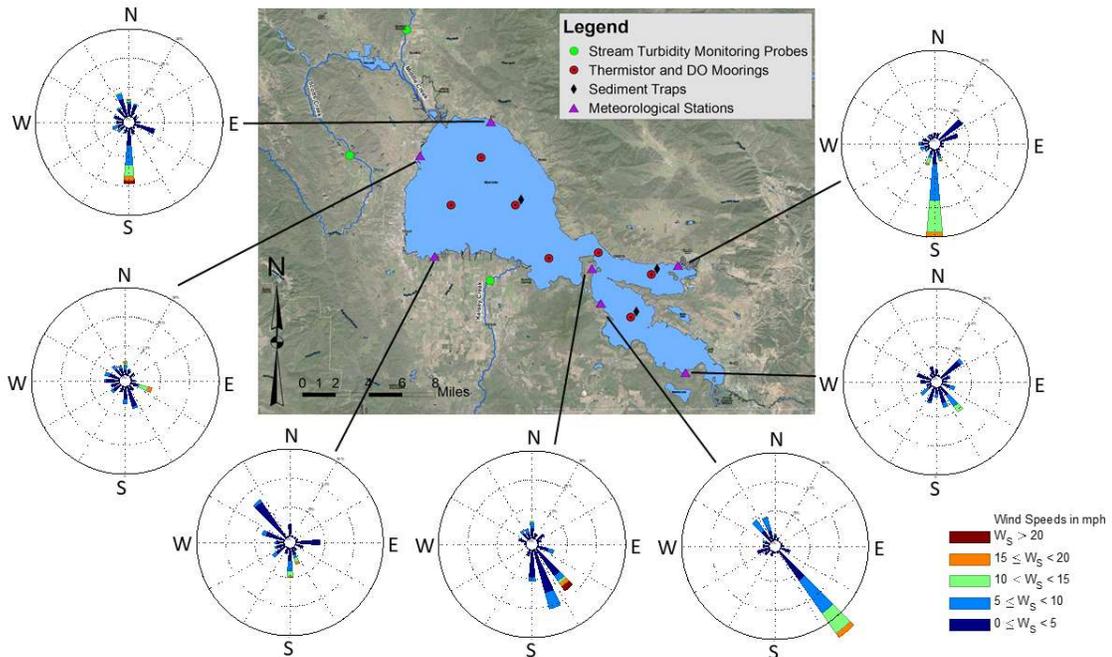
Fig. 1. The different types of monitoring stations: stream turbidity sensors (green circle), temperature and dissolved oxygen (DO) lake moorings (red circle), sediment traps (black diamond), and meteorological stations (purple triangle). Wind roses illustrate the spatial variability of the wind field across the lake.
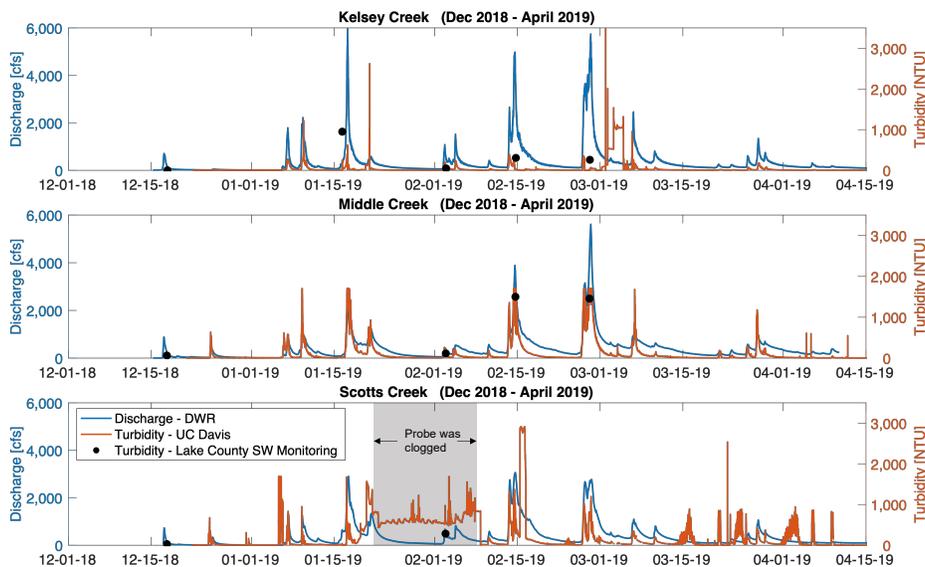

Fig. 2. Hourly average time series of discharge (blue) and turbidity (orange) measured at the three monitored creeks (Kelsey, Middle, and Scotts) during winter and spring in 2019. Black dots show the turbidity values from grab samples collected by Lake County. Gray rectangle marks when the turbidity sensor at Scotts Creek was clogged.

3.2.3. Lake physico-biogeochemical properties – Seven "permanent" water quality stations (or moorings) are deployed in Clear Lake to measure water temperature and dissolved oxygen concentrations (Fig. 1).

Each station consists of a set of temperature sensors spaced ~1 m through the water column and recoding data every 10 s. In addition, the moorings have one to three dissolved oxygen sensors unevenly distributed through the water column which provide time series every 30 s. Results from our mooring deployments between March and June 2019 show how the lake thermal stratification built up (as evident by the range of colors from top to bottom from Days 115 to 135) and vanished at least twice (Day 100-105, and Day 138-145) during the studied period (Fig. 3). Strongly stratified periods were coincident with anoxic/hypoxic (low DO) conditions in the near-bottom water column. Our observations also highlight the significant spatial variability of the thermal structure and dissolved oxygen distribution at a given time across the lake (data not shown).

In addition to the "permanent" mooring stations, we are collecting profiles of physico-biogeochemical properties of the lake water adjacent to the seven moorings every 6 weeks using a Seabird SBE-19 water quality profiler. The profiler measures temperature, conductivity, depth, turbidity, and DO. Measurements of photosynthetically active radiation (PAR) are made throughout the water column using a LiCOR L250.

Profiles are paired with the collection of discrete water samples at 4 depths at each mooring station. The water samples are analyzed for the following nutrients and water quality constituents:
- Nitrogen forms: dissolved nitrite + nitrate (NO_2+NO_3), total dissolved nitrogen (TDN), particulate nitrogen (PN);
- Phosphorus forms: dissolved orthophosphate phosphorus (SRP), total dissolved phosphorus (TDP), particulate phosphorus (PP);
- Particulate carbon (PC), dissolved organic carbon (DOC);
- Chlorophyll-*a*, phytoplankton identification, and enumeration; and,
- Particle size distribution.

Water samples from the last five sampling events have been analyzed at the TERC laboratories, and the data are currently under a QA/QC process.

Finally, we are aiming to quantify sediment deposition in the bottom of Clear Lake using sediment traps currently deployed at the deepest site of each basin (Fig. 1). Sediment traps consist of clear cylindrical tubes with no lid, located ~1 m off the lake bottom. Sediments caught in the traps are analyzed for organic matter content and total suspended sediments.

3.3. Numerical Modeling - We are conducting simulations using a three-dimensional hydrodynamic and water quality model (Si3D).

The model is based on the continuity equations for incompressible fluids, the Reynolds-averaged form of the Navier-Stokes equations for momentum, the transport equation for temperature, and an equation of state relating temperature to the fluid density. A water quality module is coupled to the hydrodynamic model in order to simulate the evolution of different constituents, such as dissolved oxygen, nitrogen species, phosphorus species, phytoplankton, and suspended solids.

We are calibrating the hydrodynamic model using recently measured data from Clear lake between March and June 2019. This entails adjusting the model parameters and forcing (meteorology and streams) within the margins of the uncertainty to reproduce the conditions that we measured in the lake during the spring. Our trial and error process is already producing satisfactory results when we compare observed and model lake temperatures (Fig. 3 top and middle panels), but further efforts are required to improve the fit to the data. The next step, model validation, entails running the calibrated model for

a different period of time but without changing and assessing the quality of the fit to the
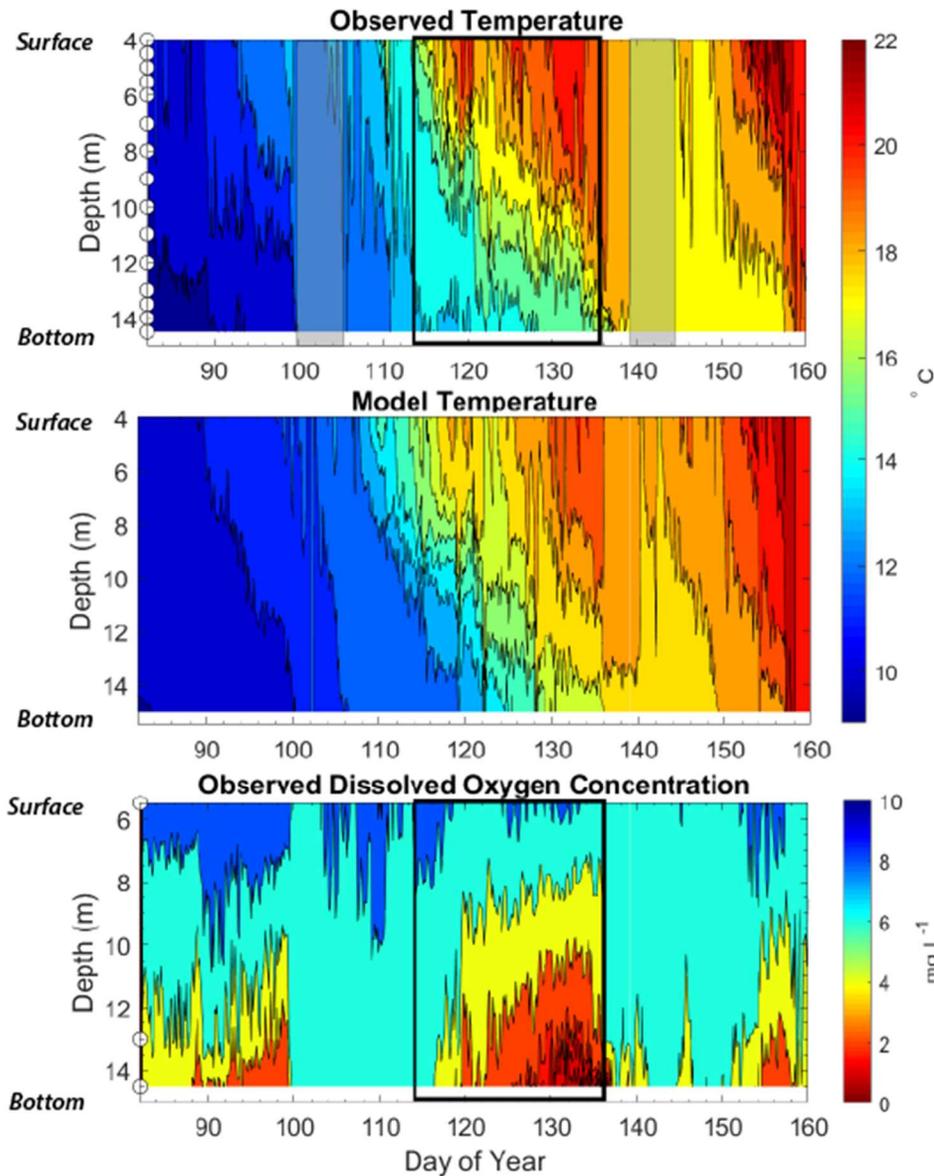
data

Fig. 3. Two-hour average observed temperature (top), model temperature (middle) and observed dissolved oxygen concentration (bottom) time series at the deepest site of the lake (Lower Arm) between March and June 2019. White dots on the left axis represent the depth of the loggers. Black and gray boxes mark stratified and mixed periods

1. UC Davis (TERC) Data Deficiencies and Next Steps

1.1. Reliable in-situ measurements of external loading during storm events – The number of grab samples taken historically during streamflow events was insufficient to adequately

calibrate a watershed model. This was in large part due to a lack of funding. In the coming winter, we are planning to coordinate intensive stream water quality grab sampling during storm events using student volunteers, but a better funded stream sampling program is required for the long-term. These reliable in-situ measurements will allow us to calibrate our continuous stream turbidity records to compute external loading into Clear Lake.

1.2. Bathymetric survey – The bathymetry (the underwater topography of the lake) forms the boundary condition of the lake model, and as such strongly influences the quality of the model results. A new bathymetric survey of Clear Lake is desperately needed. The existing data from 2002 are too sparse and will introduce error into the lake model. The resolution currently possible is far superior and would provide new information on the variability of substrate material, improved lake boundary conditions needed for 3-D modeling and help differentiate benthic substrates. There is potential for cost sharing with the USGS and EPA.

1.3. First measurements of sediment oxygen demand and nutrient fluxes from the sediments – We are taking measurements of sediment oxygen demand and nutrient fluxes from the sediments for the first time in Clear lake by collecting sediment cores quarterly from the deepest site of each basin. Nutrient fluxes are determined by measuring changes in concentration within the overlying water within each incubation chamber using anoxic and oxic treatments. Nutrient flux rates from sediment incubations will be scaled up for each basin to estimate internal P and N loading rates for the entire lake for each season.

1.4. Validation of a remote sensing tool for monitoring cyanobacteria in Clear Lake - The San Francisco Estuary Institute (SFEI) has developed a Harmful Algal Blooms (HAB) Analysis Tool that calculates a cyanobacteria index (CI) from satellite imagery for water bodies in California. We will be conducting a pilot project to compare the satellite-derived CI with in-situ cyanobacteria measurements collected using several methods at varying scales and resolutions. The planned data collection methods include multispectral data collected from UAV (unmanned aerial vehicle) flights; chlorophyll-a, turbidity, and colored dissolved organic matter (CDOM) measurements from optical sensors mounted on a Gavia AUV (autonomous underwater vehicle); and analysis of surface grab samples for chlorophyll-a, phycocyanin, and cyanobacteria species identification and enumeration. This work is scheduled for summer-fall, 2019.

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

Appendix C: UC Davis CRC 2019 Research Outcomes

UNIVERSITY OF CALIFORNIA, DAVIS

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UCDAVIS
CENTER FOR REGIONAL CHANGE

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

FROM: Jonathan London, Faculty Director
             Center for Regional Change
             University of California, Davis

RE: Clear Lake Progress Report: August 2019

DATE: August 19, 2019

Meetings & Communication

Blue Ribbon Committee Meeting participation

Several UC Davis Center for Regional Change (CRC) researchers and staff attended the Blue Ribbon Committee Meetings held in March and June 2019. Keith Taylor presented for the CRC at the March meeting, introducing the BRC and audience to the Strategic Doing model that he plans to incorporate into his research on economic development in the Clear Lake region (see his presentation here). Noli Brazil presented at the June meeting on relevant and recent socioeconomic assessments of the region (see his presentation here). He then discussed his plan to build upon these assessments by analyzing how the socioeconomic portrait in the region has changed over time and comparing the socioeconomics of the Clear Lake region to other lake communities in California.

Project Investigator Updates

M. Anne Visser: Community & Tribal Engagement

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

Noli Brazil: Socioeconomics

Since December 2018, we have collected published socioeconomic assessments of the area, established an analytic framework for assessing the Clear Lake region that contributes added value to what prior assessments have already done, collected data from publicly available secondary data sources, and have run initial analyses to test the soundness of the analytic framework.

Keith Taylor: Economic Development

We have visited the Clear Lake region several times in July, meeting with stakeholders involved in economic development, Clear Lake restoration, and Tribal interests. In addition to arranging a series of one-on-one exploratory interviews or focus groups with stakeholders, these meetings contributed to further defining our research and development goals, which will revolve around recreation and tourism amenity development.

Project Evaluation

Vikram Koundinya: Possible publications

A Journal of Extension methods paper brief on the *Strategic Doing* method and evaluation of the method (modeled on this paper: UserTesting.com: A tool for usability testing of online resources)

Preliminary Findings

Community & Tribal Engagement

Individual Tribes have recently participated in and contributed to several studies that collect social and health-related data about their communities. There is value in collecting these data sets and associated reports and disseminating the information to individual Tribes.

Socioeconomics

Race & Ethnicity: Over the past 10 years, Lake County in general had an influx of Asian (37%) and Hispanic Population. Immigrants increased in the block groups adjacent to Clear Lake (hereafter referred to as the Clear Lake Region) but decreased in Lake County. The most significant population increase, however, is of Native Americans which grew over 75% in the

Clear Lake Region and almost 60% in Lake County overall, while decreasing by a third in the bordering counties.

Age: There is a higher percent of young adults in bordering counties, but an increase in people in retirement age in the Clear Lake Region from 2006-2010 to 2013-2017. This could indicate an aging of the population overall, the immigration of individuals in retirement age, or the emigration of individuals in prime labor force age to other areas.

Economic Development

Housing and broadband internet are two priority areas for economic development. Different geographic communities have diverse economic development processes and strategies. There is no singular strategy shared by stakeholders in the Clear Lake Region. This finding has led to a different approach by the economic development team, which has been meeting with small groups of stakeholders and will continue these meetings by sector, (e.g. public and private), and by geography, (e.g. Lake County and Tribal governments).

Next Steps

Community & Tribal Engagement

In partnership with Dr. Clare Cannon, Dr. Visser plans to work with various Tribes in the Clear Lake area individually to explore opportunities to and coordinate ongoing efforts for socioeconomic development with activities and interests related to the Blue Ribbon Commission. We will hold at least 1 community meeting for all Tribal communities in the coming year.

Socioeconomics

Dr. Brazil plans to refine analyses given feedback from the Blue Ribbon Committee during the June 5th meeting, which includes collecting more data, ground-truthing information in sparsely populated areas of the region and conducting additional statistical analyses.

Economic Development

In September and October 2019 Dr. Taylor and his research team plan to organize their first Strategic Doing session with Clear Lake stakeholders. These sessions will include Dr. Taylor facilitating discussions with the following prompts: (1) framing the question from an appreciative perspective; (2) moving beyond intensive, catch all planning processes, and toward bite-sized tasks, working in 30-90 increments; and (3) organizing ideas by asking what we *could* do, what we *should* do, and what we *will* do over the next 30-90 days.

Appendix D: Complete list of 2019 Committee Recommendations

Known Disruptors	Planned or Past Changes	Proposed Changes	NEW Monitoring/Management Tools
• Excess nutrients' e.g. Nitrogen/Phosphorus • Anoxic conditions • Herbicides • Mercury contamination from Sulphur Bank *and* natural sources • Sediment discharge from dirt roads • Municipal Separate Storm Sewage System (MS4) issues • Seawalls • Release schedules from Cache Creek Dam • Griggs Riffle channelization • Keys channelization • Indirect/direct impacts from herbicides • Shoreline and emergent vegetation management (e.g. primrose/noxious plan removal *and* tule replanting) • Waste rock dam mercury discharge • OHV issues • Channelization of streams (generally) • Lack of public education regarding shoreline vegetation management • <u>Potential new issue</u>: new invasives such as quagga or zebra mussels	• Circle pipeline • Grading ordinance (county) • TMDL restrictions (mercury and nutrient) • Farm Nutrient Management Plans • Resurfacing/capping waste rock dam • Sulphur Bank stormwater improvements • County stormwater management plan and ordinance • Local Agency Management Programs (LAMPs) • Mitigation activities associated with fires	• Middle Creek Restoration Project • Update load allocations from nutrient TMDL • UCD Hydrodynamic and water quality/ecological model • Dredging projects (multiple)	• NEW LiDAR flights; compare results to previous results to identify erosion hotspots • Stream gauges and continuous monitoring of perceived hotspots to ground truth LiDAR results. • Pre/post project monitoring to ensure compliance with existing regulations (i.e., SMARTS database) • "Full Circle" pipeline completion • Tule replanting • Single POC for data management and analysis (may involve new hire) • Stormwater buffer ponds (may increase mosquito production/vector control issues) • Ranking streams by flow and relative health • Satellite imagery and ground truthing using autonomous underwater vehicles • Land Trust shoreline acquisition • Climate change projections and modeling (recommendations to include climate scenarios) • Fish recommendations from 2010 UC Davis report • CLERC grant proposals • Analyze load contributions from Tule Lake and Scott Creek • Increased funding for county inspections • Focused management actions for known disruptors such as gravel mining sites • New/improved lake bathymetry to allow better model performance, and to identify in-lake hot spots.

Appendix E: Technical Subcommittee Roster

Name	Organization
Amy Little	State Water Resources Control Board
Angela DePalma-Dow	WRD
Broc Zoller	Lake County Farm Bureau
Charles Alpers	US Geological Survey
Greg Giusti	UC Extension
Jim Steele	Lake County Resident
Karola Kennedy	Koi Nation
S Geoffrey Schladow	UC Davis Tahoe Environmental Research Center
Sarah Ryan	Big Valley Rancheria
Tom Suchanek	UC Davis (Emeritus)

Appendix F: Full Text of AB 707 (Aguiar Curry)

Assembly Bill No. 707

CHAPTER 842

An act to add Division 14.5 (commencing with Section 22085) to the Public Resources Code, relating to Clear Lake.

[Approved by Governor October 15, 2017. Filed with Secretary of State October 15, 2017.]

LEGISLATIVE COUNSEL'S DIGEST

AB 707, Aguiar-Curry. Clear Lake.

Existing law establishes in state government the Ventura-Los Angeles Mountain and Coastal Study Commission. Existing law requires the commission to make a detailed study of all factors that may significantly affect or cause irreversible modification of the present and future status of the Ventura-Los Angeles Mountain and Coastal Zone and its relationship with the region, as provided.

This bill would establish in the Natural Resources Agency, the Blue Ribbon Committee for the Rehabilitation of Clear Lake. The bill would require the committee to consist of specified persons, including the Secretary of the Natural Resources Agency, or his or her designee. The bill would require the committee to meet quarterly for the purposes of discussion, reviewing research, planning, and providing oversight regarding the health of Clear Lake. The bill would require the committee to hold 2 meetings per year in the County of Lake. The bill would require the committee to provide an annual report to the Governor and the Legislature, as provided. The bill would authorize the committee to receive assistance and funds from public and private sources and to expend funds and award grants to conduct research upon appropriation by the Legislature.

Vote: MAJORITY   Appropriation: NO   Fiscal Committee: YES   Local Program: NO

Bill Text

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1.

Division 14.5 (commencing with Section 22085) is added to the Public Resources Code, to read:

DIVISION 14.5. Blue Ribbon Committee for the Rehabilitation of Clear Lake

22085. The Legislature finds and declares all of the following:

(a) According to California census data, Lake County, among the poorest counties in the State of California, is growing at a much slower economic rate than the majority of the state.

(b) Based on the 2016 Lake County Comprehensive Economic Development Strategy, Clear Lake, in Lake County, is one of the top two contributors to the local economy, cited as "the cornerstone of the local visitor and recreation markets," mainly through boating and bass fishing tourism.

(c) Clear Lake is the oldest species-rich, warm water, natural lake in North America. The lake contributes to the surrounding ecosystems of native plants and animals, as well as species introduced by the Department of Fish and Wildlife. Clear Lake and the surrounding environment is also a home to endangered and rare animal species.

(d) Clear Lake suffers from numerous environmental hazards that negatively affect the quality of the water and the lake's fish, including all of the following issues:

(1) The State Water Resources Control Board determined that the amount of mercury found in the lake, caused by runoff, fails to meet environmental standards and is in need of improvement.

(2) The Office of Environmental Health Hazard Assessment concluded that the fish caught in Clear Lake, specifically the bass, are not safe for women and children to eat in abundance, or at all.

(3) The 2016 Lake County Comprehensive Economic Development Strategy reports that the overgrowth of seasonal algae, cyanobacteria, and invasive weeds, such as hydrilla, cause a variety of health and habitat problems for the lake. The abundance of cyanobacteria blooms produce odor and surface scum, alter processed drinking water taste, and

sometimes cause toxic conditions for pets, creating a seasonal decrease in tourism and depression in the local economy.

(e) Therefore, it is the intent of the Legislature to enact legislation that would establish the Blue Ribbon Committee for the Rehabilitation of Clear Lake. The committee will spearhead activities aimed at cleaning up the lake for environmental gains that will revitalize its regional significance so that it may once again be used for recreational purposes, thus creating jobs and inciting new economic development.

22086. There is hereby established in the Natural Resources Agency the Blue Ribbon Committee for the Rehabilitation of Clear Lake.

22087. For purposes of this division, the following terms have the following meanings:

(a) "Agency" means the Natural Resources Agency.

(b) "Committee" means the Blue Ribbon Committee for the Rehabilitation of Clear Lake.

22089. (a) The committee shall consist of at least nine members and shall include the following representatives:

(1) A representative from the University of California, Davis, to be appointed by the chancellor from the university.

(2) One member of the Board of Supervisors of the County of Lake or a designee appointed by the board of supervisors who is either an employee of the county or a resident of the county.

(3) Representatives from the Tribes in the communities impacted by Clear Lake, to be appointed by their respective Tribal councils.

(4) The secretary of the agency or his or her designee.

(5) A representative from the Central Valley Regional Water Quality Control Board, to be appointed by that board.

(6) An expert from each of the following areas, to be appointed by the Board of Supervisors of the County of Lake:

(A) Local economic development.

(B) Agriculture.

(C) Environment.

(D) A public water supplier that draws its drinking water supply from Clear Lake.

(b) The members of the committee shall serve at the pleasure of their respective appointing powers.

(c) The members shall serve without compensation, but each of the members shall be reimbursed for his or her actual and necessary expenses incurred in the performance of his or her duties.

(d) The chairperson of the committee shall be the secretary of the agency, or his or her designee.

22090. Members of the committee shall meet quarterly for the purposes of discussion, reviewing research, planning, and providing oversight regarding the health of Clear Lake. Research conducted for the committee shall go through a scientific and applied science process. Two meetings per year shall be held in the County of Lake.

22091. (a) Beginning January 1, 2019, the committee shall provide an annual report on its activities to the Governor and the appropriate policy committees of the Legislature relating to natural resources and local government.

(b) The first annual report submitted pursuant to subdivision (a) shall identify barriers to improved water quality in Clear Lake, the contributing factors causing the poor water quality, and the threats to wildlife. The report shall 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.

(c) A report submitted to the Legislature pursuant to this section shall be submitted in compliance with Section 9795 of the Government Code.

22092. (a) The committee may receive assistance and funds from public and private sources.

(b) Upon appropriation by the Legislature, the committee may expend funds and award grants to conduct research.