

Spring / Summer
2014



CALIFORNIA LAKE MANAGEMENT SOCIETY

CALM WATERS
Spring / Summer 2014

President's Message

By Laura Young, CALMS President

June 2014



Last year CALMS hosted the 2013 NALMS International Symposia held in San Diego, CA on October 30 – November 1, 2013. The theme of the NALMS conference was **Lake Management in an Era of Uncertainty**. Again I want to give a big thanks to the Host Committee and much appreciation for a job well done. The NALMS conference was a great success, and the speakers, the venues, and the events were outstanding. Since our last CALMS business meeting in San Diego last November, our Northern Director

Stephen McCord has been focused on establishing an updated CALMS website, and is busily working toward a more efficient management of the CALMS membership list and communication with members. We hope to be able to roll out the website this summer with the information on the 2014 CALMS Conference. Also this spring, the Scholarship Committee solicited and received applications for the 2014 CALMS student scholarships, and selected two recipients with very interesting research projects.

As we face a year of near record dry conditions in 2014, I'm sure this year brings challenges and much uncertainty for many CALMS members involved in lake and reservoir management, operations, and recreation. My co-workers at the Santa Clara Valley Water District and fellow water managers at California state and federal contractor water agencies are busy these days addressing water supply and water quality issues due to the drought. After receiving only 5% of the annual allotment of imported water from the delta, many water agencies are relying on alternative sources of water supply this summer and fall. Following a third year of dry annual rainfall conditions, with record low sierra snowpack and subsequent low snow melt and spring runoff, many lakes and reservoirs around the state are experiencing below average storage levels. During this time, many users including agriculture, recreational, and environmental users as well as municipal water agencies, are relying heavily on groundwater and local reservoir sources to supplement the lack of stream flows and imported water supply.

During the drought, source water quality concerns for drinking water treatment plants include high salinity and high bromide from the delta resulting from minimal freshwater inflow and saltwater intrusion, and the corresponding disinfection by-product formation in the treatment process. Another water quality concern is the

*See you at the
2014
CALMS
Conference
Oct. 9-10
UC Davis*

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To join CALMS or renew your membership, mail a check payable to CALMS to:

Joe Sullivan, Treasurer
California Lake Management Society
734 Gelston St.
Berkeley, CA 94705

Annual membership dues (mark which applies):

- ☐ \$ 40 Active Member
- ☐ \$ 5 Student Member
- ☐ \$250 Corporate Member (corporate members are entitled to exhibit space at annual meeting)

Please enter your information here, then print and mail this form with your check:

First Name:	
Last Name:	
Affiliation:	
Address:	
City:	
State:	
Zip:	
Phone:	
E-mail:	
Alternate E-mail (opt.):	

CALMS Membership Benefits:

Annual Meeting – Invitation to our annual meeting featuring specialists in lake management, discussions on current research, updates on current and future interests in California's lakes, and showcases of products and techniques in lake management. Notifications are sent to local members when workshops are offered in your area.

Newsletter – *CALM WATERS* is our periodic newsletter of regional interest including articles, events & meetings, legal issues, research, publications and just about any subject relevant to lakes. Members are invited to contribute in making the newsletter an active and useful resource!

Technical Expertise Network – Access via our contacts list to technical expertise throughout the state for guidance, peer review, and surveys.

The Triple Threat

Water quality improvement at L. Hodges, San Diego using HOS, VEM, & AFW

Alex Horne, Professor Emeritus University of California, Berkeley, Former President CALMS

How can the alphabet soup of HOS, VEM & AFW be of use to the lake manager? They are acronyms for upcoming or brand new methods that may have special application to lakes and reservoirs in our semi-arid climate. They may be useful alone or combined with the more usual methods to overcome the public's increasing demands for higher water quality in spite of the current drought.

HOS Hypolimnetic Oxygen Systems (HOS) are now over 20 years old and more installations are growing fast, especially where toxicants like methymercury and hydrogen sulfide are likely or eutrophication is due to internal nutrient loading. There are two main HOS variations: a no-bubble method using either a submerged Speece Cone or a fine bubble plume method pioneered by the TVA and most commonly associated with Mobley Engineering. In northern California, a Speece Cone was installed in EBMUD's large 425,000 af Camanche Reservoir on the Mokelumne River in 1992. The cone was designed to reduce hydrogen sulfide in the outflow which had killed a lot of steelhead in a CFG hatchery downstream. The 23 foot high cone was hidden 90 feet down on the reservoir bed. Poor quality bottom water was pumped to the top of the cone where it meet a feed of pure oxygen bubbles rising up the cone. The countercurrent flow at 3 atmospheres pressure dissolved the bubbles so that the plume of oxygenated water leaving the cone did not increased in buoyancy. There is no increase in temperature in the cone so the water remains dense and forms a layer that hugs the reservoir bed. This is the big difference between the Speece Cone and the TVA-Mobley system since the latter's small pure oxygen bubbles entrain deep water and pull it towards the surface. Bubble plumes need about 50 feet of hypolimnion to dissolve so these HOS are best used in deeper reservoirs where general fish health is important while Speece Cones can be used in very shallow or deep waters. Bubble plumes generally need long runs of pipe to provide the bubbles while the Speece Cone does not. Bubble plumes, however, do not require an electricity supply to power a water pump. Both systems can be adapted to work well in most waters, depending on water quality needs, water depth and the client's preferences. At Comanche Reservoir nutrients and chlorophyll declined substantially after installation of a Speece Cone HOS and the fishery improved giving an estimated cost benefit ratio of 1>30. Similary, installation of a TVA-Mobley bubble plume HOS in EBMUD's Upper San Leandro Reservoir, when combined with a spring mixing extension using aeration, got rid of the most of terrible geosmin taste and odor problem.

VEM Stirring lake water by aeration is the most widely used lake management method but Vigorous Epilimnion Mixing (VEM) is a new concept in the US though, without the acronym, it has been used for a decade or more in shallow European waters, including the former Royal Parks in London. The only application of VEM in the US is the 830 acre Cherry Creek Reservoir, located near Denver, Colorado which began three years ago. Still important as a flood control reservoir it is heavily used for recreation. Unlike HOS which can greatly decrease chlorophyll, most forms of aeration do not and VEM is no exception. Its purpose is to eliminate surface scums of colonial blue-green algae (cyanobacteria) which may be replaced by non-scumming blue-greens or diatoms. The main recreational problem is surface scums which look a mess and drift into public areas. In addition, the blue-green scums are ingested by animals and sometimes people. When naturally concentrated, it is possible to reach potentially toxic levels for hepatoxins and certainly for neurotoxins. VEM was devised by myself and Dr. Ken O'Hara of flowthrough and involves creating aeration "cells" that overlap and stir the upper waters. Ken likens it to adding wind mixing when there is no wind. Though called 'vigorous' that is only from the viewpoint of a microscopic algae colony; people on shore would hardly notice the mixing. So far in Cherry Creek, VEM has reduced blue-greens to almost zero but chlorophyll has not declined and there are concerns about the Wiper fishery. The VEM method has been proposed for Lake Hodges, a eutrophic drinking water supply and recreational reservoir just north of San Diego. It may be just what many other shallow or eutrophic waters need since



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aeration is cheap, well-known, and seems to make sense to the general public.

AFW Direct removal of algae from lakes and reservoirs is not cost-effective unless the product can be sold for a high price, for example blue-green algae used as a lightly-regulated food supplement. Upper Klamath Lake in Oregon supports a small health food industry based on centrifuging to concentrate the algae. In contrast, Algal Filtration by Wetlands (AFW) is a brand new method that I have devised to fix scums that cannot be reduced in other ways. Unlike VEM, but like HOS, AFW can reduce overall algal abundance. More importantly, like VEM it directly targets nuisance summing blue-green algae. Why do some algae scum? Probably it is an overcorrection to lack of light in much of the water column in the days prior to the appearance of visible scums. Under such conditions, individual blue-green algal cells run short of food starting with glycogen. We humans store glycogen in our livers after breakfast to give us energy to last till lunch, or at least to that cookie at coffee break. Similarly, algae make glycogen all day to last them through the night when they may divide into two. Glycogen is a noticeably heavy substance with a specific gravity (SG) of 1.3 which is a lot for a phytoplankton with a SG ~ 1.0. Blue-green algae dominate in warm, stratified water the world over by using buoyancy regulation. They have an array of tiny bladders of air, the gas vesicles, that give them overall positive buoyancy and thus they float – unless weighted down by heavy glycogen granules. If you recall Stokes law you will remember that sinking or rising of a particle in a fluid is primarily related to its density and the square of its radius. So if there is not enough light, starving large colonial blue-green algae will rapidly float to the surface and scum.

The AFW method takes advantage of the natural concentration strategy of blue-green scums and skims them off and transports them to specially-designed wetlands. If properly designed, wetlands are cheap to construct and have other values like good wildlife and can be aesthetically gorgeous to some humans. It is not widely appreciated that wetlands filter out algae very well. There is a 4,000 acre wetland that has been pioneered by the South Florida Water Management District as a method to remove particulate-P from the outflows of large and eutrophic Lake Apopka. Well, algae are particles too. The AFW concept is in the design phase for Lake Hodges, San Diego along with HOS and VEM. If the AFW is located near the reservoir a low head pump can be used to decrease cost and could easily be sustainably powered. In this case the wetlands may also be designed as a unit process system with several different kinds of wetlands to remove different pollutants. In particular, they will collect and treat summer nuisance surface runoff from nearby town and also the flood flows from these areas and cities upstream. I have helped design such multi-purpose wetlands close to downtown Irvine, CA and at Crystal Gardens, Phoenix AZ and they seem functional and popular with the locals. For example Sanctuary Wetlands in Irvine removes nitrate that was stimulating over-growths of seaweeds in Newport Bay but also supports over 225 species of birds, to the delight of the local Audubon Society.

CALMS 2014 Conference

Planning for our 2014 conference is underway! This year we've found a great venue at the University of California Davis (www.ucdavis.edu) with plenty of nearby hotels in the City of Davis (<http://cityofdavis.org/>). The Hallmark Inn at UC Davis is holding a block of rooms for us at a cost of \$109/night single and \$119/night double. Make your reservations under the CALMS discount rate up to one week prior the conference date. www.hallmarkinn.com/uc-davis

The theme for this year's conference is mercury management. A new statewide reservoirs mercury TMDL due to be produced this summer. (http://www.waterboards.ca.gov/water_issues/programs/mercury/), there will soon be regulatory pressure to address reservoirs as receptors and sources of this widespread pollutant. A host of other talks will round out a full day of presentations, with refreshments and networking opportunities worked in. The first day will end with a CALMS business meeting and then a social dinner in town (with live music if we're lucky!). The second day will be a field trip to a nearby reservoir. More details coming soon!

Save the Dates: October 9-10



Our mission is to promote understanding, protection and comprehensive management of California's water resources and their watersheds.

What is CALMS?

Since its founding in 1985, the California Lake Management Society (CALMS) has been a state chapter of the North American Lake Management Society. We are a non-profit organization for California's lakes and the only statewide network of individuals, lake associations and public fund representatives devoted solely to the preservation and protection of our state's lakes.

The purposes of CALMS are to:

- Provide a network for communication of lake information
- Provide technical knowledge and expertise to advise and assist members
- Support legislation that will protect our lakes and promote effective lake management
- Provide a forum for communication and education
- Conduct an annual meeting where scientists, professionals and citizens can share information and new technology

For more information, visit our website:

<http://www.california-lakes.org/>



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CALMS Annual Business Meeting

November 1, 2013, San Diego, California

Attendees:

Pete Alexander	Laura Young	Michael Anderson	Tom Buckowski
Joe Sullivan	Bill Taylor	Mike Horvath	Tom McNabb
Imad Hannoun	Todd Tietjen	Inken Mello	Stephen McCord
Rich Losee	Carl Koenig	Alan Striegle	Matt Graul
Ed Nishikawa	Doug Ball	Matthew Williams	Dave Roberts
Douglas Ball	Jeffery Pasek	Kelly Wucherpfennig	Hal MacLean

1:15 PM CALMS Business Meeting begins.

A BIG thanks to the Host Committee for a successful 2013 San Diego NALMS Meeting. (Round of Applause)

Agenda

Draft Agenda submitted and approved

Minutes

The 2012 Minutes were read there was an error with a date in the Treasurers report. The 2012 minutes were approved with that amendment.

Reflections on the 2013 NALMS Conference

- The Committee did a great job!
- NALMS was a success.
- Good presentations, speakers and facility,
- Great mixer at the Aquarium.
- Travel bans and the Government shutdown effected attendance
- Profit share for CALMS is not entirely known
- Target 400 attendees, but it was more like 400 total
- CALMS table was thrown together quickly and we did get one new member (possibly put together an application backed with a CALMS fact sheet)

A BIG round of applause to the Host Committee

New Business

Discussion to include Region 9 (Nevada and Arizona) in CALMS. The positives (more members and more information) and negatives (travel restrictions) are discussed, but it is decided that we resume the discussion at next year's CALMS business meeting.

Treasurer's Report: from Joe Sullivan

			Balance 4/30/13	Balance 9/30/13		
		Shares	\$25.32	\$25.32		
		Checking	\$6,913.67	\$5,914.92		
		CD	\$11,394.31	\$11,406.25		
		Total	\$18,333.30	\$17,346.49		
DATE	TO	FROM	Affiliate	FOR	EXPENSE	INCOME
1/25/2013	Joe Sullivan	CALMS		Tax filing	\$20.00	
5/6/2013	Imad Hannoun	CALMS		Travel Reimbursement	\$1,000.00	
10/28/2013	CALMS	Barbara Barry	LA Water Quality Control Board	CALMS Membership		\$40.00
10/28/2013	CALMS	Eli Kersh-Oliva	CS Eastbay	CALMS Student Membership		\$5.00
11/1/2013	CALMS	Jeffrey Barman	California Waters	CALMS Membership		\$40.00

Discussion on Scholarship winner's lack of involvement with CALMS annual meeting.

Motion: In 2014, CALMS will have two scholarships of \$1000. Half of each scholarship will be allocated to the student at time of the reward. The other half of the scholarship will be allocated to the student upon attending and presenting at CALMS annual meeting. CALMS will pay for the student's registration and room (two nights) at CALMS annual meeting. CALMS will pay up to \$300 for documented travel expenses to CALMS annual meeting. The Scholarship Committee has authority to act on all the above. Passed unanimously
Scholarship Committee (Rich Losee, Michael Anderson and Bill Taylor) will update the scholarship announcement and send Doug Ball the new scholarship information for the website.

Website

Doug Ball updated the website a month ago with 2013 NALMS conference update. There are two known old CALMS websites with outdated info. We don't know how to address this. Monthly cost of website is \$10. Doug paid the expenses for website maintenance and is donating his time and the annual cost. Doug plans to update and maintain the website for 2013-2014. Once we update the mailing list, he will send out an announcement of the updated website and link to the website. Doug will update the website with new scholarship information when he gets it.

Recruitment and Membership

Tom McNabb will check the Lake Recreation List and follow up on recruiting.

Motion: use list serve/Constant Contact to Automate CALMS Mailing list is passed and Stephen McCord will set up that "Constant Contact" mailing list. Passed unanimously.

Elections

Motion: Kelly Wucherpennig will be CALMS President Elect for 2014. Passed unanimously.

Motion: the Officers and Directors will remain the same for one more year.

Passed unanimously.

2014 Officers are:

President: Laura Young

President Elect: Kelly Wucherpennig

Past President: Imad Hannoun

Northern Directors: Ed Nishikawa (2nd term) and Stephen McCord

Southern Directors: Jim Grant (2nd term) and Michael Anderson

Administrative Director: Pete Alexander

Treasurer: Joe Sullivan

Secretary: Hal MacLean

Action Items:

1. Applaud the 2013 NALMS Host Committee.
2. Todd and/or Imad to follow up with NALMS about CALMS' compensation.
3. Error in Treasurers report in 2012 Minutes. Correct error and archive updated minutes.
4. Create a one page CALMS fact sheet for conference info tables.
5. Scholarship committee to update the scholarship announcement and send Doug a copy.
6. Doug to update the website with new scholarship information.
7. In December, 1st request for newsletter articles. In March 2nd request for newsletter articles for a May 2014 CALMS newsletter to include President's message, Region 9 update, and 2014 scholarship winners.
8. Post May 2014 CALMS newsletter on the CALMS website.
9. Tom McNabb will check the Lake Recreation List and follow up on recruiting.
10. Stephen McCord will set up a "Constant Contact" list.
11. The 2014 CALMS Conference Organizing Committee (Ed Nishikawa, Pete Alexander, Stephen McCord and Laura Young) will set up the 2014 CALMS Conference in Northern California (Salinas, Livermore, Davis, or Sacramento). Carrie Austin of the State Water Board is working on the Statewide Mercury TMDL for Reservoirs. We may have half a day devoted to Mercury TMDLs.
12. Imad to send the updated mailing list to Hal who will proof it and send it to Steve to be set up for list serve/Constant Contact.
13. Resume discussion to include Region 9 (Nevada and Arizona) in CALMS.

Meeting adjourned 7:03 PM

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increase in primary productivity and corresponding total organic carbon, blue-green algae blooms, and corresponding taste and odor events. These are typical source water challenges during the summer and fall months, but are even more challenging during drought conditions, as events are more pronounced and options for source changes and blending are limited.

For water agencies that import delta water via state and federal water projects, local reservoirs will be an important emergency source of supply this summer. Often serving as an important source of summer-time recreation, the operation and management of these reservoirs for water supply during times of drought also require collaboration and a large degree of planning by park agencies, too.

In addition to drought response activities, I am participating in the state's effort to address the mercury in fish tissue found in many California lakes and reservoirs. The State Water Board is implementing the Statewide Mercury Control Program in Reservoirs to reduce lake and reservoir mercury bioaccumulation in fish tissue and address fish consumption advisories. The State Board has outlined a schedule for 2014 - 2015 and defined actions through a series of stakeholder meetings and focus workshops with reservoir operators, managers, and fish biologists. The schedule indicates the staff report on the Mercury Program and Objectives is anticipated for public review in the Fall 2014, followed by public workshops and the Board workshop, with State Water Board adoption and plan implementation in 2015. The State seeks to conduct a series of pilot projects at reservoirs across the state to be conducted over a 10-year period. Partners from reservoir operators and water agencies are wanted for developing and conducting the pilot projects including primary productivity enhancement, erosion control and sediment reduction, oxygenation/aeration processes, and fishery management. The State Board staff will provide a presentation followed by focused discussion during the morning session at the CALMS Annual Conference this October.

We have an interesting list of speakers lined up for the CALMS Annual Conference this year on October 9th and 10th at UC Davis. Topics for this year's presentations include mercury in the lake ecosystem, oxygenation for mercury control, invasive mussel research, drought and climate impacts, and reservoir water quality improvement. The second day will be a field trip to Camanche Reservoir. I hope you will be able to come and I look forward to see you all there!

Laura Young
2013-2014 CALMS President
Santa Clara Valley Water District



Hume Lake

*Sequoia National Forest,
Fresno County*

By Kfasimpaur (Own work) [Public domain], via Wikimedia Commons



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2013 CALMS Scholarship Winners

Congratulations to our 2013 Scholarship Winners, Jacob Shiba, for “My Research in Aquatic Sciences”, and Alecia Brantley for her work on heterotrophic bacteria. Each will receive a scholarship in the amount of up to \$1300. Congratulations and thank you for your fine scholastic efforts!

Research Summary

Alecia Brantley —M.S. student of Hydrology

Heterotrophic bacteria contribute to the metabolic balance of lakes and are driven by organic and inorganic nutrients, and dissolved organic carbon. However, little is known about how metabolisms of bacterial communities from littoral benthic and pelagic habitats vary in lakes along a trophic gradient. A review of literature concerning bacterial productivity within lakes found only 7.5% of past studies researched the productivity of benthic bacteria and 3.5% researched both pelagic and benthic bacterial productivity. Therefore, a gap exists in the understanding of how both pelagic and littoral benthic bacterial communities contribute to the productivity of whole lake systems. Here, I quantify respiration rates of pelagic and littoral benthic heterotrophic bacteria in 9 lakes along a trophic gradient, with a focus on the change in relative contributions of littoral benthic and pelagic bacterial respiration to whole lake bacterial respiration. The following lakes (and reservoirs) in the Northwestern US will be sampled to represent a trophic gradient: Crater Lake, Lake Tahoe, Donner Lake, Cliff Lake, Castle Lake, Lake Siskiyou, Lake Shastina, Clear Lake, and Upper Klamath Lake. Water samples will be collected from each lake to determine concentrations of total phosphorus, total nitrogen, dissolved organic carbon, chlorophyll-a, and stable isotopes of carbon and nitrogen. Bacterial respiration rates will be measured using biochemical oxygen demand (BOD) techniques with a dark incubation period. I hypothesize that, in all lakes along a trophic gradient, the respiration rates of heterotrophic bacteria in the littoral benthic habitat will be more variable than pelagic bacteria. I also expect that the relative contributions of littoral bacterial respiration to whole lake bacterial respiration will decrease with an increase in trophic state.

This research will address a fundamental question on how respiration rates of littoral benthic bacteria differ from those of pelagic bacteria, in lakes across a trophic gradient. This is a crucial question involved in the broader understanding of how different habitats contribute to whole-lake metabolism, and if these contributions change in lakes with varying productivity levels. The role of lakes in the global carbon budget has become an increasingly studied topic; however, major limitations exist due to a lack of knowledge about: 1) spatial variability of carbon flux within a lake, and 2) the difference in the amount of carbon flux occurring in different lake habitats, and in lakes of differing trophic states. By providing information on variability—and the relative contributions—of littoral benthic and pelagic bacterial respiration in lakes along a trophic gradient, this research will elucidate trends of bacterial driven carbon fluxes in lakes.

CALMS Scholarships Applications Procedure

1. The applicant must provide a short resume; transcripts of college/university course work; and a statement of their interests, career goals, and intended use of scholarship funds. The packet should be limited to four pages.
2. Two letters of support must also be submitted. At least one must be from a college or university faculty member familiar with the student's abilities, interest, and career goals. Support letters must be sent separately.
3. All application material should be sent to the CALMS Scholarship Program Chair by October 1, 2014, with announcement of award winners at the Oct 9-10 2014 Annual Meeting.

Please send 3 copies of all application materials to:

Michael Anderson,
Department of Environmental Sciences,
University of California Riverside, CA 92521
Email michael.anderson@ucr.edu
Subject: CALMS SCHOLARSHIP

My Research in Aquatic Sciences

By Jacob Shiba

Methane emissions from lakes and reservoirs account for a significant part of the non-anthropogenic greenhouse gas inventory. Bastviken et al. (2004) estimated that open freshwater contributes 6-16% of global non-anthropogenic emissions. The goal of my research is to better understand the physical and chemical factors regulating storage and ebullition of methane gas in lakes. I have collected sediment from several lakes in Southern California that vary in productivity, depth, and other features. The physical factors that I have thus far quantified include water content, organic carbon content, bulk density, and texture. The chemical factors that I have also quantified include methane content, redox potential, and pH. These properties will be measured over time to quantify seasonal variation.

Methane is thought to be released from sediment by two major processes (Algar et al. 2011). The first is viscoelastic fracture, in which a main fracture in the sediment allows for methane bubble release. The second is through diffusion, in which methane diffuses through the sediment with no specific release points. I will be creating an apparatus to hold a Biosonic 201 kHz DT-X Echosounder hydroacoustic drum over the sediment. This drum sends down pings of sound that reflect off of the bottom sediment and back the receiver. Using the ecograms recorded from the drum I will attempt to specify the main release process of methane in these lakes.

I am also using Biosonics echosounder and Lowrance radar to map the bathymetry of these lakes in order to obtain acoustic signatures for methane content. With this information, the amount of methane in a lake could be quantified simply by surveying from the lake surface. This would make large scale measurements much easier to obtain and would be more cost efficient.

In addition to the location of methane in reference with area, I will also attempt to quantify methane location with respect to depth in the sediment. This will be done both, in the laboratory and in-situ. Upon collecting sediment cores from a lake, I will section off these cores and measure methane content using an HP GC-FID. Laboratory testing the 5 frequencies (50, 83, 200, 455, and 800 kHz) of the submersed Lowrance transducer will indicate the accuracy of the transducer in locating a bubble and determining its size. Should this prove reliable, I will begin making in-situ measurements in lakes throughout Southern California.

Finally, I will attempt to quantify the effect of ebullition on nutrient suspension that can ultimately contribute to internal loading. This will be done using the SonTek Argonaut-ADV. This device can measure the velocity field of water within a 1 cm^3 volume. Upon measuring the velocity field of the bulk environment, I will then measure the velocity field associated with the release of a methane bubble. This change in velocity can then be used to calculate the amount of sediment disturbance. Knowing the concentration of a certain nutrient such as phosphorous, we can then estimate the contribution of ebullition to internal loading.



Arboretum at UC Davis by dragondoodle



California Lake Management Society

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