Day 1 of the symposium focused on data use and synthesis to help direct programs and decision making, as well as some new technology to help collect data to support healthy streams and waterbodies. Day 1 also highlighted Water Board programs and data support efforts to collect and synthesize quality data to inform management actions aimed at improving the physical, chemical, and biological condition of water bodies.

10:00-10:40 – Introduction and Keynote Speaker
- Dan Hammer, Earth Genome – Data Science, Designed (Video | Abstract | Bio)

10:40 – 12:00 – Synthesis – More than the sum of the parts (15 min talks) Moderator – Ali Dunn (Bio)
- Andrew Gray, UC Riverside – Consideration of Non-Stationary Sediment Dynamics in Watershed Based Plans (Video | PowerPoint | Abstract | Bio)
- Bryn Phillips, UC Davis – Factoring Pesticides of Emerging Concern in the TMDL Process (Video | PowerPoint | Abstract | Bio)
- David Gillett, SCCWRP & Grant Sharp, OC Public Works – Developing a Screening Causal Assessment Framework for California’s Waters (Video | PowerPoint | Abstract)
- Karen Worcester, CCWQCB – Central Coast Healthy Watersheds assessment: Integrating surface water, groundwater and land use data into a regional assessment to support management decision-making (Video | PowerPoint | Abstract | Bio)

12:00 – 1:15 – Lunch

1:15 – 2:45 – Emerging Technology and Data (15 min talks) Moderator – Erick Burres
- Tamara Kraus, USGS – High-Frequency Nutrient and Biogeochemical Monitoring: Connecting the Dots between Drivers and Effects of Constituent Concentrations
- Steve Steinberg, SCCWRP – Using small unmanned aerial systems (sUAS) for environmental mapping and monitoring
- Sarah Lesmeister, CDWR – Use of FlowCAM in the Sacramento-San Joaquin Delta: An Innovative Technology to Rapidly and Reliably Perform Particle Analysis
- Kate Wing – Artificial Intelligence, Image Recognition & Conservation, or How to Make Computers Do the Boring Parts of Your Job
- Flash Emerging Technology Talks (5 minute talks) – see Special Session Information

2:45 – 3:00 – Networking Break
3:00 – 3:30 – **More Emerging Technology**

- Flash Emerging Technology Talks (5 minute talks)- see Special Session Information

3:30 – 4:50 – **Emerging Laboratory Methods and Analyses** (15 min talks) Moderator- Claire Waggoner

- **Megan McWayne, USGS** – Passive Sampling of Surface Waters in the Sierra Region of Northern California for Pesticides used In Cannabis and Timber Cultivation

- **Alvine Mehinto, SCCWRP** – Test-driving a new CEC framework to effectively screen for chemical occurrence and effects in aquatic environments

- **Mandi Finger, UC Davis** – Development and Evaluation of an Environmental DNA (eDNA) Protocol to Monitor Wild Delta Smelt

- **Tim Otten, Bend Genetics** – Case Studies: Application of DNA-based tools for cyanobacterial monitoring
Keynote - Data Science, Designed
DAN HAMMER (Earth Genome)

The objective of data science is to convert raw data into actionable insight. Finding relevant questions to ask and answer requires user research, human centered design, and empathy. There is nothing scalable about empathy. This talk will begin to address the central, coordinated investments required in order to enable a diverse set of applications that rely on water data. How do we scale data science for a better, more sustainable allocation of water in California? The talk will present strategies and success stories from private industry; and will map them to environmental or public contexts, more broadly.

Consideration of Non-Stationary Sediment Dynamics in Watershed Based Plans
ANDREW GRAY (UC Riverside)

Suspended sediment is a complex component of aquatic systems. All natural rivers and streams transport these fine sediments, where they play important physical, chemical and biological roles. However, over-abundance of suspended sediment and their contamination with human generated pollutants together represent the most prevalent impairments of water bodies in the US. Efforts to define thresholds of acceptable sediment abundance and composition, and develop actions to meet such targets at the watershed scale are often complicated by highly variable and poorly characterized natural sediment regimes. Variability in fluvial sediment loads also tend to exhibit non-stationary (i.e. time dependent) behaviors stemming from hydro-meteorological forcings, landscape feedbacks, and natural and human disturbances. This seminar focuses on the issue of non-stationary sediment behavior, and why it should be explicitly considered during the development of watershed based plans for water quality mitigation.

Factoring Pesticides of Emerging Concern in the TMDL Process
BRYN PHILLIPS (UC Davis), Brian Anderson, Dawit Tadesse, Debra Denton, Mary Hamilton, Karen Worcester, Robert Budd, Xin Deng, and Noelle Patterson

Most of the arthropod invertebrates used for aquatic toxicity testing are sensitive to pesticides, which account for much of the toxicity in California state and regional monitoring programs. Toxicity and chemical analyses have led to 303(d) listings and pesticide-related total maximum daily loads (TMDLs) in many California water bodies. The succession of new pesticides has historically outpaced monitoring and regulation. TMDLs for the organophosphate chlorpyrifos were developed in four central coast watersheds between 2011 and 2014, but monitoring data from several programs demonstrated that pesticide usage in these watersheds has changed to pyrethroids, and more recently, to neonicotinoids. California is taking steps to get ahead of the pesticycle. The California Department of Pesticide Regulation (DPR) has developed a pesticide prioritization model that incorporates pesticide use as well as chemical properties, monitoring results, and application information at different spatial and temporal scales. Coordinated and cooperative monitoring has also been implemented to speed the transfer of information among state and federal agencies. In collaboration with DPR, the State Water Board is conducting water column toxicity tests at DPR surface water monitoring locations to determine if water toxicity is caused by current-use pesticides, such as neonicotinoids, or other pesticides of
emerging concern. As the patterns of pesticide use have changed, the test species used in monitoring must evolve to assess risk to aquatic life because of differing sensitivities among standard test species. Organisms such as *Ceriodaphnia dubia* are sensitive to the organophosphate insecticides chlorpyrifos, but are less sensitive to other classes of pesticides. Monitoring plans that include a range of test species are needed to evaluate targeted pesticides and potential alternative pesticides. For example, an additional test species was added to the State Water Board’s Stream Pollution Trends Program (SPoT) to address potential sediment toxicity associated with fipronil. These activities are also informing the design of a statewide urban monitoring framework for pesticides and toxicity as part of the State Water Board’s Strategy to Optimize Resource Management of Storm Water (STORMS). Successful or meaningful reduction of pesticides in urban and agricultural environments can only be confirmed with up-to-date monitoring tools that include biological measurements and analytical chemistry. This includes the development of next generation bioanalytical tools that have cell lines with neurotoxin receptors. This presentation will discuss examples of changing pesticides, and suggest preemptive strategies for avoiding negative outcomes.

**Some Supporting Documents:**

**Developing a Screening Causal Assessment Framework for California’s Waters**
DAVID GILLETT (SCCWRP) & Grant Sharp (OC Public Works)

Sites in poor ecological condition often require causal assessment to determine appropriate follow-up actions. A key component of the causal assessment is to identify a series of ecologically similar (comparator) sites that are used to compare and contrast biological condition and stressor exposure at the site of interest. A good set of comparator sites should: 1) be capable of supporting similar biota to the impaired site in the absence of disturbance; 2) comprise a gradient of biotic condition; and 3) contain enough sites to assess variability. We propose a quantitative approach to select good sets of comparator sites from a large pool of potential sites using expected biological similarity. Expected biological similarity was measured as Bray-Curtis dissimilarity values (BC) calculated from the expected
taxa lists produced by a predictive biotic index of stream health based upon benthic macroinvertebrates for California. Sets of comparator sites were created for 15 demonstration sites across Southern California in poor condition. We examined the stressor and biological data collected at the 15 sites and their comparators to assess the likelihood of four example stressors – total nitrogen, ammonia, specific conductivity, and bifenthrin – as potential causes for the poor biotic conditions that were observed. We were able to select more than 100 comparator sites for all but 1 of the 15 demonstration sites at a BC <0.1. These sets of comparator sites were then used to evaluate the four example stressors using two commonly used causal assessment lines of evidence. Elevated conductivity was the most frequently supported likely cause among the demonstration sites, though total nitrogen and bifenthrin were also indicated at some sites. Though our specific approach was tailored for application in California’s stream bioassessment framework, the concepts could be adapted for any bioassessment program with a large amount of sample data and an associated predictive index of biotic condition. Furthermore, this approach lays the groundwork for developing a novel approach to causal assessment that begins with a rapid, screening-level evaluation of stressors common to a region using these data-rich groups of comparator sites, which then informs and streamlines follow-up actions.

Central Coast Healthy Watersheds assessment: Integrating surface water, groundwater and land use data into a regional assessment to support management decision-making
KAREN WORCESTER (Central Coast RWQCB), Dave Paradies (Bay Foundation of Morro Bay)

The Central Coast Water Board has established goals of healthy aquatic life, clean ground water and proper land management to support its vision of “Healthy Watersheds”. We have used both modeled and measured data to evaluate surface water health, and are now working to integrate that data with other data associated with groundwater quality and land management. To support this effort, we have made use of Recovery Potential Analysis (RPA), a tool developed by U.S. EPA to combine and map geographic data representing ecological status, stressors, and the human potential for affecting change. We have incorporated data sets from the State’s Groundwater Ambient Monitoring and Assessment program (GAMA) and the California Healthy Watersheds Assessment, as well as locally collected datasets related to land management. The EPA RPA tool can be customized to focus on specific watersheds, regions, or issues of concern. A version of RPA already populated with data specific to the state of California is available at http://www.ccamp.us/ccamp_org/tech_support/, and can be readily adapted for use by others.

High-Frequency Nutrient and Biogeochemical Monitoring: Connecting the Dots between Drivers and Effects of Constituent Concentrations
TAMARA E.C. KRAUS, Brian Bergamaschi, Bryan Downing

Advances in sensor technology are allowing us to collect high resolution water quality data across both time and space. These sensors (e.g., chlorophyll-a, blue green algae, nitrate, dissolved oxygen) are becoming increasingly important tools for long-term water quality monitoring, for rapid detection of water quality impairment, and for understanding links between drivers, constituent concentrations, and ecosystem effects. These rich data sets provide scientists, managers and policy-makers information to make sound water resource management decisions. The use of in situ nutrient sensors (nitrate, ammonium, phosphate) capable of collecting high frequency data are of particular interest because of the well-known adverse effects of nutrient enrichment on harmful algal blooms, hypoxia, and human
health. In the Sacramento-San Joaquin Delta, the USGS has developed a network of high frequency water quality stations that include sensors for chlorophyll, blue green algae, and nitrate. We have also been testing sensors for phosphate and ammonium. Deployment of these sensors in tandem with a suite of other tools on boats allows us to rapidly map water quality across diverse habitats. This presentation will relate several examples of how these tools can provide information not previously achievable with discrete sampling approaches, and discuss some of the advantages, opportunities and challenges associated with high-frequency data collection programs.

Links
https://waterdata.usgs.gov/nwis
http://pubs.acs.org/doi/abs/10.1021/acs.est.6b05745

Using small unmanned aerial systems (sUAS) for environmental mapping and monitoring
STEVEN J. STEINBERG, Ph.D., GISP**, Nikolay Nezlin, Ph.D. and Dario W. Diehl (SCCWRP)

Aerial imaging from satellites and manned aircraft has a long history of applications for environmental mapping and monitoring. However, given the requirements for many environmental applications, synchronization of orbital or pilot scheduling, acceptable weather conditions and costs limit the utility of these approaches. In the fall of 2016, the Federal Aviation Administration finalized regulations for the professional use of small unmanned aerial systems, (sUAS) opening the way to their use in the collection of high-quality, on-demand aerial imagery at the site level. Coupled with photogrammetric and image methods sUAS offers new opportunities to efficiently and effectively support site-level mapping and monitoring with a range of different sensors types. This presentation addresses emerging opportunities to use of sUAS systems for environmental monitoring and mapping in context of surface waters and the adjacent built and natural environments.

Use of FlowCAM in the Sacramento-San Joaquin Delta: An Innovative Technology to Rapidly and Reliably Perform Particle Analysis
SARAH LESMEISTER (CDWR)

The FlowCAM (Flow Cytometer and Microscope) is an automated imaging technology that analyzes particles accurately, reliably and quickly in various research settings worldwide. The technology is able to count, capture and save images of particles and microorganisms (2μm-2mm) in a fluid stream, at a rate up to 10,000 images per minute. For each image, 30 different measurements (i.e. length, width, and fluorescence) are provided in real-time and can be sorted, filtered and classified using the innovative Visual Spreadsheet software. Prior studies in the Delta using FlowCAM technology have provided valuable information on phytoplankton and harmful algal blooms. Current studies using the technology are investigating the effects of the 2014 and 2015 drought on Microcystis and zooplankton abundance and biovolume. Not only can the FlowCAM technology be used in future special studies, it can be integrated into long-term monitoring programs to address changes in taxa characteristics (e.g. size) over time.
Artificial Intelligence, Image Recognition & Conservation, or How to Make Computers Do the Boring Parts of Your Job
KATE WING (K|W Consulting)

AI may seem like a magic solution or impossible science fiction. The current reality falls somewhere in the middle and the tools are improving all the time. A number of projects are underway to apply AI in saltwater fisheries management, with lessons for other natural resource issues. As a non-technologist, I’ll walk through guidelines for thinking about how you could use image recognition in your work, best practices for defining a project, things to avoid, and resources to get started.

Passive Sampling of Surface Waters in the Sierra Region of Northern California for Pesticides used In Cannabis and Timber Cultivation.
MEGAN McWAYNE (USGS)

The Sierra region of Northern California, while not an area of intense agricultural activity, has its own unique pesticide applications. Unregulated Cannabis cultivators apply unknown types and quantities of pesticides including substances banned in the United States. In addition, pesticides are used in commercial timber production and for maintenance of rights-of-way. These chemicals may be entering streams at concentrations harmful to aquatic animals and plants. This pilot study utilized passive sampling techniques to sample surface waters downstream from Cannabis and timber production sites. Passive sampling can catch pollutant pulses that may be missed by traditional grab sampling. Trace levels of pesticides can be concentrated in passive sampler media to detectable levels without requiring large volumes of water to be collected, which is especially useful when sampling more remote locations. These attributes make passive sampling an attractive technique for areas that receive seasonal or episodic pesticide loads. Samplers were deployed in the fall of 2016 and spring 2017. Initial data include laboratory extraction testing and initial field deployment results. Preliminary analytical results, along with laboratory extraction testing, and future directions will be presented.

Test-driving a new CEC framework to effectively screen for chemical occurrence and effects in aquatic environments
ALVINE MEHINTO (SCCWRP)

Current monitoring programs target individual groups of chemicals for which robust analytical methods exist, but do little to address the presence of unexpected contaminants (e.g. metabolites, transformation products). Moreover, this approach doesn’t consider the ecotoxicological risk that complex environmental mixtures may present. In vitro cell assays have shown promise as screening tools to assess environmental mixtures. In recent years, we have conducted a series of laboratory and field studies to adapt and apply these tools for water quality benchmarking. Our initial work focused on the evaluation and optimization of endocrine related cell assays such as estrogen receptor assay. Standardized protocols were then applied to screen aqueous samples from various environments across California (e.g. freshwater streams) and final wastewater effluents. Results of these studies indicated that wastewater effluents had the highest levels of endocrine bioactivity followed by samples from effluent-dominated rivers, while most perennial streams showed little to no bioactivity. Cell assay results compared favorably to the targeted chemistry data. To further evaluate the potential of cell assays for toxicity screening, the relationship between bioactivity and animal/community responses...
were examined. Altogether, these studies indicate that cell assays can provide valuable information on both occurrence and potential adverse effects of contaminants in the environment.

**Development and Evaluation of an Environmental DNA (eDNA) Protocol to Monitor Wild Delta Smelt**
MANDI FINGER (UC Davis)

Environmental DNA (eDNA) sampling is a suite of techniques where a sample from the environment, such as water or soil is taken for the purpose of inferring the presence of a taxon or taxa of interest. It is an effective sampling method when organisms are hard to detect or visually identify. There are several additional advantages including the limited disturbance to an organism to detect it with eDNA. I will describe the various eDNA methods being utilized today (for example biodiversity sampling and detection of invasive species), the ways that eDNA is complementary to traditional surveys, review the ways that eDNA has been applied to date, and discuss the caveats.

**Case Studies: Application of DNA-based tools for cyanobacterial monitoring**
TIM OTTEN (Bend Genetics, LLC)

Cyanobacterial blooms are a common feature in many North American lakes and reservoirs during the summer and fall months. Many monitoring programs utilize a tiered management approach whereby potentially toxic cyanobacterial cells in excess of a given threshold illicit a beach closure or trigger toxin testing. Under this framework, toxin analyses are informed by knowledge of the genus of cyanobacteria present and their recognized potential to produce a given toxin. However, many strains of cyanobacteria are nontoxic, so this approach often wastes resources by screening for toxins when they are not present. Research indicates that cyanobacteria tend to produce toxins if they have the ability to do so; those that do not produce toxins physically lack the genes necessary to produce these compounds. DNA-based tools that target toxin genes can be used to improve monitoring efforts by more directly predicting which samples are likely to contain toxins. This presentation will provide an overview of the real-time quantitative PCR (QPCR) methodology—including its Pros and Cons, and these data will be compared with traditional metrics such as cell counts and toxin measurements using peer-reviewed and published data sets (Otten et al., 2012; Otten et al., 2015; Otten et al., 2016). In addition to predicting toxins, we provide additional data showing that QPCR can be used to predict taste-and-odor compounds such as geosmin. Additional topics to be covered include: sample collection/processing/storage, data interpretation, relative costs, turnaround times, and broader applications (e.g., sediment analysis).

Data to be presented can be found in the following publications and Supplementary Material:

