INFORMATION ITEM

Lead Scientist's Report

Summary: This month, we feature a study by Lehman, Kurobe, and Teh (affiliations: California Department of Water Resources and UC Davis) that highlights the impact of switching between extreme drought and wet conditions, a.k.a. "climatic whiplash" on cyanobacteria harmful algal blooms (CHABs), within the upper San Francisco Estuary (USFE). It is expected that the frequency and duration of these whiplash events are likely to increase with continued climate change. Understanding the effects these events have on CHABs and the related primary producer communities is essential. Here, Lehman and colleagues evaluate the controls on *Microcystis* blooms in 2014 and 2017 (extreme dry and wet, respectively) and provide evidence for low freshwater flows and high water temperature being the most influential drivers of bloom events. Further, the research team asserts that once *Microcystis* is established, it remains persistent even during wet years. This work directly addresses action 5C of the 2022-2026 Science Action Agenda (*Determine how environmental drivers interact to cause harmful algal blooms in the Delta, identify impacts on human and ecosystem health and well-being, and test possible mitigation strategies*.)

IMPACT OF EXTREME WET AND DRY YEARS ON THE PERSISTENCE OF MICROCYSTIS HARMFUL ALGAL BLOOMS IN SAN FRANCISCO ESTUARY

Microcystis is the most common freshwater CHAB that has recently been found throughout estuarine environments, including the Chesapeake Bay, San Francisco Bay, and Neuse River Estuaries in the US. Blooms impact fish health and survival, as well as the community composition of phytoplankton and bacteria. Freshwater CHAB blooms also appear to be increasing with climate change; in the USFE, blooms were nonexistent before 1999. Here, blooms have been shown to vary more with wet and dry conditions compared to nutrient concentrations. In 2011, wet conditions resulted in the near-removal of *Microcystis* from the USFE and a return to pre-bloom conditions, leading to a hypothesis that CHABs are reversible with high flows. On the other hand, 2014, a record dry year in the USFE, featured a *Microcystis* bloom 13-76% larger than all previous years. These observations inspired the study by Lehman and colleagues, which sought to elucidate how

Microcystis abundance and its controls vary from extreme dry to extreme wet years, using 2014 and 2017 as the focal years.

Out of 20 possible environmental controls on *Microcystis* abundance (including temperature, nutrients, oxygen, salinity, and flow metrics), analyses showed that the most influential predictors were the X2 index (a measure of how far into the Delta that salinity intrudes, primarily sensitive to Delta outflows) and water temperature. Namely, *Microcystis* increased in abundance with higher temperature and lower flows, and together these two controls explained 58-78% of the variability in bloom surface biovolume or subsurface abundance in statistical models. In contrast to the initial hypothesis, despite high streamflow in 2017, *Microcystis* was not removed from the USFE. However, the bloom was smaller, initiated later, had a shorter duration, and produced fewer toxins. Lehman and colleagues concluded that once *Microcystis* is established during dry years, seed material is retained in the estuary, and blooms will likely persist during subsequent wet years as long as water temperature and other water quality factors are favorable.

This article is relevant to the Council's work because it suggests that in scenario-based tradeoff analyses, X2 and water temperature—two easily predictable quantities from models—are predictive of CHAB abundance. Likewise, it suggests that any actions that increase X2 may result in a substantial increase in CHABs; in 2014-2015, an increase in X2 of just 3 km was associated with a threefold increase in *Microcystis*. This work is not predictive of blooms at specific times or locations within the Delta (i.e., Science Action Agenda action 2B). Still, it does suggest that a monitoring program for CHABs (i.e., the objective of the Science Program's November 2022 HABs workshop) should include, at a minimum, collection of data on water temperature and flows.

DELTA SCIENCE PROGRAM ACTIVITIES

Science for Communities Workshop

Work to further community-engaged science approaches is also taking place via an in-person Science for Communities **workshop** that will be held on Oct. 6th from 3-7 pm at the Big Break Visitors Center in Oakley, CA. This free public workshop aims to foster opportunities for scientists to contribute to communities and communities to contribute to science. The goal is to boost the Sacramento-San Joaquin Delta community's awareness of and access to the environmental data and technical tools that are available to them, as well as to boost scientists' awareness of the

community's priority needs for science. This workshop will showcase the collaborations formed between science and community partners to meet important Delta issues with data-driven solutions.

At the event, Chair Virginia Madueno will be the plenary speaker. There will be panel discussions from California Indian Environmental Alliance, Sacramento Regional Coalition to End Homelessness, Sustain Our Abilities, Public Health Advocates, Restore the Delta, and Little Manila Rising. They will discuss their partnerships with academic and agency scientists to address important topics, including harmful algal blooms and climate change impacts on underrepresented communities. Registration began at the end of August and information on how to register was distributed through the DSC listserv and other channels.

Social Science Community of Practice: Advancing Interdisciplinary Research Symposium

This fall, work continues towards integrating the Bay-Delta Social Science Community of Practice into the Delta science landscape, by hosting a two-part "Advancing Interdisciplinary Research" event. The first part, on October 14th, will provide training social science disciplines and methodologies and will highlight case-studies of how interdisciplinary approaches have been applied to social-ecological challenges elsewhere. The second part, on October 20th, will be an interactive workshop in which social and natural scientists will be paired to co-develop mock proposals for interdisciplinary research projects that support the 2022-2026 Science Action Agenda. Both events will be free to register and held online, with an optional in-person networking event hosted in Sacramento in the late afternoon on Oct 20th. Registration links and additional event details are now on the Council's social science webpage.

Delta Salinity Management Workshop Series

The Delta Salinity Management Workshops, a two-part series spanning 2022-2023 that kicked off with an April 2022 workshop, aims to develop a collaborative, scenario-based strategy for salinity management planning in the face of extended drought and sea-level rise. In the period between the two workshops, the workshop planning team (a multi-stakeholder group convened by the Delta Science Program) is working with a modeling team to develop a demonstration scenario-based exercise to compare nature-based and traditional engineering salinity management alternatives and to develop new modeling tools specific to drought and sea-level rise conditions. On August 30, the modeling team met with a technical-focused working group of participants from Delta water agencies and irrigation districts to

seek technical feedback on the proposed demonstration exercise. A second, more general focus group meeting will be advertised for later this fall.

Finally, the workshop planning team convened a separate social science team, composed of a diverse group of stakeholders, to evaluate the human dimensions of salinity management. This group met for the first time in mid-August. It will contribute to ongoing efforts to develop new models and tools to assess future salinity scenarios likely to impact the Delta and explore potential management solutions.

ON YOUR RADAR

Heterosigma okashiwo HAB Event

Starting in late July/early August of 2022, a bloom of *Heterosigma okashiwo* was detected in the San Francisco Bay, near Alameda/Oakland. The bloom is a non-cyanotoxin HAB event, with toxicity impacts on fish and potentially other wildlife, with a potential for depletion of water-column dissolved oxygen. By mid-August, the bloom expanded over large swaths of the South Bay, with evidence that it may be expanding into the Central Bay and possibly San Pablo Bay. Scientists with the US Geological Survey, California Water Science Center, and San Francisco Estuary Institute are currently monitoring the bloom's progress and keeping the Delta Science Program apprised. Although blooms of this organism have been observed previously in the San Francisco Estuary (SFE), their frequency has been rare (about 2 out of every 30 years) and of a smaller extent than the current bloom. The trigger for this year's bloom is unknown, but the combination of elevated nutrients within the Bay, warm temperatures, and long residence times have been hypothesized to play a major role. Questions about whether the bloom may migrate into the Suisun Bay and the extent to which elevated nutrients have contributed underscore the need for an integrated approach to HABs monitoring and analysis across the entire SFE. The Delta Science Program is contributing to the collection of data on the fish kill associated with the bloom event.

One of the ways in which the Science Program funds work responsive to the Science Action Agenda is through directed actions. Directed actions fund urgent, important scientific work outside of the regular Public Solicitation Notice (PSN) cycle that must meet one of the following criteria: 1) responsive to rapidly developing or rapidly changing conditions, 2) responsive to priorities of collaborative groups/workshops, 3) advances new techniques or new technology that may still be experimental in nature, 4) helps promote diversity, equity, and inclusivity in Delta

science. All directed actions undergo peer review by three independent reviewers prior to a decision by the Lead Scientist to fund the work.

Starting with this month, pending directed action awards will be featured in the Lead Scientist's report. Four directed actions are currently pending.

Delta social-environmental science data integration

Currently, social science data for the Delta resides in disparate locations, can be difficult to find or not publicly available, and is not inherently compatible with environmental data. These realities serve as barriers to projects that integrate social science with biological and physical science. This directed action would fund a team at the US Geological Survey, San Francisco Estuary Institute, and Sacramento State to locate and gather relevant social science data and create a searchable catalog that provides social science data in a format compatible with other environmental datasets. The team will hold a stakeholder workshop to orient users to the social science data catalog, solicit feedback, and make improvements. To demonstrate how the new data formatting can foster connections and answer research questions, they will also produce a synthesis manuscript which utilizes combined environmental and social science data. This work, done in partnership with the Social Science Community of Practice, will help implement the Social Science Task Force report and Social Science Integration Team Action Plan, as well as advance SAA actions 1A "Establish publicly accessible repositories, interactive platforms [...] in support of timely decision-making and collaborative efforts" and 3B "Develop integrated frameworks, data visualization tools, and models of the Delta system."

Salinity Management Workshop Series demonstration exercise

An integral part of the Salinity Management Workshop Series is a demonstration exercise that will help identify key knowledge and resource gaps for evaluating tradeoffs of future salinity management scenarios and stimulate meaningful discussion about how to evaluate those scenarios. To do so, the demonstration exercise will simulate how a limited subset of alternative management scenarios—including a drought barrier, wetland restoration, and potentially regulatory changes—impact salinity under future sea-level rise and extended drought. The combination of structural alterations to the Delta and sea-level rise will have complex three-dimensional effects on the way that salinity is distributed through the Delta. Robustly simulating these effects requires large amounts of computational time, which has served as a barrier in tradeoff analyses. In this work,

the modelers will use artificial intelligence to "learn" from the three-dimensional simulations to create a computationally efficient but physically robust "shortcut" to relate future salinity to inflows. This new computational tool, which will be made openly available, will enable a wide range of future scenarios for Delta salinity management to be evaluated. It will be implemented for the set of scenarios that will be evaluated in the demonstration exercise. These scenarios are currently being vetted through a series of technical working groups. The project is responsive to SAA action 6B "Evaluate [...] impacts and tradeoffs of drought management actions on ecological and human communities."

Evaluating the impacts of fire retardants on Chinook Salmon and Rainbow Trout

Phos-Chek is a new, widely used fire retardant with poorly understood effects on aquatic life. This project evaluates the lethal and sublethal toxicity of Phos-Chek and other fire retardants on Chinook Salmon and rainbow trout, with the intention of developing new regulatory standards of LC50 ("Lethal concentration," which causes death of half of test animals) and EC50 ("Half Maximal Effective Concentration," which is the concentration that causes half of the maximum possible sublethal effect or response). This work is supported by the Interagency Ecological Program Contaminants Project Work Team and is responsive to the severe fire season that is developing. It contributes to SAA actions 5A "Identify environmental thresholds [...] and strategies that will support species recovery" and 5D "Quantify spatial and temporal 'hotspots' of chemical contaminants and evaluate ecosystem effects."

Refining strategies for applying Early Detection and Rapid Response (EDRR) for eradicating invasive species, using a case study involving ribbon weed

For the control of invasive species, prevention of new invasions is considered the best defense, but having a plan for Early Detection and Rapid Response (EDRR) for new invaders is a paramount secondary defense. The goal of an EDRR strategy is to eradicate or limit the spread of new species before they proliferate to the extent that they become uncontrollable. In their biennial Delta Invasive Species workshop, held in December 2021, The Delta Interagency Invasive Species Coordination Team identified establishment of an EDRR strategy for the Delta as a priority. This project, led by CSU Long Beach and the Delta Conservancy, will evaluate and test an EDRR framework using ribbon weed, a submerged aquatic weed that recently invaded the Delta, as a case study. It addresses SAA actions 3E "Conduct applied [...] research [...] to inform EDRR strategies" and 5A "Identify and test innovative methods for control and management of invasive aquatic vegetation."

BY THE NUMBERS

Delta Science Program's summary of current numbers related to Delta water and environmental management (Attachment 1) provides information on recent counts, measurements, and monitoring figures driving water and environmental management issues.

LIST OF ATTACHMENTS

Attachment 1: By the Numbers Summary (provided at the Council Meeting)

Attachment 2: Article Visual of Lehman et. al., 2022

Attachment 3: Adult Sturgeon Mortality and Life History in the San Francisco Estuary

Attachment 4: Sturgeon Carcass Reporting

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