980 Ninth Street, Suite 1500
Sacramento, CA 95814
www.deltacouncil.ca.gov

Lead Scientist's Report

Summary: This report covers six items:

Collaborative Science Activities: (1) Preview of the Bay-Delta Science Conference;

Science Communication: (2) Summary of a journal article on atmospheric rivers and climate change; (3) One synthesis article from the *San Francisco Estuary and Watershed Science* (*SFEWS*) journal on climate change and the Delta; (4) Brown Bag seminar on nutrients; (5) One poster from the New York Scientific Data Summit on an open environmental data system; and (6) the "By the Numbers" summary.

Collaborative Science Activities

Preview of the 9th Biennial Bay-Delta Science Conference

The Bay-Delta Science Conference will be held at the Sacramento Convention Center Nov. 15-17. The biennial Bay-Delta Science Conference is a forum for presenting technical analyses and results relevant to the Delta Science Program's mission to provide the best possible, unbiased, science-based information for water and environmental decision-making in the Bay-Delta system. The conference program will feature oral and poster presentations, organized within topical sessions. The theme of this year's conference is "Science for Solutions: Linking Data and Decisions."

The three-day conference will kick off on the morning of Tuesday, Nov. 15 with the opening plenary session. Invited plenary speakers from outside the Delta include Dr. Steve Gaines (UC Santa Barbara) speaking on "The Future of Food from the Sea" and Dr. Daniel Schindler (University of Washington) speaking on "Challenges of Establishing Appropriate Baselines for Watershed Restoration."

Additional plenary speakers include Dr. Peter Moyle, Felicia Marcus, former Council member Phil Isenberg, and Delta Science Program Lead Scientist Dr. Cliff Dahm. Dr. Moyle will address how academic research has vastly improved knowledge of the Delta. Ms. Marcus will describe how the State Water Resources Control Board incorporates science into decision-making. Mr. Isenberg's "Guide for the Perplexed" will enlighten us about why good scientific work is sometimes ignored. Dr. Dahm will close with a discussion of possible future directions for Delta science.

Special events at the Conference include:

- Town Hall Meeting (Nov. 16) – A fun and interactive session led by Delta Science Program staff to gather community input for the 2017 Science Action Agenda.

- The Art of Data Visualization (Nov. 15-17) – Art exhibition and an organized panel discussion exploring how art and science can work together to increase awareness of estuarine ecology.

Sessions of interest:

- Communicating complex science to multiple audiences
    - Lost in Translation: The Art of Interpreting Complex Science for Policymakers (Nov. 16) – A panel discussion between authors of chapters in *The State of Bay-Delta Science, 2016* and policymakers grappling with decisions related to each author's chapter.
    - Collaborative Science and Adaptive Management Program (CSAMP): Moving from Litigation to Collaboration (Nov. 17) – Presentation of the history of CSAMP, and funded studies through CSAMP of adult delta smelt entrainment and movement, juvenile salmonid survival in the Delta, and recommendations for future investigations.

- Adaptive Management
    - Integrated Scientific Approaches for Adaptive Management of Invasive Aquatic Plants in the Delta (Nov. 16)
    - Adaptive Management in the Delta: Learning from Habitat Projects (Nov. 16) – Discussion of current habitat restoration projections, and an overview of large scale spatial data initiatives that can contribute to adaptive management at the project, regional, and Delta-wide scales.

- Perspectives and approaches to increase understanding of the Delta ecosystem
    - Re-Envisioning the Delta with New Knowledge from the Past (Nov. 15) – Bringing together scientists and managers to present recent advances in the Delta's historical ecology, and its application to inform the Delta Conservation Framework and other restoration work.
    - CASCaDE II: Computational Assessments of Scenarios of Change for the Delta Ecosystem (Nov. 16) – An overview of this USGS-led modeling effort assessing the responses of watershed flows, sediment, water temperatures, meteorological forcings, and sea level to scenarios of climate change.
    - Progress in Floodplain Ecology: Lessons from Yolo Bypass and other Central Valley Floodplains (Nov. 17) – Addressing the beneficial role of floodplain habitat to the aquatic food web and native fishes.
    - Delta as an Evolving Place (Nov. 17) – Discussion of the socioeconomic challenges and opportunities that must be addressed to ensure that proposed ecosystem and infrastructure projects enhance the Delta's character and heritage.

- Improving Habitat Along Delta Levees (Nov. 17) – A presentation describing the recently released report from the Council, which provides guidance on how levee investments can also contribute to long-term improvement of river corridors.

For more information, please see the Bay-Delta Science Conference website (http://scienceconf2016.deltacouncil.ca.gov/), and a press "tip sheet" highlighting potentially newsworthy conference sessions (Attachment 1 – to be provided at the Council meeting).

Science Communication

Atmospheric river landfall-latitude changes in future climate simulations

Christine A. Shields and Jeffrey T. Kiehl. National Center for Atmospheric Research, Colorado. August 2016. Geophysical Research Letters 43:8775-8782.

Atmospheric rivers (ARs) are a double-edged sword for California. They are a major source for our water supply and the main mechanism for devastating floods. A large part of our water supply in California comes from a limited number of storms. This strongly seasonal pattern of precipitation is fundamental for the delivery, storage, and transport of our water supply. ARs are long, narrow, "rivers in the sky" made up of large quantities of water vapor in the lower atmosphere that originate in the subtropical oceans of the world. The moisture in ARs, combined with strong winds, can cause severe rain at lower elevations and heavy snowfall at higher elevations when they hit land. ARs play a major role in the global water cycle, and they are major mechanisms for transporting evaporated water from the subtropics to temperate regions throughout the Earth.

Given the impact of ARs, scientists are researching how they may be affected by climate change. Previous research has looked into this question, with variable conclusions. The majority of these earlier studies suggest a world with more ARs. Yet, the general location and intensity of the resulting precipitation in the temperate zones remain in question.

In a research article published in Aug. 2016, scientists at the National Center for Atmospheric Research (NCAR) used updated computer models to evaluate how changes in the atmosphere under future climate simulations might affect ARs. The NCAR researchers project that further global warming will lead to increased numbers of ARs in Southern California. The ARs also will have greater intensity of precipitation. At the same time, the study projects a decrease in AR storms in Northern California and the Pacific Northwest. In summary, under the global warming scenarios explored in this study, ARs are projected to produce more rainfall in Southern California and less rainfall and snowfall in Northern California. Cool season precipitation is projected to move towards the equator in California in a warmer world.

2016 Volume 14 Issue 3 of the *SFEWS* Journal: Special Section on the State of Bay-Delta Science

SFEWS is an open access journal, funded by the Council, and is a key venue for publishing the latest research addressing Delta scientific questions. The current issue of the *SFEWS* journal includes a special edition section that is also the second part of the State of Bay-Delta Science (SBDS). The next issue of the journal will include the rest of the SBDS papers.

SBDS is a synthesis of the best available science about the Delta, emphasizing progress made on key research questions and remaining knowledge gaps. SBDS was initiated by the Delta Science Program and is managed by Delta Science Program staff. The first edition of SBDS, edited by CALFED Bay-Delta Program lead scientist Michael Healey, Michael Dettinger of the U.S. Geological Survey and Scripps Institution of Oceanography, and Richard Norgaard of the UC Berkeley was published in 2008. Topics for this edition of SBDS address the most relevant scientific issues for the Delta identified by senior scientists and managers. One article from the SBDS 2016 Special Issue, Part 2, is summarized below.

Climate change and the Delta
Mike Dettinger, Jamie Anderson, Michael Anderson, Larry Brown, Daniel Cayan, Ed Maurer

Anthropogenic climate change poses a substantial threat to the management of the water supply and ecosystems in the Sacramento-San Joaquin Delta. The water management system in California is one of the largest and most complex in the world, a consequence of the very high natural variability (both in space and time) of available water resources. The associated massive machinery and largely successful management of this wildly variable hydrological and climatic system provides some optimism that the Delta will be able to withstand and adapt to a changing climate.

Climate change, however, remains a serious challenge to management and ecological systems, with success dependent on understanding the specific effects of climate change and applying this understanding to decision-making. Moreover, different levels of uncertainty accompany different aspects of our current understanding.

Dettinger and colleagues review the current state of knowledge regarding climate change as it relates to the Delta, focusing on temperature, flood and drought risk, and sea level rise. The authors describe a projected 2°C average increase in temperatures above late-20th century averages by the middle of the century and a nearly 4°C average increase by the end of the century. The confidence surrounding these temperature projections is high. In contrast, projections of precipitation are more uncertain, because some models predict wetter conditions while others predict drier conditions for the Delta.

Despite these disagreements on the amount of precipitation, when storms happen, they will bring more precipitation as rain and less as snow. More concentrated rainfall coupled with higher temperatures and higher evaporation and transpiration rates suggest that climate change will likely bring both increased flood and drought risks. Sea level rise is also a concern with projections for a three-fold increase in the rate of sea level rise. For subsided Delta islands, the increase in sea level poses serious threats. Corresponding ecosystem risks in the Delta include increased salinity intrusion and breaching of levees. The effects of climate change on ecosystems and water resource

management remain uncertain, although new conditions will undoubtedly favor invasive species and stress native ones.

The authors also describe environmental changes that are already being observed and will continue. These include earlier snowmelt, stream flows that are more driven by storms than snowmelt, and longer summers at warmer temperatures. All can be traced to anthropogenic climate change. To address and prepare for these wide-ranging effects, Delta scientists and resource managers will need to focus on increasing understanding of extreme events and the thresholds beyond which management approaches will fundamentally need to change. Meeting these goals will require sustained investments in research and monitoring of past and current conditions, as well as flexibility to address unforeseen changes.

Brown Bag Seminar – <u>Delta Nutrients: Sources, Sinks, Sags, Soups, and Sensors</u>

Increasing clarity of waters, the emergence of harmful algal blooms, the proliferation of aquatic water weeds, and altered food webs have brought the issue of nutrient dynamics to the forefront in the Delta. Nutrients, such as nitrogen (e.g., ammonium and nitrate) and phosphorus can be beneficial or detrimental to water systems, depending on the type and levels of input. In the right amounts, nutrients can promote healthy plant and animal growth. High levels of nutrients, however, can cause water quality concerns and negatively alter the food web.

Dr. Cliff Dahm, Lead Scientist for the Delta Science Program, has spent his career studying nutrient biogeochemistry in aquatic ecosystems. In this Brown Bag Seminar, he discussed five research areas for nutrients within the Delta – sources, sinks, sags, soups, and sensors – weaving in insights from past studies.

Dr. Dahm began by noting that despite higher nutrient concentrations in the San Joaquin River, the much greater volume of water flowing from the Sacramento River into the Delta results in the Sacramento being a particularly important source of the Delta's nutrients. Fortunately, the quantity of nutrients entering the Central Valley has reduced over time, due in part to the implementation of Best Management Processes for pesticides. Once released from their sources, where the nutrients end up (sinks), the nutrients can be tracked with stable isotope tracers, which provide a signature ratio of heavy to lighter forms of an element (e.g., $^{15}N/^{14}N$).

Dr. Dahm suggested that aquatic plants, and increasingly aquatic weeds, likely make up a large proportion of the nutrient sinks in the Delta. The discussion of 'soups' focused on algal blooms, both beneficial and harmful. Dr. Dahm described two occurrences of soups this past summer. First, release of water over the Yolo Bypass by Department of Water Resources scientists led to a measurable increase in algae at the base of the Delta food web. Such strategic uses of flow could potentially provide additional food for species of concern, like delta smelt. Second, the proliferation of cyanobacterial harmful algal blooms (a bad kind of soup) were particularly pronounced in the southern Delta this year, demonstrating the increasing need to study such events.

For the final two topics of his talk, Dr. Dahm provided overviews of approaches to continue studying how nutrients cycle. Comparing sags (changes) in the production and fate of gases and nutrients, such as oxygen produced through photosynthesis and nitrogen assimilated into tissue, provides another means to understand where nutrients end up (e.g., algae, aquatic plants, decaying vegetation, sediments). Today's advances in sensor technology allow continuous sampling of nutrients, temperature, and water quality, providing a more complete profile of the state of the ecosystem. Many sensors are currently deployed in the Delta, and will provide a strong basis for assessing shifts in nutrients and biological processes as the Sacramento Regional Wastewater Treatment Plant (a major source of ammonium in the Delta) is upgraded by 2021.

Poster Summary from the 2016 New York Scientific Data Summit

The following poster, presented at the 2016 New York Scientific Data Summit, focuses on a shared environmental data system for California.

Enhancing the Vision for Managing California's Environmental Information

The passage of Assembly Bill 1755 (D-Dodd; The Open and Transparent Water Data Act) on Sept. 23, 2016, required that California State agencies create a statewide data information system to integrate critical water and ecological data into a user friendly, publicly accessible website. Such a data system seeks to improve transparent access to important water and other ecological resource data.

The Delta Reform Act of 2009 requires the development, adoption, and implementation of a comprehensive resource management plan for the Delta. To fulfill this requirement, the Council has been taking a leadership role to establish a vision for an open data system for environmental information, which could be used to make AB 1755 a reality. The current state of California's data science and vision for the future was the subject of a poster presented by staff scientist George Isaac at the 2016 New York Scientific Data Summit conference, in collaboration with co-authors Tony Hale and Peter Goodwin.

The poster describes the convening of the Environmental Data Summit (EDS) in 2014 to bring together scientists, resource managers, decision makers, academia, stakeholders, and interested citizens to formulate recommendations for a new era in information management. The summit shed light on the great challenges associated with the use of disparate, large-scale, diverse, and high-resolution data sets that must be addressed to support complex decision-making. The identified challenges include an active data stewardship program, data visualization, and a sustainable business model.

These challenges and the recommended solutions were captured in *Enhancing the Vision for Managing California's Environmental Information*, a white paper synopsis of the lessons learned at EDS. An active data stewardship program includes the management and oversite of data assets to help data users discover, access, supply, and use data in a consistent manner. Supporting the

stewardship program requires open source software that integrates data from disparate sources, consistent with data standards. Once integrated, data can be visualized by the data manager in a transparent way that conveys the most meaning in the simplest way possible. Finally, developing a successful open source data system will necessitate a sustainable business model with stable investments and a framework built on partnerships with multiple agencies and non-governmental organizations.

By the Numbers

Delta Science Program staff will give a summary of current numbers related to Delta water and environmental management. The summary (Attachment 2) will inform the Council of recent counts, measurements, and monitoring figures driving water and environmental management issues within the Delta and the Delta catchment.

List of Attachments

Attachment 1: 2016 Bay-Delta Science Conference Tip Sheet *(report to be provided at the Council Meeting)*
Attachment 2: By the Numbers Summary *(report to be provided at the Council Meeting)*

Contact

Dr. Cliff Dahm Phone: (916) 445-0463
Lead Scientist