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Lead Scientist's Report

Summary: This report covers 7 items:

Collaborative Science Activities: (1) Sacramento River Temperature Modeling (SRTM) Workshop; (2) Delta Independent Science Board Meeting on levee hazards;

Science Communication: (3) Summary of a journal article on deep groundwater in California; (4) Brown bag seminar on Chinook Salmon growth on inundated floodplains; (5) Research articles from San Francisco Estuary and Watershed Science (SFEWS) Journal on the State of Bay-Delta Science (SBDS) and on factors affecting an invasive predator of Delta Smelt; (6) One poster from the Interagency Ecological Program (IEP) workshop, and; (7) the "By the Numbers" summary.

Collaborative Science Activities

Sacramento River Temperature Modeling Workshop

Delta Science Program staff convened a two-day workshop July 11-12 to provide a broader understanding of the way temperature-related management decisions are made for the Sacramento River. The workshop trained members of the Sacramento River Temperature Task Group and affiliated staff on the U.S. Bureau of Reclamation's (USBR) SRTM and provided a general overview of the model. The SRTM is used to develop temperature operation plans on the Sacramento River. The morning of the first day was open to the public and provided general and technical overviews of the model and operational constraints compatible with USBR procedures. The remaining day-and-a-half consisted of hands-on training sessions that guided participants through the reproduction of historical scenarios using the SRTM. Training provided members of the Temperature Task Group with the ability to conduct additional, independent modeling of Sacramento River temperatures to inform management decisions surrounding federal water project operations. This workshop was a Delta Plan Interagency Implementation Committee High Impact Science Action.

Delta Independent Science Board Meeting

The Delta Independent Science Board (DISB) convened a meeting at UC Davis on July 14-15 to learn about seismic and high-water hazards to Delta levees. The meeting included talks, poster presentations, and panel discussions of the latest science related to hazards and Delta levees with recommendations for future research needs and opportunities. Recent findings presented at the DISB meeting, based on data from the 2014 Napa earthquake and smaller earthquakes in the Bay Area from 2007 to 2015, indicate that previous Delta ground motion estimates may over-predict seismic hazards. The updated estimates are being considered in the decision-support tool that informs the Delta Levee Investment Strategy. Recommendations from the meeting will also contribute to the Delta Science Program's Science Action Agenda.

Science Communication

Salinity of Deep Groundwater in California: Water Quantity, Quality, and Protection

Mary Kang and Robert B. Jackson, Stanford University, Stanford, CA. Proceedings of the National Academy of Sciences, June 2016.

This recent article investigated the amount and usability of previously undescribed water deep underground in California's Central Valley. New sources of fresh water could provide needed relief to drought-stricken California, making this a high profile research article. The results, however, do not suggest that this water should be considered as an immediate source for agriculture or drinking water.

Previous estimates of the amount of groundwater in California are decades old, and based on a maximum depth of 300 meters (~1,000 feet) underground. For the first time, scientists estimated the quantity and quality of water from 300 to 3,000 meters (~10,000 feet) underground. The estimates are based on analyses of public records collected from gas and oil industries' drilling operations.

The results show that aquifers in the Central Valley contain three to four times the amount of usable water than previously thought. This is an important finding with implications for California's water supply. The results, however, should be interpreted with an understanding of the limitations of this water source: salinity, accessibility, and contamination.

Much of the water identified contains dissolved salt and other contaminants at levels not suitable for drinking or agricultural use without treatment. The depths of the reservoirs present another significant challenge. Drilling wells and pumping out water from 1,000-3,000 meters below the ground is expensive. Extracting groundwater can also lead to undesirable outcomes such as subsidence. Additionally, significant oil and gas activities have occurred (or do occur) in regions where much of the usable water is located making it vulnerable to contamination.

This article is the first description of the vast amounts of deep groundwater in California. The findings represent a critical first step in understanding a potential source for water. To determine the feasibility of using this water, further groundwater monitoring is needed, especially in regions with oil and gas drilling operations. The economic feasibility of accessing and treating this water to meet drinking water standards and agricultural requirements must also be assessed.

Brown Bag Seminar – Farms as Floodplain: Five Years of Experimental Flooding of Yolo Bypass Ag Land

The Yolo Bypass is one of the Delta Plan's six high-priority habitat restoration areas, and among the largest floodplains on the West Coast. At this June 20 seminar, Lynn Takata from the Department of Water Resources, discussed the Agricultural Floodplain Study, a report that examines how juvenile Chinook Salmon benefit from flooding the

Yolo Bypass. The study began with a pilot project that transported hatchery Chinook juveniles to flooded fields at Knagg's Ranch in 2012 and expanded to ranches in other regions of the Delta over time. Because experiments were conducted during dry years from 2012 through 2015, fields during these years were artificially flooded. This year provided the opportunity to examine the potential consequences for fish of natural "overtopping" onto the Bypass at the Fremont Weir, although flooding events happened late in the season.

Overall, this study showed that:

- Inundated agricultural fields increased juvenile salmon growth and zooplankton production
- Juvenile Chinook preferred deeper waters near areas of water inflow during the day, but often inhabited shallower waters at night
- The condition of the field after the growing season (e.g., rice stubble, stomped, fallow) did not affect salmon growth or survival
- Timing of the flooding matters, such that if flooding occurs too inconsistently or too late, juvenile salmon may not benefit or water quality can be compromised
- Coordination of adaptive research can present challenges when environmental conditions and landowner management decisions are dynamic, necessitating frequent and open communication among participating parties

Future studies aim to better understand if benefits of Yolo Bypass flooding extend to wild-origin Chinook salmon and other fish species, and the extent to which natural flooding events could increase growth rates for salmon.

2016 Volume 14 Issue 2 of the SFEWS Journal: Including Special Section on the State of Bay-Delta Science

San Francisco Estuary and Watershed 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 will also be the first part of the SBDS. The Lead Scientist will give a brief overview of SBDS, and will highlight the papers in this first part of SBDS for the Council.

The SBDS is a synthesis of the best available science about the Delta, emphasizing progress made on key research questions and remaining knowledge gaps. The first edition of SBDS, edited by CALFED Bay-Delta Program lead scientist Michael Healey, Michael Dettinger of the United States Geological Survey and Scripps Institution of Oceanography, and Richard Norgaard of the University of California at Berkeley was published in 2008. Topics for this edition of SBDS address the most relevant scientific issues in the Delta identified by senior scientists and managers. Topical papers cover issues ranging from contaminants in the Delta to levee stability and from Delta food webs to recent discoveries about salmon migration. These topical papers are written for a scientific audience. Two additional papers, one describing the challenges of managing

water and ecosystems in the Delta and another that discusses policy implications of the recent scientific findings, are written for managers and policy-makers.

The first installment of SBDS papers in this edition of the SFEWS Journal are:

- **The State of Bay-Delta Science 2016 — An Introduction**
  Michael Healey, Peter Goodwin, Michael Dettinger, and Richard Norgaard

- **Delta Smelt: Life History and Decline of a Once-Abundant Species in the San Francisco Estuary**
  Peter B. Moyle, Larry R. Brown, John R. Durand, and James A. Hobbs

- **Anadromous Salmonids in the Delta: New Science, 2006–2016**
  Russell W. Perry, Rebecca A. Buchanan, Patricia L. Brandes, Jon R. Burau, and Joshua A. Israel

- **Predation on Fishes in the Sacramento–San Joaquin Delta: Current Knowledge and Future Directions**
  Gary D. Grossman

- **The Delta as Changing Landscapes**
  John Wiens, Letitia Grenier, Robin Grossinger, and Michael Healey

Part one of SBDS is currently available online at http://escholarship.org/uc/jmie_sfews.

2016 Volume 14 Issue 1 of the SFEWS Journal

The March issue of the SFEWS Journal is available online in the archives. This edition included one essay and five research papers. One of these five articles is highlighted here.

> **Abundance Trends, Distribution, and Habitat Associations of the Invasive Mississippi Silverside (*Menidia audens*) in the Sacramento-San Joaquin Delta, California, USA**
> *Mahardja, Brian; Conrad, J. Louise; Lusher, Lester; Schreier, Brian M.*
>
> Abundances of the Mississippi Silverside, an invasive fish, greatly increased at the same time as a notable decline in several fish species during the early 2000's, including Delta Smelt (the Pelagic Organism Decline; POD). The Mississippi Silverside is a predator on the early life stages of Delta Smelt, and has been identified as a possible factor contributing to the decline of the species. Despite its potentially significant impacts on Delta Smelt, the life history and habitat associations of the Mississippi Silverside are not well known. In this study, researchers from the Department of Water Resources and UC Davis examined the changes in Silverside abundances over time, and occurrence in relation to habitat and seasonal factors. Based on 19 years of survey data, they found an overall increase in the number of Mississippi Silversides caught, particularly in the western Delta region during the time of the POD. Several

habitat factors were also associated with the presence of the predator, including higher water temperatures and turbidity, moderate to high dissolved oxygen levels, and lower salinity levels. Analyses of seasonal factors suggested that higher summer freshwater inflow and spring water exports from the Delta were correlated with reduced numbers of Silversides. With the exception of increased water temperature, many of the habitat factors overlap with those of Delta Smelt. While the increase in Mississippi Silversides clearly coincided with the decline in Delta Smelt, further investigations are needed to determine if or to what extent this caused a reduction in populations of the endangered fish.

Poster Summary from the 2016 Interagency Ecological Program (IEP) Workshop

The following poster, presented at the 2016 IEP meeting, is based upon a report by Novick et al. (2015) that was partially funded by the Delta Science Program.

Combined Use of Stable Isotopes and Hydrologic Modeling to Trace Water and Nutrient Sources in the San Joaquin River and Delta
M. Young, C. Kendall, M. Guerin, S. Peek, E. Novick, R. Holleman, T. Jabuch, J. Sun, P. Trowbridge, and D. Senn.

Excess nitrogen from agriculture and wastewater treatment enters into Delta waterways and can cause harmful algal blooms and low dissolved oxygen, which in turn negatively affects sensitive species. Megan Young and colleagues from USGS, Resource Management Associates, and San Francisco Estuary Institute (SFEI) examined the potential sources of nitrogen and factors contributing to cycling of the nutrient within the Stockton Deepwater Ship Channel. Samples were collected from sites throughout the San Francisco Bay-Delta estuary and San Joaquin watershed during several large-scale monitoring programs. Using hydrologic modeling along with nitrogen markers, Young and colleagues describe a technique for tracing the sources of nitrogen from water samples. This approach can be used in many cases to determine the origin of the nitrogen, although some sources (e.g., fertilizer and soil, or animal and human wastes) could not be cleanly distinguished from each other. The specific body of water from which the nitrogen source is derived (San Joaquin River or Sacramento River) could be determined using the nitrogen marker. The authors observed a clear response in the nitrogen marker where the Sacramento River physically mixed with the San Joaquin River in the Stockton Deepwater Ship Channel. The strong fertilizer marker in the San Joaquin can be differentiated from the strong wastewater effluent marker in the Sacramento, and the mixing zone between the two rivers can be clearly seen.

By the Numbers
Delta Science Program staff will give a summary of current numbers related to Delta water and environmental management. The summary (Attachment 1) 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: By the Numbers Summary *(Report to be provided at the Council Meeting)*

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