INFORMATION ITEM

Delta Science Program Scientific Synthesis Efforts

Summary

Delta Science Program staff will present updates on two major scientific synthesis efforts coordinated by the Delta Science Program: the latest edition of the State of Bay-Delta Science, and synthesis working groups organized in collaboration with the National Center for Ecological Analysis and Synthesis (NCEAS). For this presentation, staff will provide an overview of the role synthesis plays in supporting water and environmental management and then share how each of these projects make unique contributions to support the advancement of our understanding of the Bay-Delta.

Background

The Sacramento-San Joaquin Delta is one of the most studied ecosystems in the world[1], but the information and data gathered through research are often siloed, sequestered to specific databases or institutions. One of the Delta Science Program's core functions is to lead and facilitate scientific "synthesis" (derived from the Greek word *syntithenai*, meaning 'to put together'), which refers to putting together existing information or data to generate new analyses and scientific insights. Rather than collecting new data from the field or lab, synthesis offers the ability to unleash new insights from the wealth of data that already exists.

Synthesis can include:

- performing literature reviews to distill major takeaways from several independent reports or publications.

[1] Luoma, S. N, Dahm, C. N, Healey, M., & Moore, J. N. (2015). Challenges Facing the Sacramento–San Joaquin Delta: Complex, Chaotic, or Simply Cantankerous? *San Francisco Estuary and Watershed Science*, 13(3). doi:https://doi.org/10.15447/sfews.2015v13iss3art7 Retrieved from https://escholarship.org/uc/item/3nd0r71d

- performing new statistical analyses on data collected in different ways or by different research efforts; and
- combining data collected by multiple individual studies or monitoring efforts into a single integrated dataset.

Synthesis is a critical component of ecosystem-based management and informed decision-making, both of which are tools for achieving the coequal goals. Previous interagency synthesis efforts in the Delta have had significant impacts on water and fisheries management. For example, a synthesis working group led by leading scientists from the Interagency Ecological Program (IEP) and leveraging long-term monitoring data collected by the IEP is widely recognized for providing critical evidence of the main causes of the declining abundance of several fish species, including Delta smelt, in the mid-2000s. The need for increased capacity, dedicated time, and coordinated synthesis in the San Francisco Estuary is widely recognized and referenced in the Delta Science Plan, Science Action Agenda, and Interagency Ecological Program Science Strategy.

The Delta Science Program leads and coordinates syntheses on key scientific issues important to the management of the Sacramento-San Joaquin Delta. These collaborative efforts aim to update the state of scientific knowledge, guide adaptive management, and identify science needs and data gaps, effectively turning research into future action for managers and scientists working in the Delta. Two recent synthesis efforts led by the Delta Science Program provide specific examples of these different forms of scientific synthesis. The first example is the 2022 State of Bay-Delta Science which synthesizes information from scientific articles and reports, which aims to summarize our understanding of the positive and negative impacts of plants and algae in the Delta. The second example is a synthesis working group coordinated in partnership with the National Center for Ecological Analysis and Synthesis (NCEAS) that combined datasets and statistical analyses to answer questions about food webs in the estuary. Although very different in nature, both synthesis projects provide critical new information for our understanding of major management issues and future science investigations in the Delta.

The State of Bay-Delta Science 2022: Ecosystem services and disservices of plants and algae

The State of Bay-Delta Science is an ongoing synthesis and communication project coordinated by the Delta Science Program. To date, three editions have been produced (in 2008, 2016, and 2022). Each edition contains collections of articles that summarize the scientific understanding, or "state of the science," of various topics relevant to the management of the Bay-Delta system. The effort intends to distill key advances in our understanding and highlight remaining knowledge gaps for science and policy audiences.

For the 2022 edition, seven articles explore how plants and algae affect ecosystems and respond to the management of the estuary and its watershed. While most often recognized for their position in the food web, plants, and algae (i.e., "primary producers") contribute to many areas of critical management interest in the Bay-Delta. Primary producers provide numerous ecosystem services - which ultimately benefit humans - as well as so-called "ecosystem disservices," which negatively affect human communities. Individual articles focus on the contributions of plants and algae to food webs and carbon cycles in ecosystems (e.g., primary production), the ecology and control of invasive aquatic vegetation, harmful algal blooms, carbon sequestration and subsidence reversal by wetlands, and remote sensing methods for quantifying ecosystem services and disservices of Delta primary producers.

All articles for the 2022 edition of the State of Bay-Delta Science will be published in the forthcoming issue of the peer-reviewed and open-access *San Francisco Estuary and Watershed Science* journal (anticipated release in late January or early February 2023). Titles and authors for each of the seven publications are listed below.

1. **Introduction: Ecosystem Services and Disservices of Primary Producers in the Delta** - Laurel Larsen, Sam Bashevkin, Maggie Christman, Louise Conrad, Cliff Dahm, Janet Thompson

2. **Landscape change and variation in invader abundance drive primary production of aquatic vegetation in the Sacramento-San Joaquin Delta** - Katharyn Boyer, Samuel Safran, Shruti Khanna, Melissa Patten

3. **Ecology and ecosystem impacts of aquatic vegetation in the Sacramento-San Joaquin Delta** - Maggie Christman, Shruti Khanna, Judith Drexler, Matthew Young

4. **Management of invasive aquatic vegetation in the Sacramento-San Joaquin Delta and Suisun Marsh: the history and science of control efforts and recommendations for the path forward** - J. Louise Conrad, Madison Thomas, Karen Jetter, John Madsen, Paul Pratt, Patrick Moran, John Takekawa, Gina Skurka Darin, Lydia Kenison

5. **Remote sensing of primary producers in the Delta** - Erin Hestir and Iryna Dronova

6. **Status, trends, and drivers of harmful algal blooms along the freshwater to marine gradient in the San Francisco Bay Delta system** - Raphael Kudela, Meredith Howard, Stephen Monismith, Hans Paerl

7. **Carbon sequestration and subsidence reversal in the Sacramento-San Joaquin Delta: management opportunities for climate mitigation and adaptation** - Lisamarie Windham-Myers, Patty Oikawa, Steve Deverel, Dylan Chapple, Judith Drexler, Dylan Stern

Each edition is developed under the direction and guidance of an interdisciplinary editorial board that includes the Delta Lead Scientist, Delta Science Program staff, and distinguished scientists from the Bay-Delta community. The editorial board identifies topics and invites authors to participate in each edition. While previous editions covered a broad set of topics, forthcoming editions are planned to be released approximately every two years and take a more focused, themed approach, as was done for the 2022 edition.

The 2024 edition is currently underway and will focus on extreme events in the Delta. More information about the effort, including how to access previous editions, is available on the SBDS web page.

Synthesis Working Groups: A Collaboration with the National Center for Ecological Analysis and Synthesis (NCEAS)

Established in Santa Barbara, California, in 1995, the National Center for Ecological Analysis and Synthesis (or NCEAS) is a research center that has become world-renowned for analyzing and synthesizing existing data to address major fundamental issues in ecology and allied fields. NCEAS encourages applying science to natural resource management and public policy decision making.

The Delta Science Program partnered with the NCEAS in the fall of 2021 to lead a collaborative synthesis working group. The synthesis working group had two major goals:

1. to provide high-quality training in data science and statistical techniques to primarily early-career scientists working in the Bay-Delta; and
2. to provide a focused opportunity for enhanced collaboration between scientists from federal and State agencies as well as academic scientists. Training topics include reproducible research and collaboration techniques and statistics relevant to aquatic ecology.

The 2021 working group consisted of 18 participants from nine agencies and universities interested in synthesis projects involving primary productivity, contaminants, connectivity, climate change, growth, floodplains, zooplankton, food web linkages, forecasting, hydrodynamics, and more. Working group participants convened for three weeks of training and collaboration facilitated by experts from NCEAS. Following this working group event, participants performed data analysis and synthesis using their newly developed skills to address questions important to Bay-Delta management.

To date, outputs from this effort include multiple publications, reproducible workflows (e.g., exact records of what was done to a dataset, including analyses, to generate results), statistical software code (e.g., R functions), and integrated data. Products from this working group will inform decision-making for restoration, the protection of endangered fish species, and the management of flow actions. In addition to specific products, this effort has effectively supported the advancement of open science in the Delta by increasing the technical skills of our collaborators, which will have a lasting application to resource management (Science Plan, Action

3.11). Open science is an international movement in science, critical to move from data to useable information and is important for accessibility, inclusion and transparency. More information about these products, including the open science curriculum developed for the working group events, is available on the DSP-NCEAS web page.

Following the success of the first NCEAS collaboration, planning is underway for a second iteration. The next round, to begin in 2023, will focus on integrating and analyzing social, economic, and environmental data to provide insight on issues at the human-environment interface in the San Francisco Estuary. This focus supports the implementation of Management Need 3, "Expand multi-benefit approaches to managing the Delta as a social-ecological system," in the 2022-2026 Science Action Agenda. Future synthesis working groups are anticipated to occur approximately every two years.

Fiscal Information

The Council provided $189,654 to support the participation of editorial board members and several authors of the 2022 State of Bay-Delta Science chapters.

The Council provided $177,407 to the National Center for Ecological Analysis and Synthesis (NCEAS) through a contract with the University of Santa Barbara to support NCEAS staff's participation in the 2021 synthesis working group effort.

List of Attachments

Attachment 1: 2022 State of Bay-Delta Science Information Sheet

Attachment 2: Delta Science Program & NCEAS 2021 Synthesis Working Group

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