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Lead Scientist's Report

Summary: This report includes seven items: (1) summary of one article from San Francisco Estuary and Watershed Science on ecological flow management in the Delta and Sacramento River; (2) summary of one article from Climate and Atmospheric Science on advancements in predicting atmospheric river activity; (3) information about the Delta Science Plan update and summary of the public workshop; (4) overview of the Delta Structured Decision Making pilot effort; (5) summary of State Scientist Day; (6) announcement of a new online educational resource, "The Beginner's Guide to the Delta"; and (7) By the Numbers Report.

Improving Multi-Objective Ecological Flow Management with Flexible Priorities and Turn-Taking: A Case Study from the Sacramento River and Sacramento–San Joaquin Delta. Alexander, Clint A. D.; Poulsen, Frank; Robinson, Donald C. E.; et al. *San Francisco Estuary and Watershed Science*. April 2018.

Management of the Sacramento Delta often requires trade-offs among many potentially conflicting objectives. In such cases, the challenge is not in finding a single optimal solution because it is impossible to optimize many different objectives simultaneously, no matter how clever or sophisticated the methods or models may be. Rather, the challenge is to use management approaches that enable the flexibility and trade-offs needed in real-world scenarios. In this paper, Alexander *et al.* develop and demonstrate a method for allocating water that incorporates multiple objectives: "turn-taking" optimization (TTO). This approach uses models to evaluate and alter management priorities depending on current conditions and the recent history of outcomes. One central idea behind this method is recurrence frequency (RF), which recognizes that most Delta species are adapted to variable flows and thus may not need optimal conditions each year. TTO operates on the concept that if an ecological indicator is achieved for a set amount of time (the RF), the model will not target that indicator for optimization in the immediate future so that other ecological indicators (e.g., habitat quality or spawning success) can "take turns" being prioritized.

This team of researchers applied the TTO approach to multiple hydrologic models that were linked to the Ecological Flows Tool (EFT). The EFT is a decision support tool that evaluates how different aspects of flow affect habitat conditions for 15 species and 31 indicators. The researchers used the EFT to compare the TTO method to a reference case scenario based on current management practices, and they found that 12 of the ecological flow indicators improved, 14 did not change, and five worsened under the TTO approach. Performance for individual species improved for four, did not change in four, and worsened for one species. The exploratory study demonstrates the value of these new tools and analysis methods, and it highlights that management approaches that account for shifting priorities across years via "turn-taking" could lead to broader benefits across multiple objectives.

Skillful Empirical Subseasonal Prediction of Landfalling Atmospheric River Activity using the Madden–Julian Oscillation and Quasi-Biennial Oscillation. Mundhenk, Bryan D.; Barnes, Elizabeth A.; Maloney, Eric D.; and Baggett, Cory F. *Climate and Atmospheric Science (Nature Partner Journals)*. February 2018.

Atmospheric rivers (ARs) are narrow plumes of water vapor that move atmospheric water from the tropics to our region; they are important meteorological phenomena affecting precipitation along the west coast of North America. When ARs reach land, the moisture within them cools and becomes precipitation. California, in particular, receives about 40 percent of its average annual precipitation from ARs. In a given year, a high or low frequency of ARs that reach the coast could result in periods of either flooding or drought, respectively. Although ARs impact many social sectors (e.g., agriculture, energy production, resource management, insurance), traditional forecasting techniques currently provide little guidance on abnormal AR activity within a "subseasonal" time scale (i.e., 2–5 weeks). However, subseasonal predictions would be very valuable for managing the risks of potentially extreme conditions due to ARs—for example, water resource managers could better control reservoir levels and farmers could modify their water use and planting schedules based on reliable predictions of events on this time scale.

In this study, Dr. Mundhenk and colleagues from Colorado State University predicted AR activity within the 2–5 week time scale using information from two large-scale tropical climate cycles: the Madden–Julian oscillation (MJO) and the Quasi-biennial oscillation (QBO). These two climate cycles operate on different time scales, but both are key factors affecting atmospheric patterns in the tropics, with far-reaching effects on weather in higher latitudes. While the general relationship between the MJO and ARs has been known for some time, the authors used insight from interactions between the two oscillations to make their predictions. The authors found that their analysis performed well in predicting abnormal AR activity (both periods with highly active AR events and those with abnormally low AR activity) within a 2–5 week period—better, in fact, than state-of-the-art weather prediction models, which typically focus on predictions on a 1–2 week period. They assert that their results will benefit decision makers and multiple sectors of society along the west coast of North America, given the extensive impacts associated with ARs.

Delta Science Plan update and public workshop

The Delta Science Program is leading the five-year review and update of the Delta Science Plan. Originally completed in November 2013, the Delta Science Plan fulfills a recommendation in the Delta Plan (GR 1) to address the need for collaborative approaches to develop and communicate scientific knowledge that informs policy, management, and the public. The Delta Science Plan is intended to be a guidance document that is shared across the Delta science community, and it includes mechanisms to promote open and transparent science that supports the many programs addressing Delta issues. The goals of this first comprehensive review and update are to incorporate new concepts that reflect the current science, management,

and policy landscape of the Delta; identify what has been accomplished under the original Delta Science Plan; and recognize how science in the Delta has advanced since the document's release in 2013.

Since January 2018, the Delta Science Program has been conducting outreach to collaborative science groups in the Delta (*e.g.*, Delta Regional Monitoring Program, Collaborative Adaptive Management Team, Interagency Ecological Program) to receive early input on the overall update of the Delta Science Plan. On April 6, 2018, a public workshop was held in Sacramento to receive more focused input on the different topic areas within the Plan. A total of 56 participants attended, representing 28 different entities. The workshop consisted of a networking icebreaker to provide information towards understanding the complex networks of agencies and other organizations engaged in Delta science, topic-specific breakout sessions, and a group discussion. The breakout sessions addressed topics that are integral to the update of the Plan, including policy-science interactions, data organization and accessibility, and science communication and synthesis. In the breakout sessions, participants provided feedback on a preliminary draft of the updated Plan, including whether the current purpose, objectives, and vision of the Delta Science Plan met their expectations, and how they were willing to support the Delta Science Plan. A summary of the comments and feedback received can be found here: http://deltacouncil.ca.gov/docs/delta-science-plan/2018-delta-science-plan-review-and-update-public-workshop-summary-april-6

Delta Structured Decision Making update

In April 2017, the US Bureau of Reclamation (Reclamation) approached the Delta Science Program with a request for assistance in facilitating a pilot effort to explore the use of Structure Decision Making (SDM) in the Delta. Reclamation has been successful using SDM to prioritize resource use through the Central Valley Project Improvement Act over the past few years, and this success led them to explore the use of SDM in the Delta. The goal of the pilot effort is to help Reclamation evaluate the trade-offs of potential future actions in the Delta, and inclusively and transparently guide their decisions regarding allocation of resources. This effort was presented to the DPIIC in 2017, and DPIIC members and their staff have shown support for the pilot effort. The Delta SDM team meets twice a month, once in-person for an all-day workshop and once by conference call. The team includes professionals from many different disciplines and from a wide range of state and federal agencies, private companies, and other stakeholder groups. To date, the Delta SDM team has developed the framework for decision making and is currently creating conceptual models for Chinook salmon and Delta Smelt; they plan to have preliminary results to share by late fall 2018.

State Scientist Day

The 30th annual State Scientist Day took place on May 10, 2018. This event attracted thousands of students from area grade schools to the State Capitol, where State scientists presented hands-on displays showcasing the essential and fascinating scientific work being supported through dozens of state agencies. Staff from the Delta

Stewardship Council hosted a booth to educate students about the importance of the Delta, including the exhibits below:

- An opportunity to use a microscope to see plankton and to learn about the importance of the "invisible things in the water" that support the food web.
- A dissection of water hyacinth to understand invasive plants and the problems they cause in the Delta.
- Stormwater design kits to show students the value of wetlands and how landscapes affect water quality.
- An interactive map activity that teaches students where the Delta is in relation to their schools.

State Scientist Day presented an outstanding opportunity for Council staff to interact directly with the public and to educate young students about the value of the Delta and the importance of on-going science that furthers our understanding of this complex ecosystem.

The Beginner's Guide to the Delta

The end of May marks the launch of a new online educational resource about the Delta. This platform, called the "Beginner's Guide to the Delta", was created by Heidi Williams, a 2017 Sea Grant Fellow. The Delta Plan identifies that there is a "lack of a clearly recognized, widely communicated identity for the Delta" and the fact that "many visitors and even some residents of Delta cities and suburbs are unfamiliar with the region".

The purpose of the Beginner's Guide is to serve as an online resource that communicates the identity and importance of the Delta through interactive features such as clickable maps, audio clips, "pull quotes", and other interactive features. The format is inspired by long-form digital storytelling platforms that have been used very effectively by The New York Times and others.

The Beginner's Guide is comprised of eight main sections: laying the groundwork, history of the Delta, the Delta as place, a Delta tour, the Delta as an ecosystem, Delta challenges, management context, and additional resources. It is intended for a wide audience, from potential tourists to Delta professionals looking for a jargon-free refresher on the basics. The Guide will be found as a link on the "Public Engagement" section of the Delta Council website in the near future. A brief presentation (Attachment 1) will allow the Council to get a preview of the website.

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.

List of Attachments

Attachment 1: Beginner's Guide to the Delta Sample (to be provided at the Council Meeting)

Attachment 2: By the Numbers Summary (to be provided at the Council Meeting)

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