

State of Bay-Delta Science 2025: Extreme Events

Information Sheet



**Delta
Science
Program**

DELTA STEWARDSHIP COUNCIL

- The State of Bay-Delta Science 2025 contains articles exploring extreme climate and weather events and their impact on the Bay-Delta watershed.
- Five articles explore our current understanding of and future science needs for governance and climate adaptation; droughts and water availability; temperature patterns and heatwaves; wildfires and water quality; and atmospheric rivers and floods.
- The editorial board concludes the edition by sharing perspectives on future Bay-Delta science and management areas to meet the challenges of extreme events in a changing climate.

Background

The State of Bay-Delta Science (SBDS) is an ongoing synthesis and communication project coordinated by the Delta Science Program. Editions contain 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. While the first two editions, published in 2008 and 2016, covered a broad set of topics, current editions are released approximately every 2–3 years and take a more focused, themed approach.

March 2025

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. The editorial board identifies topics and invites authors to collaborate for each edition. Authors are invited to summarize the current science, key research questions, knowledge gaps, and proposed research and/or management areas.

About this edition

The 2025 edition explores extreme climate and weather events and their impacts on the Bay-Delta and its watershed. Individual chapters address heatwaves, droughts, atmospheric rivers, wildfires, and related governance and climate adaptation considerations. In the final chapter, the editorial board provides a synthesis chapter with perspectives on how science and management can meet the needs of a changing Delta that faces increasingly frequent climate and weather extremes.

This edition of SBDS is closely aligned with Management Need 6 from the [2022-2026 Science Action Agenda \(SAA\)](#), which identifies the need to assess and anticipate the impacts of climate change and extreme events to support successful adaptation strategies.

Articles

A total of seven chapters will be released across multiple issues of the online, open-access [San Francisco Estuary and Watershed Science \(SFEWS\)](#) journal in 2025. The first four articles shown below comprise Part 1 and are in the March 2025 issue of SFEWS. Part 2, the final release, is planned for late 2025 and will contain the remaining three articles shown below.

Part 1 – March 2025

The State of Bay-Delta Science: An Introduction to the 2025 Extreme Events Edition

Janet K. Thompson, Clifford N. Dahm, Mairgareth A. Christman, Denise D. Colombano, Nicholas A. Rowlands, Lisamarie Windham-Myers

- This fourth edition of SBDS is focused on extreme events affecting the Bay-Delta—heatwaves, droughts, atmospheric rivers, and wildfires.
- Articles explore physical and ecological processes within the Bay-Delta that are responding to changes in largescale forcing phenomena, primarily those associated with climate change.
- Chapters in this edition offer a regional perspective on the intensifying effects of climate change on the Bay-Delta, rather than event-specific attribution studies and analyses.

Assessing the State and Efficacy of Climate Governance Research and Practice in the Sacramento-San Joaquin Delta

Jessica Rudnick, Tanya Heikkila, Elizabeth Koebele, Tiffany Morrison, and Chelsea Batavia

- The efficiency, efficacy, and equity of governance systems' responses to climate change can vary dramatically based on their structure and processes.
- The Delta's governance system is largely "polycentric," meaning it encompasses numerous resource domains, is distributed across many entities, and includes multiple scales of decision-making. This can improve opportunities for learning, innovation, and broad participation, but requires strong coordination mechanisms.

- Furthermore, Delta governance must contend with challenges such as legacy policies (e.g., water rights) and long-standing conflicts resulting from the over-allocation of limited natural resources.

Heatwaves and Rising Temperatures in the Upper San Francisco Estuary: Trends and Effects on Ecosystems and Humans

Brian Mahardja, Sam Bashevkin, Catarina Pien, Shruti Khanna, Dharshani Pearson, Brittany Davis, Rupa Basu

- Air and water temperatures in the Delta are increasing, with heatwaves becoming more frequent and severe.
- Potential ecological impacts include phenological shifts, increased species invasion, and conditions that favor smaller-bodied individuals of many species.
- People may suffer adverse health impacts ranging from dehydration and heat exhaustion to lower birth weight, mental health problems, and increased rates of violence.

Drought in the Delta—Socioecological Effects, Responses, and Tools

Rosemary Hartman, Noah Knowles, Amanda Fencl, Julie Ekstrom

- Drought frequency and severity are predicted to increase over this century, with impacts that extend beyond the Delta's borders and are likely to exacerbate conflict between competing water uses.
- Other impacts may include decreased survival of migratory fishes, promotion of harmful algal blooms, and salinization of irrigation water.
- Droughts often catalyze development of new resource management tools, including regulations, land use change, infrastructure, education campaigns, hatcheries, and habitat restoration.

Recent Findings and Future Prospects for Water Quality Effects from Catastrophic Wildfires in California, USA

Clifford N. Dahm, Denise D. Colombano, Randy A. Dahlgren

- Mega-fires (fires burning areas larger than 25,000 acres) in California are increasingly large, frequent, and severe, with the eight largest wildfires in the state since 1932 all taking place between 2017 and 2024.
- Mega-fires impact various aspects of water quality, including water temperature, sediment load, dissolved oxygen, nutrient runoff, and organic and metal contaminants.
- Water quality impairment increases linearly with burn area and exponentially with burn severity. Urban areas in particular are hot spots for pollutant production and transport.

Atmospheric Rivers and Flooding in California's Changing Hydroclimate

Alexander Gershunov, Benjamin Hatchett, Alexander Weyant, Michael Dettinger, Lu Su, Alan Rhoades, Park Williams, Michael Anderson, Pamela Rittelmeyer, Dennis Lettenmaier, Daniel Cayan, Rosa Luna Niño, Tom Corringham, Romain Maendly, F. Martin Ralph

- Climate projections suggest an increasingly variable regional hydroclimate. Precipitation is expected to be less frequent overall, but extreme precipitation events will be more frequent and more intense.
- Atmospheric rivers are expected to carry more moisture and produce more precipitation in the warmer future climate.
- Heavy precipitation will drive disproportionately more intense runoff events in the Delta watershed.

The State of Bay-Delta Science 2025: Perspectives on Advancing Science and Governance in the Era of Climate Change and Extreme Events

Denise D. Colombano, Jessica Rudnick, Mairgareth A. Christman, Clifford N. Dahm, Janet K. Thompson, Nicholas A. Rowlands, Lisamarie Windham-Myers

- Looking forward, the Delta’s scientific system must strengthen its capacity to anticipate and respond to new climate realities and effectively communicate about them to remain relevant to the challenges of natural resource management in the 21st century.
- To achieve this, the editorial board presents perspectives on scientific research, engagement, and informed decision-making.
- The perspectives range from continuing long-term monitoring to improving forecasting capabilities to adopting decision-science frameworks that embrace future uncertainty.

Delta Science Strategy

The Delta Science Strategy is a three-part planning, implementation, and reporting strategy made up of the Delta Science Plan, the SAA, and SBDS. This strategy establishes a foundation for One Delta, One Science—an open Delta science community that works together to build a common body of scientific knowledge. SBDS summarizes progress made following each iteration of the Delta Science Plan and SAA and highlights remaining knowledge gaps and needs to inform future updates of those guidance documents.

In 2025, the Delta Science Program is developing the third iteration of the Delta Science Plan with a goal to address grand challenges to science in the Sacramento–San Joaquin Delta. This SBDS edition of the State of Bay-Delta Science complements this update by providing perspectives from authors and the editorial board on future science needs to strengthen our capacity to anticipate and respond to a changing climate, and to remain relevant to the challenges ahead.

Where can I find more information?

Learn more and access the reports at sbds.deltacouncil.ca.gov. All individual articles are peer-reviewed and available online via the open-access [SFEWS website](#).

Email us at SBDS@deltacouncil.ca.gov to share your feedback on this edition!