BALANCING NEEDS IN THE DELTA · WATER ISSUE OVERVIEW

Balancing needs in the Delta

Can the Delta stay healthy for people, farms, fish, and wildlife, now and in the future?

INTRO

Millions of Californians rely on freshwater from the Sacramento-San Joaquin Delta. Pumping facilities in the Delta divert water into canals for export to communities and farms elsewhere in California. At the same time, the Delta is a living place, home to communities, farms that grow food, and fish and birds that depend on rivers, wetlands, and a healthy estuary.

WHY THIS MATTERS

The Sacramento–San Joaquin Delta sits at the heart of California's water system. Pumping facilities in and around the Delta convey water to cities and farms throughout the San Francisco Bay Area, San Joaquin Valley, Southern California, and other parts of the state. The Delta is also a highly altered ecosystem of wetlands, waterways, and important fish species. Families, farmers, fishing communities, and Tribal nations have deep ties to this landscape.

Over time, dams, levees, reservoirs, and pumping plants have changed how water moves through the Delta and into the San Francisco Bay estuary. The Delta historically experienced large seasonal shifts in freshwater and salinity conditions. Today, upstream reservoir releases, water quality requirements, and export operations strongly influence these patterns. Wetlands have been converted to farmland, creating islands protected by levees, many of which now lie below sea level. Habitat alterations and invasive species have also contributed to major changes in fish populations and water quality conditions.

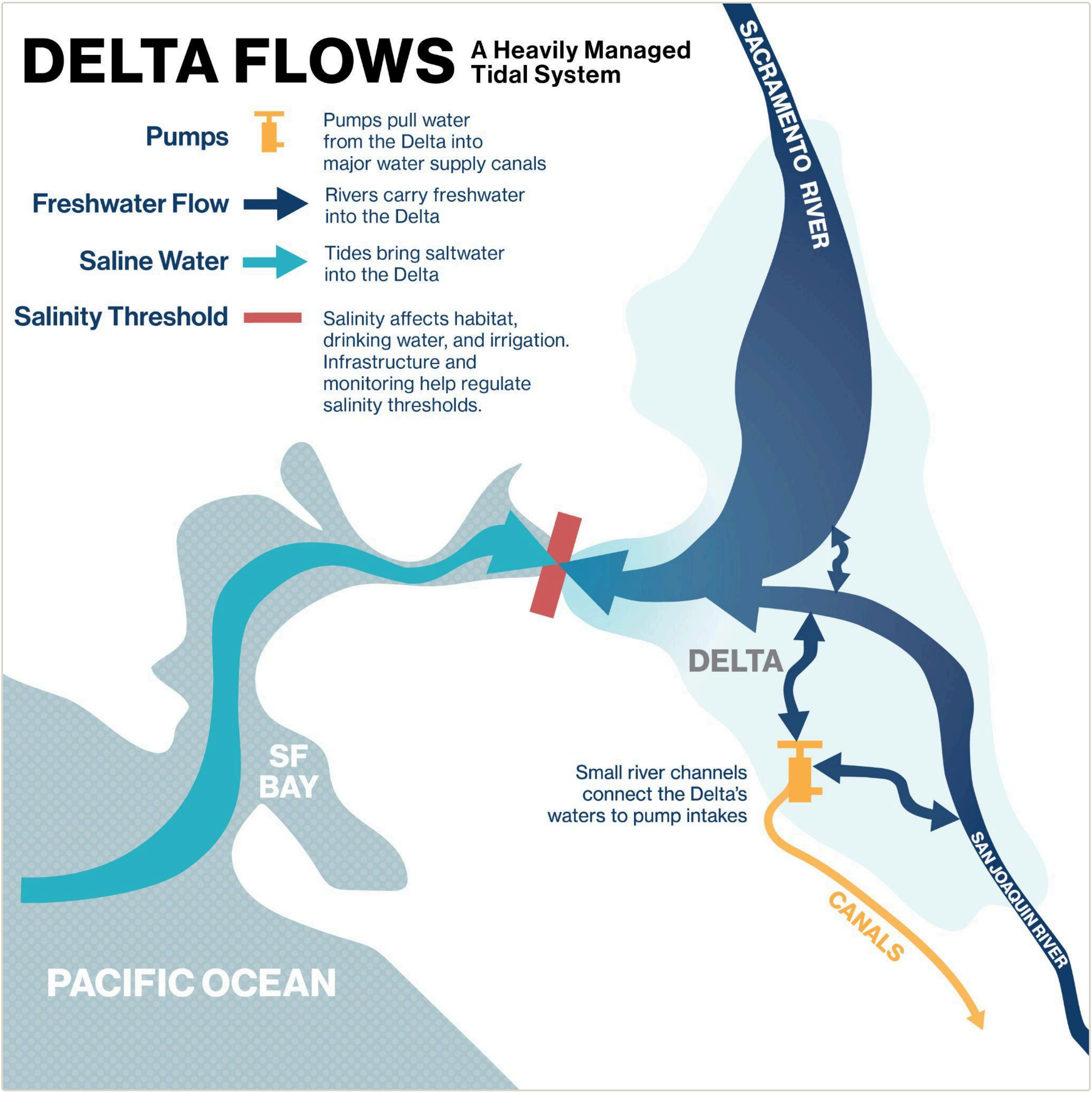
A transformed Delta now faces additional pressures. Droughts are lasting longer. Heat waves are more intense. Water quality problems, including harmful algal blooms, are increasing. Sea levels are rising, changing how freshwater from rivers mixes with saltwater from the Bay and increasing risk of levee failures. These shifts stress ecosystems and uses of water inside and outside of the Delta.

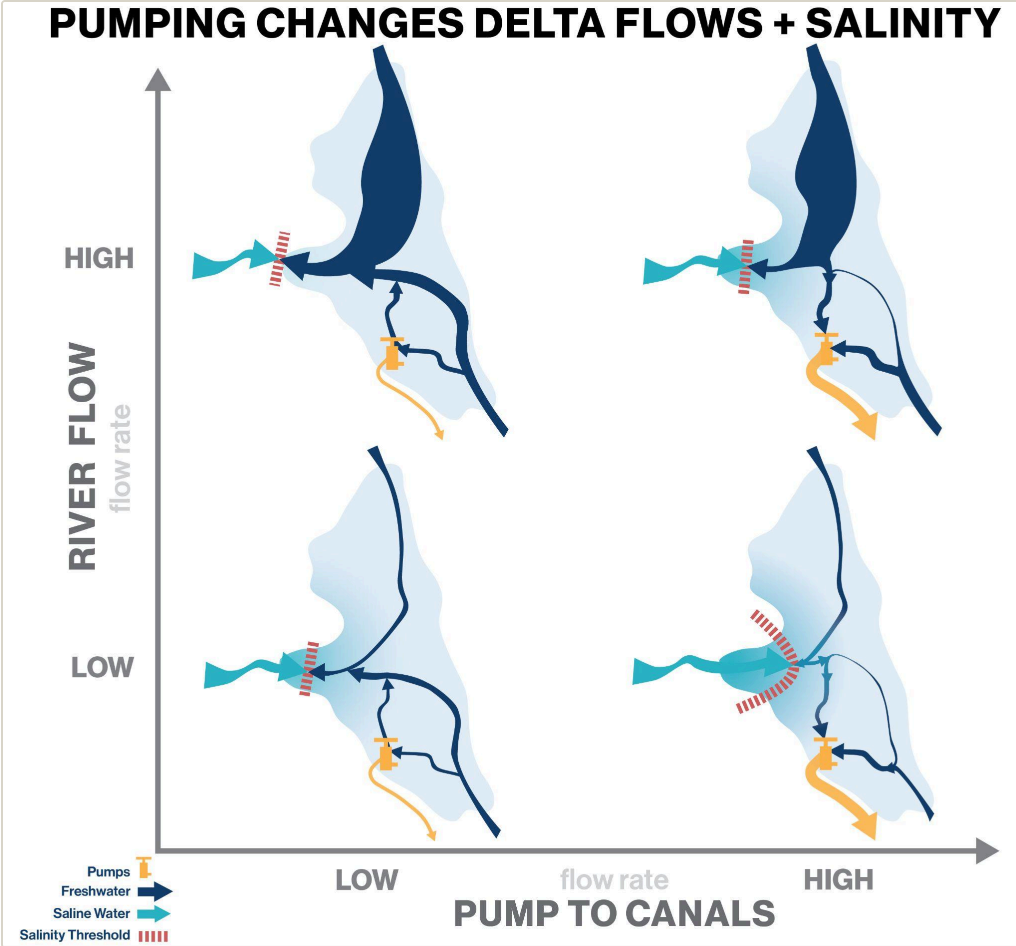
Understanding how the Delta functions as a place, water-conveyance hub, and living ecosystem helps inform decisions about its future.

How river flows and water exports affect the Delta

Freshwater flowing into the Delta and water exported through the Delta pumping facilities together influence how water moves through Delta channels and where fresh and saline water meet. When river flows are high and exports are low, freshwater generally moves seaward and limits salinity intrusion. When freshwater inflows decline or export pumping increases, flow patterns can shift and saline water can move farther inland.

These interactions create important trade-offs among freshwater available for export, water quality for in-Delta water uses, and ecosystem conditions.


DELTA FLOWS
A Heavily Managed Tidal System
Pumps
Pumps pull water from the Delta into major water supply canals
Freshwater Flow
Rivers carry freshwater into the Delta
Saline Water
Tides bring saltwater into the Delta
Salinity Threshold
Salinity affects habitat, drinking water, and irrigation. Infrastructure and monitoring help regulate salinity thresholds.
SACRAMENTO RIVER
DELTA
SF BAY
Small river channels connect the Delta's waters to pump intakes
SAN JOAQUIN RIVER
CANALS
PACIFIC OCEAN



WHAT THIS WATER ISSUE FOCUSES ON

Seasonal flow, salinity, and water use

The Delta changes with the seasons. In spring, snowmelt and reservoir releases fill rivers with fresh water, making the Delta less salty. In summer and fall, river flows decline, temperatures rise, and the Bay's saline waters can move farther inland. Salinity is shaped by freshwater inflows, sea level, tides, and the movement of water through the Delta's network of channels and wetlands. Reservoir releases help limit salinity intrusion during dry months, maintaining freshwater for in-Delta uses and for water exported from the Delta to farms and cities.

Health of the Delta estuary ecosystem

The Delta is a highly altered, novel ecosystem that has been transformed by over a century of intensive land use and water operations. Much of the natural habitats in the Delta have been lost or degraded and the system now supports a multitude of native and non-native species.

Changes in freshwater flows through the Delta from upstream reservoir releases and pumping operations affect currents, water quality, and habitat conditions for different species. But flow is only one influence on Delta ecology. Habitat, invasive species, water temperature, food-web conditions, and other factors also shape ecological outcomes. As a result, changing flows alone may not improve ecosystem health without complementary actions that address other limiting factors.

System connections and trade-offs

The Delta is deeply connected to the rest of California's water system. Reservoir storage and releases, water exports, agricultural and community demands, environmental requirements, and sea-level rise all influence conditions in the Delta. Changes intended to benefit one part of the system can therefore create benefits or burdens elsewhere, sometimes far beyond the Delta itself.

Some outcomes may be highly responsive to changes in management, such as water deliveries to farms, while others, such as the ecology of the Delta, may take longer to respond and can be affected by factors beyond water management alone. Balancing needs in the Delta therefore involves more than deciding how much water should flow through or be exported from the Delta.

WHAT TO KEEP IN MIND

- In-Delta water quality and salinity are sensitive to freshwater inflows, reservoir operations, exports, sea-level rise, tides, and climate conditions. Changes in these factors can affect freshwater for in-Delta uses and exports, as well as ecosystem conditions.

- Freshwater flow is important to Delta ecology, but Delta outflows alone do not address all factors limiting ecosystem health. Habitat, invasive species, water temperature, food-web conditions, and other factors not fully represented by COEQWAL also influence ecological outcomes.

- A Delta Conveyance Project scenario evaluates how the proposed project could affect modeled water-system outcomes, but does not capture the full range of potential social, cultural, economic, and environmental benefits and impacts associated with the project.

- Changes in operational rules do not always produce simple or direct responses. Even when operational rules change under a scenario, other requirements, such as water quality standards, may remain in place. As a result, management changes do not always translate directly into expected changes in Delta outflows, salinity, or ecosystem conditions.

- Delta conditions are influenced by both management and climate. The hydroclimate futures include changes in freshwater conditions and sea-level rise, which together can affect salinity, ecosystem conditions, in-Delta uses, and water exports.

WHAT MANAGEMENT STRATEGIES ARE EXPLORED

This water issue explores scenarios that affect the volume, timing, and quality of water moving through the Delta. These include alternative Delta outflow targets, changes in reservoir operations and salinity standards, and new conveyance infrastructure. This water issue specifically focuses on scenarios that:

- Reduce Delta outflow targets (35% of unimpaired flow)

- Maintain Delta outflow targets (45% of unimpaired flow)

- Increase Delta outflow targets (55% of unimpaired flow)
- Increase Delta outflow targets (65% of unimpaired flow)
- Increase Shasta carry-over storage
- Relax Delta fall salinity standards
- Delta Conveyance Project

Together, these scenarios examine how different management actions influence conditions in the Delta and the broader performance of California's interconnected water system.

For more information about each of these scenarios, visit **Data and Documentation** (https://coeqwal.org/data).

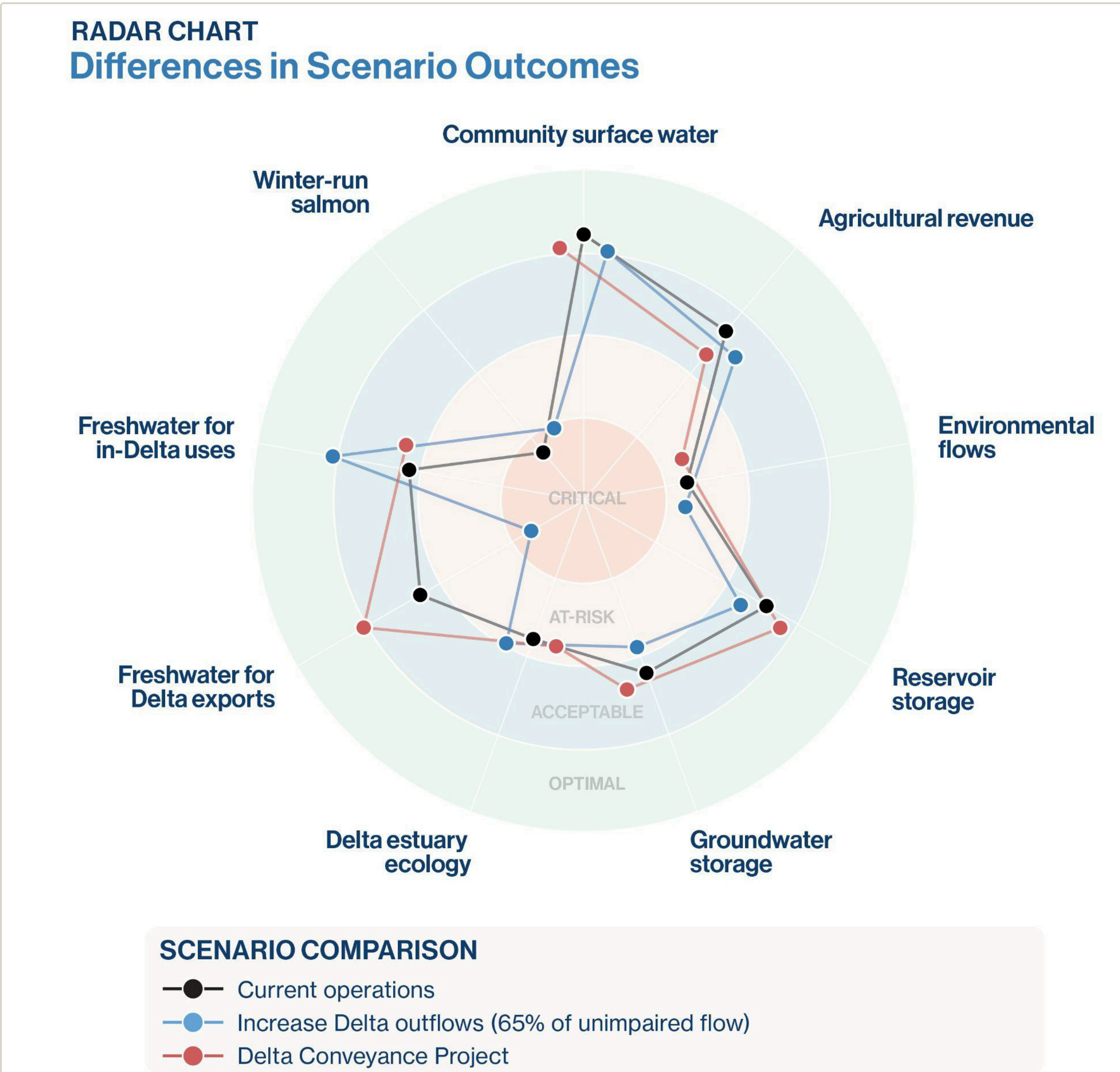
WHAT THE MODELS SHOW

The **Explore Tool** (https://coeqwal.org/explore) allows you to explore how scenario outcomes compare under alternative management strategies and climate conditions. There are complementary ways to visualize tradeoffs, equity, and resilience of water management strategies. The examples below illustrate results from select scenarios for this water issue.

Trade-offs

How do different management strategies affect overall system performance across multiple outcomes?

The radar chart in the **Explore Tool** (https://coeqwal.org/explore) summarizes performance across nine key outcomes, revealing broad system-level trade-offs within and between scenarios. The chart displays the average performance across all locations of interest for each scenario, providing a system-wide view of how these management strategies influence multiple outcomes simultaneously. The chart specifically compares **Current operations** (black), **Increase Delta outflow targets** (**65% of unimpaired flow**) (blue), and **Delta Conveyance Project** (red) under the historical hydroclimate. The points show the average condition across all locations of interest for each outcome, classified into four outcome levels: optimal, acceptable, at-risk, and critical. See **[Data and Documentation](https://coeqwal.org/data)** (https://coeqwal.org/data) for more information on how these categories are defined.



The results show how the two strategies shift the balance of outcomes within and beyond the Delta. Increasing Delta outflow targets to 65% of unimpaired flow increases freshwater moving through and out of the Delta through a combination of increased upstream flows and reduced export pumping. This substantially reduces freshwater available for export while improving freshwater conditions for in-Delta uses. By contrast, the Delta Conveyance Project diverts some Sacramento River water through new intakes in the northern Delta, increasing freshwater available for export while producing relatively little change in modeled freshwater conditions for in-Delta uses.

Both scenarios also affect outcomes elsewhere in the system. Increasing Delta outflows reduces reservoir and groundwater storage, while the Delta Conveyance Project improves both. Community surface-water deliveries decline slightly under both scenarios relative to **Current operations**, but remain at or near the Optimal threshold. Environmental flows also decline slightly, while the modeled outcome for winter-run salmon improves slightly under both scenarios. Agricultural revenue increases slightly under the increased-outflow scenario but declines under the Delta Conveyance Project.

The modeled Delta estuary ecology outcome improves modestly under the increased-outflow scenario. This does not mean that freshwater flow is unimportant to Delta ecosystems. Rather, the result reflects that ecological conditions are also constrained by habitat, invasive species, food-web conditions, and other factors that are not changed by this scenario. Improving flows alongside habitat restoration and other complementary actions could potentially produce broader ecological benefits than changing flows alone.

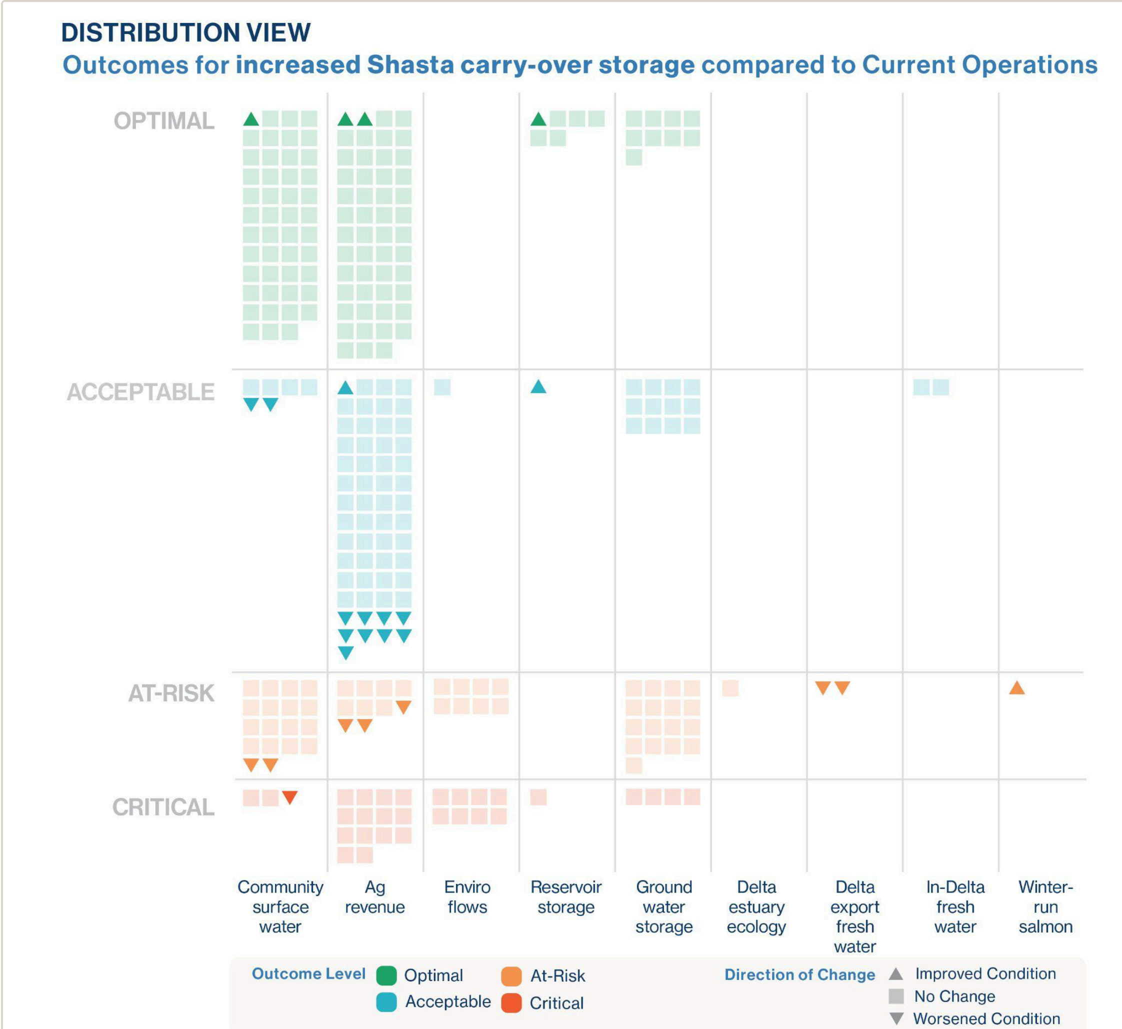
These modeled outcomes capture only some dimensions of the proposed Delta Conveyance Project. They do not capture many other important considerations, including effects on Delta communities, Tribal priorities, agriculture, and ecosystems; construction impacts and costs; or how benefits and burdens would be distributed among regions.

Equity

Where do benefits and impacts occur, and who is most affected?

System-wide averages can hide important differences in scenario impacts. Communities, farms, ecosystems, and water users within and outside the Delta depend on water moving through the system in different ways. As a result, changes in reservoir operations, Delta flows, salinity, or exports can shift the benefits and impacts to different locations.

The Distribution view in the **Explore Tool** (https://coeqwal.org/explore) shows results for individual locations of interest. The figure summarizes how outcomes shift across locations under the **Increase Shasta carry-over storage** scenario relative to **Current operations** under the historical hydroclimate. This scenario targets approximately 20% more September storage in Shasta Reservoir than under Current operations by adjusting water allocations earlier in the year. Arrows indicate direction of change relative to current operations and color represents optimal (green), acceptable (blue), at-risk (orange), or critical (red) outcomes for the scenario. Squares represent locations that did not change condition relative to current operations.



The Distribution view shows that increasing Shasta carry-over storage has limited effects on most outcomes and locations. In many years, the additional amount of water needed to reach the September storage target may be relatively modest and can be accumulated through adjustments spread over several preceding months. Other demands and operating constraints can also limit how strongly this change propagates through the system. Community surface water deliveries and agricultural revenues decline at a small number of locations, while reservoir storage improves at two locations. Freshwater for Delta exports declines. Environmental flows, groundwater storage, Delta estuary ecology, and freshwater for in-Delta uses do not change.

These results show how a strategy intended to maintain more water in storage can create benefits and negative impacts in different parts of the system. The locations benefiting from increased reservoir storage are not necessarily the same locations experiencing declines in environmental flows, agricultural revenues, or community surface water deliveries.

Overall, the Distribution view reveals patterns hidden by system-wide averages and helps identify where management strategies create benefits, where they create burdens, and how evenly those effects are distributed.

Resilience

How consistently do management strategies perform under different climate futures?

Climate change is expected to place increasing stress on California's water system. A management strategy that performs well today may respond differently as droughts become more frequent, temperatures rise, and water availability changes. The Resilience heatmap in the **Explore Tool** (https://coeqwal.org/explore) examines how management strategies perform across a range of plausible hydroclimate futures, representing increasing levels of stress to the water system. See **Data and Documentation** (https://coeqwal.org/data) for more information about hydroclimate futures.

The Resilience heatmap compares outcomes for **Current operations** and **Relaxing Delta salinity standards** under the historical hydroclimate and future hydroclimates representing Moderate, Moderate-High, High and Extreme levels of stress. This relaxed salinity scenario removes the fall X2 salinity standard, which regulates how far saline water can move into the Delta during fall by setting a required location for the low-salinity zone. Outcomes are categorized as optimal (green, 1.00 - 1.99), acceptable (blue, 2.00 - 2.99), at-risk (orange, 3.00 - 3.99), or critical (red, 4.00 - 4.99), with higher numerical values indicating worse performance.

HEATMAP

Comparing Outcomes Across Operational and Hydroclimate Scenarios

Outcome Level: Optimal · Acceptable · At-Risk · Critical

HYDROCLIMATE SCENARIO

OPERATIONAL SCENARIO: **CURRENT USBR OPERATIONS**

	Historical	Moderate Stress	Moderate High Stress	High Stress	Extreme Stress
Community surface water	1.78	1.97	1.99	2.27	2.52
Agricultural revenue	2.33	2.80	2.77	2.90	2.98
Environmental flows	3.73	3.79	3.80	3.98	4.17
Reservoir storage	2.45	2.40	2.32	2.63	3.51
Groundwater storage	2.79	2.64	2.83	3.01	3.28
Delta estuary ecology	3.22	2.94	3.20	3.32	3.60
Delta export freshwater	2.72	3.15	3.33	3.83	4.11
In-Delta freshwater	2.86	3.19	3.18	3.58	4.23
Winter-run salmon	4.24	3.97	4.65	4.88	4.78

OPERATIONAL SCENARIO: **RELAX DELTA SALINITY STANDARDS**

	Historical	Moderate Stress	Moderate High Stress	High Stress	Extreme Stress
Community surface water	1.75	1.93	1.88	2.14	2.51
Agricultural revenue	2.32	2.78	2.74	2.88	2.95
Environmental flows	3.72	3.77	3.79	3.97	4.17
Reservoir storage	2.38	2.33	2.28	2.54	3.45
Groundwater storage	2.78	2.64	2.83	2.99	3.27
Delta estuary ecology	3.18	2.92	3.14	3.29	3.59
Delta export freshwater	2.40	2.97	3.11	3.67	4.10
In-Delta freshwater	3.15	3.62	3.49	4.13	4.69
Winter-run salmon	4.12	4.05	4.53	4.87	4.81

Relaxing the fall Delta salinity standard produces relatively small changes in system outcomes under the historical hydroclimate. All outcomes remain within the same performance category. Delta freshwater exports improve slightly, while freshwater for in-Delta uses falls from an "acceptable" to "at risk" level under the historical climate. .

Across the hydroclimate futures, many outcomes become less favorable as the climate becomes more stressful, but the responses are not always linear. Some outcomes improve under particular hydroclimates even as overall climate stress increases. For example, Delta estuary ecology performs better under the Moderate future than under historical conditions, for both scenarios. Some outcomes, including environmental flows, Delta estuary ecology, Delta exports, freshwater for in-Delta uses, and winter-run salmon, fall to at-risk or critical levels with increasing climate stress, while others, such as community surface water deliveries and agricultural revenues, remain at acceptable levels. These patterns show that individual outcomes can respond differently to the particular combination of conditions represented by each hydroclimate.

Differences between Current operations and Relaxing Delta salinity standards generally remain modest across the hydroclimates examined. In this comparison, changes associated with the hydroclimate are generally larger than the differences between the two management strategies, suggesting that climate has a stronger influence on overall system performance than relaxing the fall salinity standard alone.

HOW TO EXPLORE FURTHER

Together, these data visualizations show the trade-offs involved in managing water through the Delta, how benefits and impacts are distributed across locations and uses, and whether those effects persist under different climate futures. Visit the **Explore Tool** (https://coeqwal.org/explore) to examine how changes in Delta outflows, salinity standards, reservoir operations, and infrastructure affect conditions within the Delta and across California's interconnected water system.

If this is your first time using the **Explore Tool** (https://coeqwal.org/explore), we recommend visiting the **Get Started** (https://coeqwal.org/learn) section before beginning your exploration.

CONTACT US

Do you have questions or feedback about this water issue and the COEQWAL project? Please email coeqwal@berkeley.edu (mailto:coeqwal@berkeley.edu)