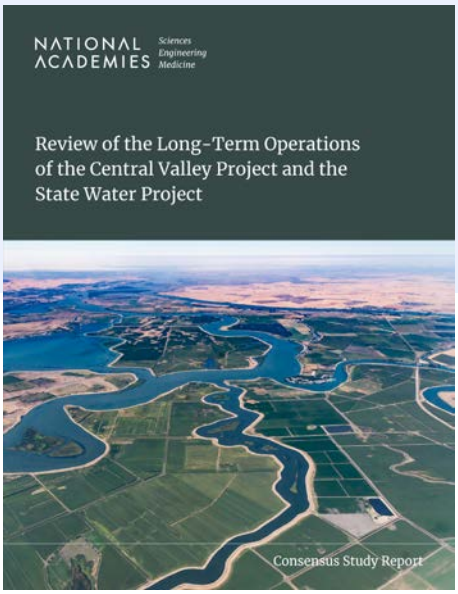
Review of the Long-Term Operations of the Central Valley Project and the State Water Project



Water management in California includes two of the largest multipurpose projects in the world—the federal Central Valley Project (CVP), operated by the U.S. Bureau of Reclamation (USBR), and the State Water Project (SWP), operated by the California Department of Water Resources (CDWR). The CVP and SWP (referred to collectively as "the Projects") transfer billions of gallons of water per day from Northern California to drier Central and Southern California through a network of dams, canals, tunnels, pumps, and power plants. At least two-thirds of California's population and more than 4 million acres of California farmland rely in whole or in part on water delivered by these projects.

For many reasons, the Projects rarely deliver their full contracted amount of water. Such shortfalls are inherent in the operation of a large water project with multiple and growing demands in a dry and highly variable climate. In addition, the Projects must comply with federal and state law to prevent extinction of six endangered fish species that experience direct and indirect effects of water diversions, including Delta smelt, longfin smelt, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, and the southern distinct population segment of North American green sturgeon.

At the request of USBR, the National Academies of Sciences, Engineering, and Medicine established a committee to conduct a biennial review of the monitoring, modeling, and other relevant scientific activities of the CVP and SWP. This first report in the series evaluates three actions that are consequential both for species survival and for their effects on water deliveries—the Shasta Coldwater Pool Management Action, the Old and Middle River (OMR) Flow Management Action, and the Summer-Fall Habitat Action. To inform its work, the committee heard from numerous experts from many of the agencies and parties that provide scientific input to the management of the Projects (see Box 1).

BOX 1
Scientific Enterprise Informing the Projects

In addition to USBR and CDWR, numerous parties in the Delta region have contributed to the overall science enterprise that informs management of the Projects, including the U.S. Fish & Wildlife Service, the National Marine Fisheries Service, the California Department of Fish and Wildlife, the California State Water Resources Control Board, the U.S. Geological Survey, the Delta Stewardship Council (including the Delta Science Program), Native American tribes, environmental nongovernmental organizations, water contractors, researchers from many universities, electrical utilities, consultants, and others.

SHASTA COLDWATER POOL MANAGEMENT

Shasta Reservoir, the largest storage reservoir in the CVP, is managed so that water is released to maintain flood conservation space, meet downstream instream flow and water delivery requirements, generate hydropower, and provide cold water to support spawning winter-run Chinook salmon. The construction of Shasta Reservoir in the 1930s blocked salmon from spawning in their native habitats, such that all adult holding and spawning, as well as egg incubation and rearing, occurs just below Keswick Dam. The Shasta Coldwater Pool Management Action (see Figure 1) aims to ensure that water cold

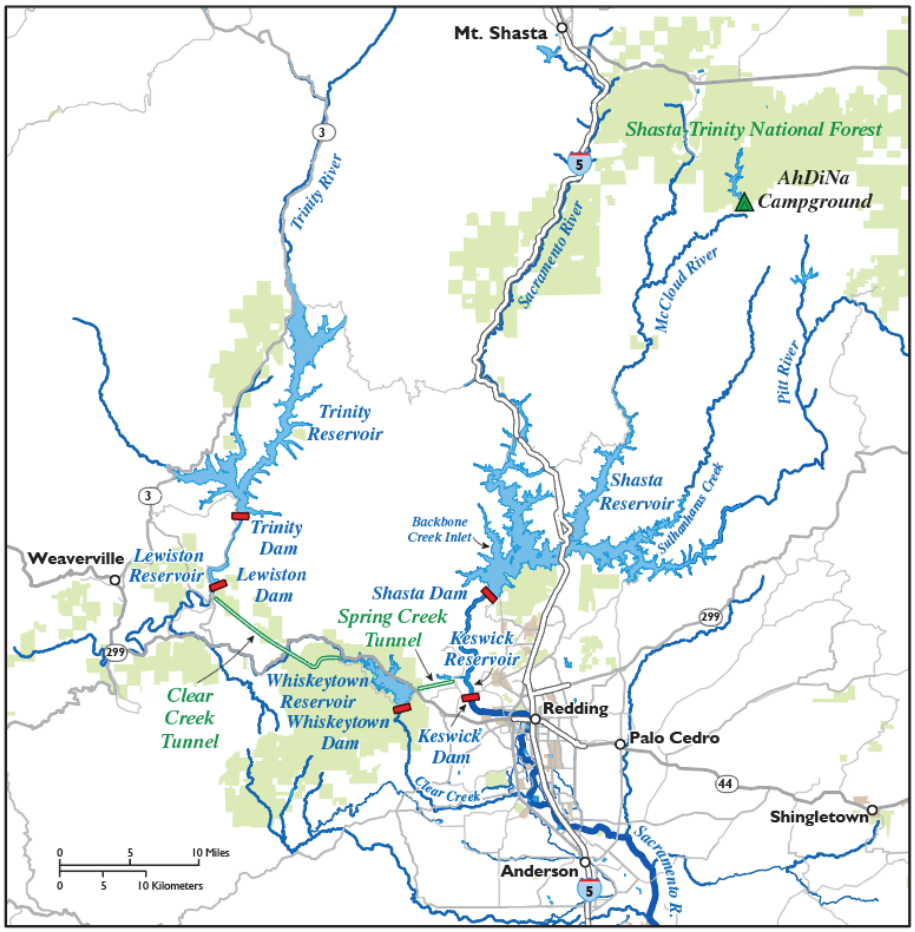


FIGURE 1 Map of the Upper Sacramento River basin relevant to the Shasta Coldwater Pool Management Action.

enough to support winter-run Chinook adult holding and spawning and egg incubation is present in the reaches downstream of Keswick Dam over the summer months.

To achieve this aim, USBR typically retains cold water in Shasta Reservoir until the summer and then operates a Temperature Control Device to blend water from warmer and colder layers within Shasta Reservoir to maximize the benefits of the cold water throughout the summer months. The action is supported by a wide range of planning, monitoring, and modeling activities that assess physical and ecological conditions within the reservoir/river system. Finally, the action depends on the winter-run Chinook salmon hatchery program, particularly in drought years.

The committee suggests a three-pronged approach to near-future Shasta Reservoir management: (1) continuing to improve temperature management downstream of Keswick Dam; (2) continuing hatcheries management; and (3) reintroducing winter-run Chinook salmon above Shasta Dam, which will be essential to the protection of the species as the climate changes.

USBR should enhance the monitoring of (1) Shasta Reservoir and (2) rivers relevant to the coldwater pool management action. Additional temperature sensors in key river and reservoir locations could provide information that enhances the predictive accuracy of USBR's innovative Water Temperature Modeling Platform. The installation of four to six Lake Diagnostic Systems throughout Shasta Reservoir would help operators better understand how high-frequency physical dynamics within the reservoir (such as internal waves) affect the thermocline depth and generate more accurate estimates of the coldwater pool volume.

High levels of "unattributed mortality" of winter-run Chinook salmon eggs must be better understood, through research that defines specific pathways for reducing said mortality, in order to develop management actions that can increase confidence in the use of egg-to-fry survival as the principal focus for coldwater pool management. Ongoing studies investigating the temperature, dissolved oxygen levels, and flow of water through redds (gravel nests created by salmon for spawning) could evaluate the potential benefits of larger-scale actions such as channel and floodplain restoration, gravel augmentation, and pulse flows in sustaining pool-riffle sequences and other geomorphic features conducive to spawning.

OLD AND MIDDLE RIVER FLOW MANAGEMENT

Projects divert large quantities of freshwater from the San Joaquin and Sacramento rivers, primarily through the two south Delta pumping stations (see Figure 2). Operation of the pumps can lead to entrainment of the listed fish species at both pumping facilities, meaning they are drawn toward water intakes for the pumps along with flowing water. Other impacts to fish include changes to the flow patterns within the Delta that reroute fish to places where habitat conditions are less optimal for survival, prevent fish from completing their natural migration, and make fish increasingly subject to predation.

The OMR Flow Management Action seeks to maximize the export of water while minimizing the adverse effects of pumping to fish populations when fish are rearing in and migrating through the Delta (December through June). The report concludes that the OMR flow management action, which uses thresholds for the number of fish salvaged at the pumps, flow levels, and turbidity levels as triggers for placing limitations on pumping, has a reasonable scientific basis, although there are substantial uncertainties.

The underlying scientific bases of the thresholds and corresponding export reductions used in OMR flow management should be made available so that their use can be appropriately reviewed. Although it did not thoroughly analyze each threshold value, the committee noted examples of thresholds that are not scientifically defensible.

To move OMR flow management beyond the use of salvage numbers as a proxy for impacts to fish in the Delta, monitoring and modeling in support of the action should evolve to address: (1) What is the zone of influence of operations? (2) What proportion of any

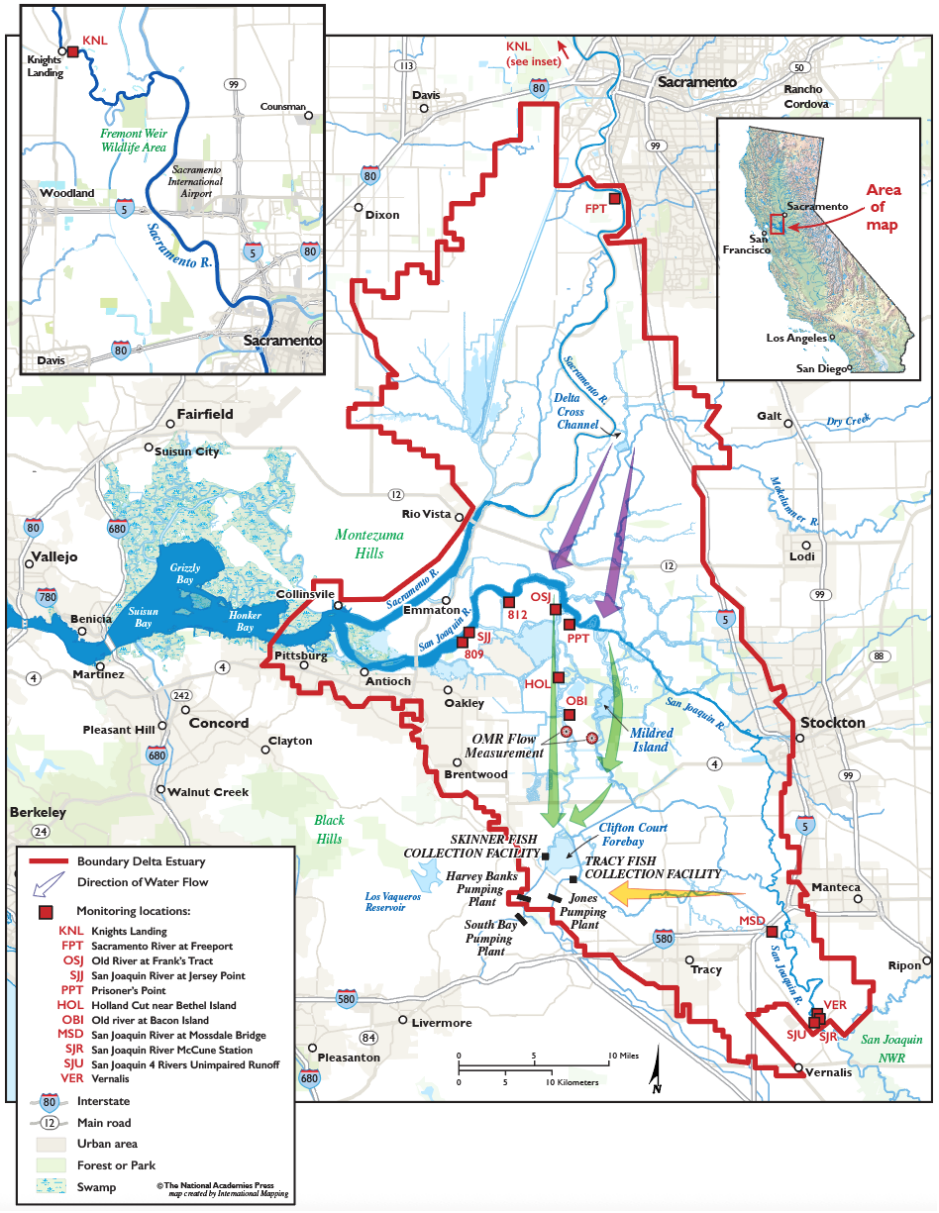


FIGURE 2 Map of the Old and Middle River Area of the Bay-Delta relevant to the OMR Flow Management Action.
NOTE: Purple arrows indicate direction of water flow when the Delta Cross Channel is open, while green and yellow arrows indicate direction of water flow from the Sacramento and San Joaquin rivers, respectively, during exports.

given fish population is under that influence? (3) What is the impact to fish in these regions? (4) What are the consequences of these impacts at the full population level? Expanded modeling efforts should build on USBR's zone of influence analysis to study changes in key factors such as temperature, submerged aquatic vegetation, salinity, and other water quality conditions across the Delta under a variety of flow conditions, spanning dry to wet years, and under a range of pumping rates.

SUMMER-FALL HABITAT ACTION FOR DELTA SMELT

Although the Delta smelt was once considered one of the most abundant fishes in the Delta, they are now extremely rare, with zero caught in most catch indices in recent years. The Summer–Fall Habitat Action (SFHA) seeks to address this by providing more low salinity habitat in the Suisan Marsh area (see Figure 3) during the summer and fall to better support Delta smelt recruitment and population growth. The SFHA consists of

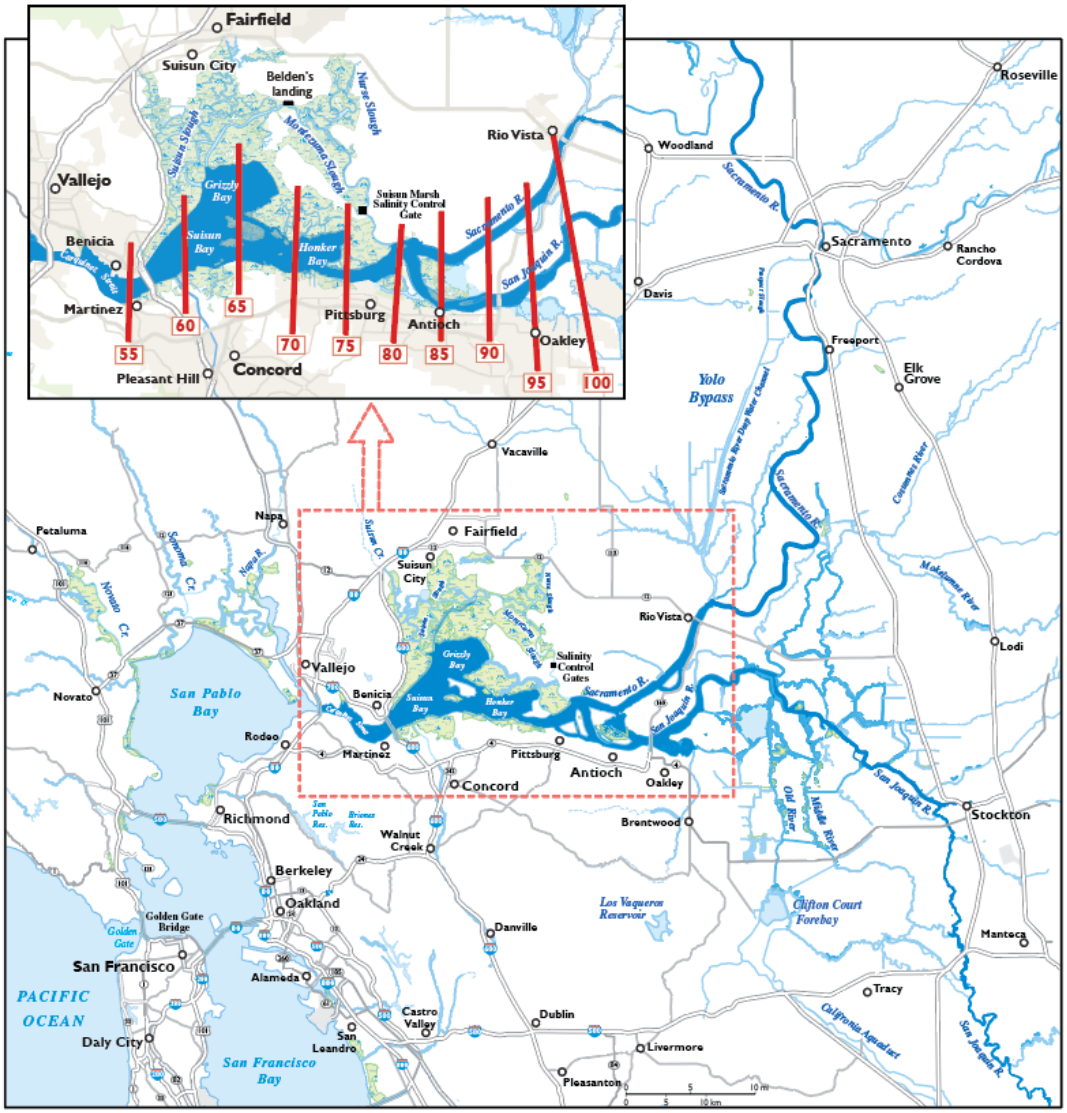


FIGURE 3 Map of the Bay-Delta and Suisun March (inset) where the Summer-Fall Habitat Action is focused.
NOTE: Red bars in the insert show the location of X2 measured in km from the Golden Gate Bridge.

(1) managing the location of X2 (the 2 parts per thousand bottom salinity isohaline) in the fall, (2) operating the Suisun Marsh Salinity Control Gates to adjust salinity in Suisun Marsh, and (3) possibly releasing an additional 100,000 acre-feet of water.

USBR and CDWR are to be commended for embracing an ecosystem-based approach to protecting Delta smelt that attempts to overlay Delta smelt distribution with food supplies and the favorable habitat conditions of the low salinity zone. Nonetheless, the greatest uncertainty about the SFHA is the inability to detect a response to the action in fish populations.

Several targeted lines of research, particularly the **development of a process-based Delta smelt model in a spatial food-web context,** could increase understanding of the effectiveness of various SFHA components.

An annual decision process for the SFHA founded on a series of environmental triggers that encompass more than water year type should be considered. Lessons from previous SFHA implementation, such as the 2017 Fall X2 action, show that the response of Delta smelt may be determined by environmental conditions unrelated to water year type, including water temperature and antecedent conditions.

OVERARCHING ISSUES

Cross-cutting issues that emerged from the committee's analyses of the three actions include the need to (1) enhance collaborative science to improve the pace and effectiveness of Bay-Delta watershed science efforts that inform management actions; (2) enhance the modeling enterprise; and (3) more strongly consider how changes in climate impact drivers will affect long-term operations.

A formal feasibility study should be undertaken to assess the potential for a Science Hub for the Bay-Delta and its watershed. This hub must be fit-for-purpose and grounded in the needs and culture of the science community. It should be designed to develop solutions to problems that are difficult to address within existing agency or academic silos, without interfering with agency mandates or diminishing internal capacity. It should enhance institutional expertise by creating a collaborative environment where new approaches can be developed and tested, monitoring can be better coordinated, and cross-agency training can be implemented. It would also facilitate better coordination across the science that supports CVP and SWP activities.

CONCLUSION

The three actions reviewed in this report are important elements of a broader effort to protect listed fish species while maintaining Project operations. In the near term, and perhaps for the long term, maintaining and fine-tuning these actions will be necessary for achieving key CVP and SWP goals. Nonetheless, taken in isolation the individual actions will be insufficient to achieve species recovery; rather, ecosystem-wide thinking on the part of action agencies will be imperative.

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FOR MORE INFORMATION

This Highlights was prepared by National Academies' staff based on the Consensus Study Report *Review of the Long-Term Operations of the Central Valley Project and the State Water Project* (2025).

To read the full report, visit https://nap.nationalacademies.org/catalog/29130.

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