Chapter 5

Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta

5.1 Introduction

The Bay-Delta Plan, like all water quality control plans, includes beneficial uses of water, water quality objectives for the reasonable protection of those uses, and a program of implementation identifying how the objectives will be met—in addition to monitoring, special studies, evaluation, and reporting measures. This chapter describes possible updates to the Bay-Delta Plan for the reasonable protection of fish and wildlife. It also describes information on the State Water Board's regulatory responsibilities and authorities, existing Bay-Delta Plan requirements, and the need and basis for changes to those requirements. This chapter describes proposed changes to the Bay-Delta Plan or Plan amendments that were largely identified in the State Water Board *July 2018 Framework for the Sacramento/Delta Update to the Bay-Delta Plan* (2018 Framework) (^SWRCB 2018), updated to some extent. The 2018 Framework was released in advance of consideration of the 2018 updates to the Bay-Delta Plan and following completion of the draft *Scientific Basis Report in Support of Possible New and Modified Requirements for Inflows from the Sacramento River and Its Tributaries and Eastside Tributaries to the Delta, Delta Outflows, Cold Water Habitat, and Interior Delta Flows* (Scientific Basis Report) (^SWRCB 2017) to support Sacramento/Delta updates to the Bay-Delta Plan.

While the updates to the Bay-Delta Plan identified in the 2018 Framework and further described in this chapter are referred to as the "proposed Plan amendments," the State Water Board has made no decisions on actual updates to the Bay-Delta Plan, and all alternatives evaluated in this draft Staff Report remain available for consideration and approval after the public planning process. The State Water Board is also considering a proposed Voluntary Agreement (VAs) proposal that was submitted in 2022, later in the process of development of this draft Staff Report, by the California Department of Water Resources (DWR), U.S. Bureau of Reclamation (Reclamation), California Department of Fish and Wildlife (CDFW), California Natural Resources Agency, California Environmental Protection Agency, and various water users in the watershed (see Chapter 9, *Proposed Voluntary Agreements*). The State Water Board may choose to move forward with that VAs proposal or other alternatives for updating the Bay-Delta Plan in the future. That decision will be informed by public comments on this draft Staff Report and peer review of the *Final Draft Scientific Basis Report Supplement in Support of Proposed Voluntary Agreements for the Sacramento River, Delta, and Tributaries Update to the San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan*. Following receipt of public comments on this draft Staff Report and submittal of additional VA documents described further in Chapter 9 (including draft agreements to implement the VAs, a draft funding plan, and draft flow accounting methods for approval by the State Water Board), the State Water Board will provide additional opportunity for comment on the specific regulatory text changes to the Bay-Delta Plan, including the specific changes to the program of implementation text, which has not yet been developed.

The proposed VAs are described and evaluated separately in Chapter 9, *Proposed Voluntary Agreements*. They include flow assets and habitat restoration measures on major tributaries to the

Sacramento/Delta, including the Sacramento, Feather, American, Yuba, Mokelumne, and Tuolumne[1] Rivers and Putah Creek, as well as contributions to Delta outflows and habitat restoration in the Delta and water purchases. The proposed VAs identify a regulatory implementation pathway that would exist in parallel with the VA implementation pathway. The Proposed Voluntary Agreements Alternative evaluated in this draft Staff Report identifies that the regulatory pathway would apply to non-VA regions and could apply in VA regions in the event the VAs are discontinued after the proposed 8-year term of the VAs, as described in Chapter 9. The proposed VA regulatory pathway is largely consistent with the proposed Plan amendments described in this chapter, except that instead of updating the water quality objectives, the inflow, inflow-based Delta outflow, and cold water habitat provisions of the proposed Plan amendments would be included in the program of implementation; they would be applicable to non-VA regions and could become applicable to VA regions in the future if the VAs are not continued. The Proposed Voluntary Agreements Alternative is described in more detail in Chapter 9.

The Bay-Delta Plan includes water quality objectives to protect municipal and industrial,[2] agricultural, and fish and wildlife beneficial uses. Also, under consideration as part of this update to the Bay-Delta Plan is the addition of tribal and subsistence fishing beneficial uses, including the following beneficial uses.

- Tribal Tradition and Culture (CUL): Uses of water that support the cultural, spiritual, ceremonial, or traditional rights or lifeways of California Native American tribes, including but not limited to, navigation, ceremonies, fishing, gathering, or other consumption of natural aquatic resources (including fish, shellfish, vegetation, and abiotic materials).
- Tribal Subsistence Fishing (T-SUB): Uses of water involving noncommercial catching or gathering of natural aquatic resources, including fish and shellfish, for consumption by individuals, households, or communities of California Native American tribes to meet needs for sustenance.
- Subsistence Fishing (SUB): Uses of water involving noncommercial catching or gathering of natural aquatic resources, including fish and shellfish, for consumption by individuals, households, or communities, to meet needs for sustenance.

The water quality objectives include narrative and numeric objectives. The numeric objectives in the Bay-Delta Plan are for the most part flow-dependent objectives directed at protecting the beneficial uses of water from the effects of water diversions, including impacts from changes in flows and other operational effects. The program of implementation includes actions the State Water Board will take to implement the objectives and protect beneficial uses and the actions that others should take to do so.

Two major and distinct watersheds drain into the Bay-Delta, the Sacramento River watershed and the San Joaquin River watershed. The last major update to the Bay-Delta Plan occurred in 2018 and revised flow objectives for the reasonable protection of fish and wildlife in the Lower San Joaquin River (LSJR) and its three salmon-bearing tributaries, the Stanislaus, Tuolumne, and Merced Rivers.

[1] The Tuolumne River component of the VAs will require changes to the Bay-Delta Plan adopted in 2018 and is being considered separately from the other components of the VAs. However, the potential benefits of these flows on Delta outflows is evaluated in this draft Staff Report.

[2] For the purposes of this document, a reference to *municipal use* includes domestic and industrial uses unless otherwise specified. The terms *urban* and *municipal and industrial (M&I)* are also sometimes used in this document to generally reference municipal water supplies.

Because flows from the LSJR greatly influence salinity in the southern Delta, the update included a revised salinity objective for the reasonable protection of agricultural beneficial uses in the southern Delta. In addition, the programs of implementation for both the flow and salinity objectives were revised (collectively, referred to as the *LSJR/SD update*). In July 2022, the State Water Board issued a Notice of Preparation (NOP) for a regulation to implement the LSJR/SD update. In April 2023, the State Water Board also released an NOP for consideration of the Tuolumne River portion of the VAs that requires separate consideration from other portions of the proposed VAs that are being considered as part of the Sacramento/Delta update to the Bay-Delta Plan.

The last major update to the flow objectives for the protection of fish and wildlife beneficial uses in the Sacramento River watershed and Delta occurred in 1995. That update was largely consistent with agreements reached in the early 1990s establishing new outflow and other requirements. Minor updates to the Bay-Delta Plan were then made in 2006.

The State Water Board assigns responsibility for implementing the objectives to water right holders and claimants through water right actions and water quality actions, such as conditioning of water rights, adoption of regulations, and water quality certification associated with Federal Energy Regulatory Commission (FERC) hydropower licensing processes. The current Bay-Delta Plan is primarily implemented through water right requirements included in State Water Board Water Right Decision 1641 (D-1641).

The proposed Plan amendments described in this chapter are based on the science discussed in the preceding chapters and the Scientific Basis Report, as well as the modeling and environmental and economic analyses discussed in the subsequent chapters and appendices of this Staff Report. The proposed changes include new and modified narrative and numeric objectives; a program of implementation to achieve the objectives; other actions to protect fish and wildlife; and changes to monitoring, reporting, and assessment provisions. Narrative objectives describe the conditions that are protective of fish and wildlife and explain the conditions the numeric objectives and the program of implementation are intended to achieve.

Protection of the Bay-Delta ecosystem and its native aquatic species requires an integrated approach to effectively connect upstream suitable cold water nursery habitat, floodplains, tidal marshland, and turbid open water habitats in the Delta and Bay—and to connect those environments to the ocean. Accordingly, changes to the Bay-Delta Plan are being considered to provide for a flow regime that supports a connected and functioning ecosystem linking and integrating tributary inflow, cold water habitat, Delta outflow, and interior Delta flow measures with physical habitat restoration and other complementary ecosystem measures. As described in this chapter, the proposed objectives may be implemented through several mechanisms, including through voluntary implementation plans, which are distinct from the proposed VAs discussed above and evaluated in Chapter 9, *Proposed Voluntary Agreements*.

The proposed objectives include new inflow and cold water habitat objectives for the Sacramento/Delta tributaries, new and modified Delta outflow objectives, modified Suisun Marsh objectives, and new and modified interior Delta flow objectives. The proposed changes to the program of implementation include a description of actions to implement the proposed new and modified objectives and to maintain the existing narrative salmon objective. Implementation includes recommendations for physical habitat restoration and other complementary ecosystem measures in conjunction with new and modified objectives. The proposed changes to the program of implementation also describe accounting, monitoring, reporting, assessment, and adaptive

management provisions for compliance and effectiveness; provisions for public safety and drought; measures to reduce or avoid redirected impacts; and complementary measures to protect fish and wildlife.

5.2 State Water Board Responsibilities and Authorities

The State Water Board is responsible for adopting statewide water quality control plans and adopts the Bay-Delta Plan because of the importance of the Bay-Delta as a major source of water for the state. The State Water Board is the only state agency with authority to oversee and regulate water rights. Because California combines its water rights and water quality authorities (Wat. Code, § 174), the Bay-Delta Plan addresses water diversions and use in the water quality planning context, including the federal Clean Water Act and state Porter-Cologne Water Quality Control Act (Porter-Cologne Act). When addressing water diversions and use, implementation of the Bay-Delta Plan's water quality objectives is pursuant to the State Water Board's water quality and water rights authorities under state law. There are a variety of water right and water quality authorities that the State Water Board may utilize to implement new and revised objectives, and the State Water Board has discretion in which it chooses to use in accordance with state law. (See Wat. Code, § 13242.)

5.2.1 Water Quality

The Clean Water Act is a comprehensive federal water quality law designed to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." (33 U.S.C., § 1251(a).) The regulatory framework follows a "cooperative federalism" approach whereby individual states adopt and implement major provisions of the law provided that certain minimum standards and criteria are met and approved by the U.S. Environmental Protection Agency (USEPA). The Clean Water Act requires states to establish water quality standards that specify both the beneficial uses of waterbodies and the levels of quality that must be met and maintained to protect the designated uses. In California, beneficial uses of waterbodies and objectives necessary to protect the beneficial uses are prescribed in water quality control plans (basin plans). In addition, the basin plans reflect, incorporate, and implement applicable portions of national and statewide water quality plans and policies.

The Porter-Cologne Act (Wat. Code, § 13000 et seq.) is California's broad-based regulatory program implemented by the State Water Board and nine regional water boards. The Porter-Cologne Act integrates portions of the federal Clean Water Act, specifically the National Pollutant Discharge Elimination System (NPDES) permit process, and certain federal water quality planning requirements. Each regional water board formulates, adopts, and updates a basin plan for its region, subject to approval by the State Water Board and, for waters subject to the Clean Water Act, USEPA. Under Water Code section 13170, the State Water Board may also adopt water quality control plans, which supersede any regional water quality control plans for the same waters to the extent of any conflict. The State Water Board develops and adopts the Bay-Delta Plan because of the critical importance of the Bay-Delta watershed to the state's water supplies and environment.

Under the Porter-Cologne Act, water quality objectives are established to ensure the reasonable protection of beneficial uses and prevention of nuisance, in consideration of various factors including past, present, and probable future beneficial uses of water. Water Code section 13242

provides that a program to achieve objectives shall include a description of the nature of the actions necessary to achieve objectives, including recommendations for appropriate action by any entity, public or private, a time schedule for actions to be taken, and monitoring to determine compliance. A water quality objective is distinguishable from how an agency implements and enforces the objective as either a point source (subject to USEPA authority) or nonpoint source (not subject to USEPA authority).

Under the Clean Water Act, point-source discharges of pollutants to waters of the United States are prohibited unless authorized under an NPDES permit issued by USEPA or the state. Nonpoint-source pollution includes all other pollution exempted from the NPDES permitting program. Water diversions, dams, and reservoirs fall in this category. For these parameters, the State Water Board can implement water quality objectives pursuant to other authorities under water quality and water rights law, which includes water right permitting authorities, the state law prohibitions on waste and unreasonable use, and obligations under the public trust doctrine (discussed in more detail below).

Under section 401 of the Clean Water Act, water quality certification by the state is required for any activity requiring a federal license or permit, including licenses for hydropower facilities issued by FERC, that may result in any discharge to surface waters. In issuing water quality certification, the state may impose conditions on a federal project or a project required to obtain a federal permit, in order to certify that the project protects beneficial uses and meets water quality objectives as specified in the basin plan. In addition, discharges from the tailrace of a dam may be considered a "discharge of waste" under the Porter-Cologne Act and may be subject to waste discharge requirements (WDR). WDRs prescribe requirements, such as limitations on temperature, toxicity, or pollutant levels, as to the nature of any discharge. WDRs may also specify conditions where no discharge will be permitted.

5.2.2 Water Rights

The State Water Board is the only public agency with authority to administer water rights in California. A water right is legal permission to use a reasonable amount of water for a beneficial purpose such as domestic, irrigation, power, and fish and wildlife preservation and enhancement uses.[3] The State Water Board helps regulate California's surface water rights by issuing permits, licenses, and registrations for the diversion of water and investigating unauthorized diversion and unreasonable use of water. The State Water Board shares the authority to enforce water right laws with the state courts.

California has a hybrid system of water rights, recognizing both appropriative and riparian water rights. A riparian water right generally provides a right to use the natural flow of a waterbody on riparian land, which is land that touches a lake, river, stream, or creek. Riparian land must be in the same watershed as the water source, and the diverted water must drain back to the source watershed. Riparian rights remain with the property when it changes hands, although parcels severed from the adjacent water source generally lose their right to the water. Riparian rights may be used to divert the natural flow of a stream but may not be used to store water for later use or to divert water that originates in a different watershed, water previously stored by others, return flows

[3] The beneficial uses of water pertaining to water rights are defined in California Code of Regulations, title 23, sections 659–672. While similar, beneficial use for water rights is different from the beneficial uses identified in basin plans for the purpose of protecting against water quality degradation.

from use of groundwater, or other water foreign to the natural stream system. Riparian rights are not lost by non-use.

An appropriative water right is generally needed for water that is diverted for use on non-riparian land or to store water for use when it would not be available under natural conditions. An appropriative right holder can use natural flow, non-natural flows like imported water from other watersheds, or irrigation return flows. Prior to 1914, appropriative water rights were acquired by putting water to beneficial use. An appropriative water right that was acquired before 1914 is called a *pre-1914 appropriative water right* and is not subject to the permitting authority of the State Water Board. Appropriative water rights obtained after 1914 require a water right permit and subsequently a license issued by the State Water Board or its predecessors. The seniority of pre-1914 and post-1914 appropriative rights is based on a first-in-time concept (priority date hierarchy). In times of water shortage, the most recent, or "junior," water right holder must be the first to discontinue use. Each post-1914 appropriative water right's priority dates to the time the permit application was filed with the State Water Board.

A variation on application priority dates is provided for state-filed water right applications. These applications were filed prospectively pursuant to Water Code section 10500 by DWR or the Department of Finance between 1927 and 1977 for the purpose of providing water for future general or coordinated plans that meet the specific criteria specified in the state filing. Parties can request assignment of the state-filed application for developing projects that are consistent with the purpose of the state filing. The applications maintain the priority date of the date they were filed, providing for a higher seniority right than could be obtained through a standard water right application. Many state-filed applications have been assigned (and the waters applied to beneficial use throughout California), and many have not yet been assigned.

In addition to water right permits, since 1989, water right registrations have been available from the State Water Board for expedited acquisition of appropriative water rights for certain small projects. Currently, water right registrations are available for the following types of small water right projects: small domestic use, livestock stockpond use, small irrigation use, and cannabis small irrigation use. The maximum use for registrations is between 4,500 and 42,000 gallons per day for direct diversion and 6.6 to 20 acre-feet per year (AF/yr) for diversion to storage.

Pursuant to Water Code sections 1840 et seq. and 5103 et seq. and the California Code of Regulations title 23, division 3, section 907 et seq., all diverters are required to submit annual water right reports of diversions to the State Water Board. The annual reports are mandatory filings that document diversions made during the previous calendar year. Annual reports are still required in times of drought or if water is not used in a particular year. All diverters who are authorized to divert greater than 10 AF/yr from rivers, creeks, springs, or subterranean streams also are required to install and maintain a measuring device or employ a method capable of measuring the rate of direct diversion, rate of collection to storage, and rate of withdrawal or release from storage for their diversions.

All water rights are subject to the common law principle, codified in California Constitution, article X, section 2, that prohibits "waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water." What constitutes a waste is relative, based on competing needs, and the determination may change as conditions change. The State Water Board's broad regulatory authority allows it to control and condition water use, consistent with public interest, including the regulation of water quality and prevention of waste in a regulation. Water

Code section 275 directs the State Water Board to take all appropriate proceedings or actions to prevent waste or violations of the reasonable use standard. In addition, all water rights are subject to the public trust doctrine. In regulating water use, the state must consider the public trust and protect the public trust when feasible. Even after an appropriation has been approved, the public trust imposes a duty of continuing supervision. In applying the public trust doctrine, the State Water Board has the power to reconsider past water allocations even if the Board considered public trust impacts in its original water allocation decision.

5.2.3 Regulations and Adjudicative Proceedings

The State Water Board makes decisions in accordance with its water quality and water right authorities described above. The State Water Board conducts both quasi-legislative and quasi-judicial administrative proceedings, and different rules apply depending on the type of action pending before the State Water Board. An adjudicative proceeding is a hearing to receive evidence for determination of facts pursuant to which the Board formulates and issues a decision. A decision determines a legal right, duty, privilege, immunity, or other legal interest of a particular person or persons. Examples of adjudicative proceedings include hearings to receive evidence concerning decisions or orders on water right applications, petitions, or complaints; cease and desist orders; and orders setting administrative civil liability. In the past, the State Water Board has conducted adjudicative water right hearings to implement the Bay-Delta Plan. The procedural rules are similar to a court in that testimony is submitted and subject to cross-examination and rebuttal, evidentiary motions may be made, and ex parte communications with the decision-maker are prohibited. This type of hearing is best suited for cases with a discreet set of issues and limited individual parties.

Rulemaking and informational proceedings, including hearings for the adoption or amendment of regulations, water quality control plans or state policy for water quality control, and hearings to gather information to assist the State Water Board in formulating policy for future action, are not adjudicative proceedings and are subject to different procedures. (See Cal. Code Regs., tit. 23, § 649 et. seq.) A rulemaking proceeding is most effective when a large number of parties will be subject to the regulation. The process can be time and resource intensive, but the procedures are less structured and better tailored for actions that require a comprehensive approach. The basin planning process is a rulemaking proceeding.

5.3 Reason for the Proposed Plan Amendments

As described in detail in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*, since the time the Bay-Delta Plan was last updated and implemented, populations of native aquatic species in the Bay-Delta watershed have shown significant signs of decline due to a combination of factors, including hydrologic modifications, non-flow physical habitat degradation, water quality impairments, and climate change.

Scientific information indicates that restoration of more natural flow functions is needed to address these declines in an integrated fashion with physical habitat improvements. Though various state and federal agencies have adopted requirements to protect the Bay-Delta ecosystem, a comprehensive regulatory strategy does not currently exist.

The current requirements are minimal, as described further below, and are focused on the Delta without considering the needs of the watershed or how those flows are provided. Specifically, a

number of tributaries do not have requirements to protect fish and wildlife or have minimal requirements. Current conditions may be protective of fish and wildlife in some locations, but action is needed to ensure that conditions are not degraded in the future and that conditions in the Bay-Delta improve based on more complete and coordinated watershed management.

As described in Chapter 2, *Hydrology and Water Supply*, under the current requirements, flows are completely eliminated or significantly reduced at certain times in some streams in the Sacramento/Delta watershed and flows out of the Delta are significantly reduced at times. At the same time, dams in the watershed disconnect migratory corridors for native aquatic species, blocking access to significant portions of historical habitat while impeding the downstream flow of nutrients, gravels, woody debris, and other materials that are the building blocks of the food chain and habitat for native species. Dams and other diversions also significantly alter the timing and quality of flows in ways that affect fish and wildlife, including through eliminating and altering peak and base flow events and changing the temperature, dissolved oxygen, salinity, and other water quality parameters. Further, water diversions in the Delta can entrain or impinge native fish and other aquatic organisms and alter circulation patterns, affecting migration of native fish, water quality, and Delta habitat conditions for these species.

Total average annual unimpaired outflows from the Bay-Delta watershed are about 28.5 million acre-feet (MAF). Upstream diversions and water exports have reduced annual average outflows by a little less than half (to 15.5 MAF), and outflows during the critical January-through-June period by more than half. However, average regulatory minimum Delta outflows are only about 5 MAF—or about a third of current average outflows and less than 20 percent of average unimpaired outflows. Existing regulatory minimum Delta outflows are too low to protect the ecosystem; without additional instream flow protections, existing flows may be reduced in the future as new storage and diversion facilities are constructed and as population growth continues. These effects are exacerbated by climate change.

As described in more detail in Chapter 2, *Hydrology and Water Supply*, existing claimed consumptive (not including power and other non-consumptive uses) water rights in the Bay-Delta watershed already are many times the total annual average unimpaired flows in the watershed. Although there is not demand for all of this water every year (e.g., once reservoirs are filled, they maintain a significant amount of storage from year to year), there likely is a significant amount of duplication in claims of water rights, and other issues that make the claimed water rights a larger number than the actual yearly demand, these figures indicate that there may be substantial future demands for water under existing water rights. In addition to existing water right claims, new water rights may be requested under new applications and state-filed water rights. As discussed above, these state-filed water rights maintain the water right priority of the date they were established, which for many date back close to 100 years ago. The remaining amounts of water that have not been allocated under these filings exceed the average annual unimpaired annual runoff from the Bay-Delta watershed.

During recent droughts, the current minimal objectives were not met and temperature management concerns were significant, frequently resulting in poor conditions for native fish and wildlife. Currently, most water users in the basin do not have limitations on their diversions to ensure that the Bay-Delta Plan objectives are met. Because of this limited responsibility, the Projects (the collective term for CVP and SWP) frequently release previously stored water to meet water quality objectives and supplement other water user demands in the watershed. Because the existing Bay-Delta Plan objectives in the Sacramento/Delta are fairly minimal, much of the time Delta outflow and

salinity requirements are met incidentally; but, in most years, the Projects must release some water from storage to comply with objectives during summer and fall. This results in reduced storage to meet water quality objectives and to provide for cold water releases. While a limited number of junior water right holders include a provision in their water right permits and licenses (Standard Water Right Term 91) that limits their diversions when the Projects are providing water from storage to meet objectives in the Delta, most water users in the watershed currently are not subject to such provisions. In addition, climate change has and is likely to continue to increase flow variability and shift the timing of flows, supporting an approach that can adjust to these changes and provides flexibility.

Changes to the Sacramento/Delta provisions in the Bay-Delta Plan could help to provide a regulatory regime that addresses the above issues by providing comprehensive minimum instream flow and cold water habitat provisions and distributing the responsibilities more broadly across the watershed in a way that adjusts to available supplies and provides for flexibility. In addition to flow-related actions, actions by others may be needed to address climate change, including fish passage projects, riparian reforestation, other habitat restoration, and other measures. The specific basis for each of the possible objectives is further discussed below, followed by a discussion of the associated possible program of implementation.

5.4 Proposed New and Modified Objectives and Implementation

This section describes the existing Bay-Delta Plan requirements for fish and wildlife in the Sacramento/Delta and possible additional requirements that would be added to the Bay-Delta Plan. Proposed changes to Bay-Delta Plan objectives include new or modified narrative and numeric objectives, including new inflow and cold water habitat objectives for the Sacramento/Delta tributaries, new Delta outflow objectives, and new interior Delta flow objectives. Tributaries where the new inflow and cold water habitat objectives would apply include tributaries in the Sacramento River watershed (i.e., the mainstem Sacramento River, Clear Creek, Cow Creek, Bear Creek, Cottonwood Creek, Battle Creek, Paynes Creek, Antelope Creek, Mill Creek, Elder Creek, Deer Creek, Thomes Creek, Big Chico Creek, Stony Creek, Feather River, Butte Creek, Yuba River, Bear River, Cache Creek, Putah Creek, the American River) and Delta eastside tributaries (i.e., the Cosumnes River, Mokelumne River, Calaveras River). The interior Delta and Delta outflow objectives would apply in the Delta. (See Figure 1-1a in Chapter 1, *Executive Summary*)

5.4.1 Voluntary and Default Implementation

The State Water Board has responsibility for addressing flow and other water quality impairments but recognizes that additional tools to improve ecological conditions can be brought to bear through voluntary measures. Accordingly, the program of implementation described in this chapter provides for voluntary implementation plans to implement the proposed Plan amendments. The voluntary implementation plans discussed in this chapter for the proposed Plan amendments are different than the proposed VAs submitted in 2022 and discussed in Chapter 9, *Proposed Voluntary Agreements*. The voluntary implementation plans discussed in this chapter are relevant to implementing the objectives described in this chapter, which are different than the objectives proposed in the 2022 proposed VAs. While enhanced flows are the principal means identified to

implement the objectives discussed in this chapter, the State Water Board recognizes that other measures also are needed that could be implemented, including measures to address barriers to fish passage, habitat loss, predation, increased water temperature, contaminants, and other conditions. Voluntary measures can provide large-scale benefits (like habitat restoration) that will amplify the ecological benefit of new and existing flows beyond what the State Water Board can require through flow and water project operations alone. Voluntary implementation plans also may reduce the volume of water that needs to be dedicated for instream purposes under the proposed objectives, and therefore reduce the potential impacts associated with decreased consumptive water uses, such as impacts on agriculture.

5.4.1.1 Processes and Requirements for Voluntary Implementation Plans

As discussed further below, voluntary implementation plans would need to fulfill certain requirements at a minimum to meet the objectives described in this chapter and to be considered by the State Water Board. Voluntary implementation plans would need to ensure compliance with applicable narrative and numeric objectives and include provisions for transparency and accountability; monitoring and reporting; and planning, adaptive management, and periodic evaluation. Voluntary implementation plans also would be required to include provisions to avoid redirected impacts on terrestrial species (including refuges), groundwater, hydropower to the extent possible, and other undesirable effects and provisions to address droughts and minimum health and safety needs.

In evaluating any voluntary implementation plans, the Board would need to make an independent finding to determine whether the plan would be enforceable and would contribute to achieving the water quality objectives and protection of fish and wildlife beneficial uses. Prior to submittal of any proposed voluntary implementation plans to the State Water Board, the proponents would be required to receive the concurrence of CDFW and to consult with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and other appropriate entities with a major role in provisions of the plan. Any comments from the fisheries agencies or other significant comments affecting the viability of the plan would be considered by the State Water Board prior to accepting a voluntary implementation plan. The public also would have the opportunity to review and comment on any voluntary implementation plans prior to the State Water Board's approval. Voluntary implementation plans not supported by CDFW could be considered for approval by the State Water Board but would require a public process on the parts of the agreement that were not agreeable to CDFW, the basis for that disagreement, and possible resolutions to the disagreements. After this process, if the State Water Board decided to approve a plan that did not have CDFW's support, the Board would be required to explain the basis for such approval and measures that the Board would take to ensure that the plan is in compliance with the narrative and numeric objectives.

Absent successful voluntary implementation plans, default provisions for implementing the proposed Plan amendments would apply, and the State Water Board would proceed to implement the Plan in the most efficient and effective manner possible using its various water quality and water right authorities. Specific voluntary and default provisions are described for each objective below. Those measures include adaptive management provisions and flexibilities that would apply for either the voluntary or default processes to maximize the benefits of flows in protecting native fish and wildlife in a reasonable manner with protection of other beneficial uses of water. In the voluntary processes, water users would have the opportunity to propose measures. While in the default process, the State Water Board would be responsible for directing adaptive management and

flexibility if appropriate and necessary. Adaptive management through either voluntary or default implementation measures would be required to be informed by regular monitoring and evaluation of the effectiveness of the measures in meeting the narrative objectives and biological goals (discussed in Section 5.6, *General Changes to the Program of Implementation*). Adaptive management actions would be subject to concurrence by CDFW, or the process described above if CDFW does not concur, and consultation with the federal fish agencies and approval by the State Water Board.

To pursue a voluntary implementation plan, water users would be required to submit a plan for developing a voluntary implementation plan to the State Water Board. Water users would be provided time to organize and develop voluntary implementation plans and supporting information while ensuring that voluntary efforts do not result in undue delay and deferral of implementation of the objectives. To pursue the voluntary implementation described below, it is proposed that, within 6 months of approval of the Plan amendments by the Office of Administrative Law (OAL), water users could either submit a proposed voluntary implementation plan to the State Water Board consistent with the provisions below or could submit an executed memorandum of understanding (MOU) to the Executive Director committing to development of a voluntary implementation plan. The Executive Director could provide an additional 6 months to develop an MOU for good cause shown that the additional time is likely to result in a successful voluntary implementation plan. The MOUs would be required to indicate to the satisfaction of the State Water Board's Executive Director that such groups are adequately organized, funded, and committed to successfully develop voluntary implementation plans to implement the objectives.

At a minimum, the MOUs would be required to identify the following.

1. All water users who have agreed to participate in development of a voluntary implementation plan and those who have not and how the voluntary implementation plan can be successfully developed without those water users.
2. A time schedule with deliverable milestones for development and implementation of the voluntary implementation plan, including interim milestones and deliverables.
3. A staffing and funding agreement to develop the voluntary implementation plan, including the resources necessary to develop and implement the plan.

Proposed voluntary implementation plans would be required to be submitted to the State Water Board within 1 year from approval of the Plan amendments by OAL. The Executive Director could provide up to 1 additional year for development of voluntary implementation plans for good cause shown. The voluntary implementation plans could include a time schedule for implementation that provides for the plans to begin implementation within 1 year of approval and be completely implemented within 3 years of approval. An additional 2 years could be approved by the State Water Board to achieve full implementation for good cause shown. At a minimum, voluntary implementation plans would be required to identify the following.

1. Specific proposed flow and cold water habitat provisions as applicable.
2. Specific information regarding the entities and their roles and responsibilities in implementing the voluntary implementation plan provisions.
3. A time schedule for implementation and specific commitments by participants to the voluntary implementation plans.
4. The proposed strategy for implementing the objectives, including proposed flow levels and time steps on which those flows will be implemented; a description of any other complementary

habitat restoration or other measures that will be implemented; adaptive management provisions; and an analysis of how the proposed measures meet the narrative and numeric objectives as applicable.

5. Provisions for development and implementation of annual operations plans for approval by the Executive Director of the State Water Board, including provisions for adaptive management; coordination with the State Water Board, fisheries agencies, and other appropriate entities.
6. Compliance monitoring and accounting measures in conformance with the above, including provisions for gaging flow and temperature levels and reporting the monitoring data electronically on a regular basis; accounting provisions for accretions and depletions; provisions for coordinating diversions to ensure that the flows are achieved; and other provisions necessary to ensure compliance with the objectives.
7. Effectiveness monitoring, special study, and adaptive management provisions in conformance with the above, identifying how the measures will be regularly evaluated and assessed.
8. Provisions for assessment and review consistent with the above, including annual, interim, and long-term measures to determine progress toward achieving the biological goals and narrative objectives and to inform whether changes should be made to the implementation measures.

The voluntary implementation plans also would be required to include provisions for the following and identify the basis for those measures.

1. Integration with measures to implement the Sustainable Groundwater Management Act (SGMA) and other measures needed to ensure no redirected groundwater impacts from implementation of the plans on groundwater overdraft, subsidence, groundwater-dependent ecosystems, and streamflows over the short and long term.
2. Avoiding impacts on refuges and native species of concern, including giant garter snakes, birds on the Pacific Flyway, and other species.
3. Measures to plan for and effectively protect aquatic beneficial uses during sustained dry conditions, including droughts.
4. As applicable, measures for ensuring minimum health and safety water supplies for human uses, fire suppression, and other critical purposes.
5. As applicable, identification of measures that will prevent flooding impacts.
6. To the extent possible, measures that minimize disruptions to other important beneficial uses, including municipal uses, hydropower, agriculture, and recreation.

If voluntary groups are not formed and an adequate plan is not submitted in the time allotted, or if the voluntary groups are not meeting the time schedules identified for development or implementation of the voluntary implementation plans, default implementation provisions would apply as described below. After the time allotted, voluntary groups could still form but would be subject to the default provisions until such time as they develop and begin to implement a successful voluntary implementation plan.

Default implementation would begin as soon as possible on streams that are not pursuing the voluntary process discussed above and would begin within 2 years of approval of the proposed Plan amendments by OAL or sooner. Immediately upon adoption of the proposed Plan amendments, the State Water Board would undertake and expedite efforts to develop initial implementation tools

followed by refined tools as needed for determining streamflows and accounting methodologies to administer the water right priority system to achieve the new flow objectives. Refinements would be made on a systematic basis through specific tributary/regional investigations to refine water right implementation activities, including refining assumptions for water right priorities and uses; compliance monitoring and evaluation, including monitoring and gage locations; assumptions for accretions and depletions, including return flows; and flow and cold water habitat measures using the flexibilities described below. Within 9 months from approval of the Plan amendments by OAL, the State Water Board would develop and release a schedule for systematic review of tributaries subject to the new requirements. The State Water Board would prioritize its systematic review starting with the highest-value tributaries/regions (e.g., based on level of impairment, contribution to outflow, fisheries, number of diverters). The schedule for systematic review may be adjusted in light of successful voluntary efforts or if information suggests that a specific tributary/region requires earlier review. In addition, the State Water Board may need to conduct short-term evaluations for specific tributaries/regions if the need arises due to temperature concerns, groundwater depletions, health and safety concerns, or other relevant factors. This process is discussed in more detail below.

5.4.2 Inflows

5.4.2.1 Existing Requirements

The only inflow objectives for the Sacramento River/Delta tributaries in the Bay-Delta Plan are minimal monthly average flows on the Sacramento River at Rio Vista for September through December that range from 3,000 to 4,500 cubic feet per second (cfs) based on water year types.[4] There is an additional requirement that the 7-day running average flow during this period not be less than 1,000 cfs below the monthly objective.

D-1641 currently assigns responsibility to DWR and Reclamation for meeting these flow requirements through conditions of their water rights for the SWP and CVP. There are currently no other instream flow requirements for the Sacramento River basin and Delta eastside tributaries in the Bay-Delta Plan. However, numerous other existing agreements and various regulatory requirements apply some flow requirements to specific tributaries.

D-1641 specifically includes flow requirements on the Mokelumne River from the Mokelumne River Joint Settlement Agreement as that tributary's contribution to meeting existing Bay-Delta Plan requirements.[5] D-1641 requires releases from Camanche Reservoir based on time period and water year type. From July through September, releases are required to be at least 100 cfs. For all other months of the year, releases are required to be at least 100 to 325 cfs.

Existing outflow requirements result in inflows; however, only DWR and Reclamation are responsible for those requirements, which can affect DWR and Reclamation's ability to retain storage for cold water and instream flows throughout the year. There are some flow requirements for other tributaries, but those requirements are not consistent between tributaries or coordinated

[4] Flows in September of all year types are required to be 3,000 cfs. Flows in October of critical year types are required to be 3,000 cfs; in all other year types, flows are required to be 4,000 cfs. Flows in November and December of critical year types are required to be 3,500 cfs; in all other year types, flows are required to be 4,500 cfs.

[5] See D-1641, pages 170–178.

with Bay-Delta Plan Delta outflow requirements. Some tributaries also have no flow requirements at all. While conditions may currently be protective of fish and wildlife in some of these tributaries, flow requirements are needed to prevent future impacts on fish and wildlife. In addition, some of these tributaries may dry up at times of year, affecting native fish and wildlife due to the lack of flow requirements; and other tributaries may have inadequate flow and water quality conditions to protect fisheries resources. Year-round inflow requirements are proposed in the Sacramento/Delta tributaries to address these issues.

5.4.2.2 Basis for New Inflow Objective

Currently, inflows to the Delta are largely controlled by upstream water withdrawals and releases for water supply, power production, and flood control. As a result, inflows from tributaries do not provide habitat or contribute flow to the Delta in the same proportions as they would have naturally. At the same time, historical upstream habitat for salmonids and other species on many tributaries is blocked by dams and other structures. As discussed in Chapter 2, *Hydrology and Water Supply*, construction of upstream dams and increased in-basin water demand have resulted in a decrease in net annual inflow to the Delta and a seasonal shift in inflows from winter-spring to summer-fall. Peak runoff from winter rainstorms and spring snowmelt is now captured in the upstream reservoirs and released later for downstream use. The result of water development in the Sacramento River basin is a river system with less seasonal and annual variability and a smaller total outflow, with outflows reduced by more than 60 percent in some years and by more than 80 percent in certain months as identified in Chapter 2. Regulated tributaries (tributaries with major on-stream reservoirs) to the Sacramento River and Delta show similar altered seasonal and annual flow patterns, with flow significantly reduced in some of the tributaries by more than 80 percent on an annual basis and 100 percent in certain months.

Water development also has altered the hydrology of unregulated tributaries (tributaries without major storage reservoirs) to the Sacramento River and Delta (^NMFS 2014a). These smaller waterways do not have large water storage facilities in their upper basin but often have small dams and other diversion structures on the valley floor above the confluence with the Sacramento River and Delta. The diversions in some tributaries reduce much, and at times all, of downstream channel flow during spring and summer, with the greatest impairments occurring in June through September of drier years when flows may be reduced by more than 90 percent in drier years on some streams and 100 percent in some months.

Inflows are needed to protect native fish and wildlife species that inhabit the Sacramento/Delta tributaries throughout the year as juveniles or adults (see Figure 1-1a). Inflows are needed to provide, for example, continuity of flows from tributaries to the Delta and to protect anadromous (primarily Chinook salmon and steelhead) and other fish and wildlife species that inhabit the Bay-Delta and its tributaries throughout the year as juveniles or adults. Inflows are needed to provide suitable habitat conditions for migration and rearing of anadromous fish species like salmonids, with runs that inhabit the Delta and its tributaries all year. Those flows also are needed to contribute to Delta outflows to support migrating, spawning, and rearing estuarine species. Preservation of higher flows already being provided in some less impaired tributaries also is needed to maintain existing protective conditions where existing flows are providing important functions to ensure that those flows are not reduced.

Specifically, flows that more closely mimic the conditions to which native fish species have adapted, including the frequency, quality, timing, magnitude, and duration of flows, as well as the

proportionality of flows from tributaries, would be expected to improve protection of native species. These flow attributes would support key functions, including floodplain inundation, temperature control, migratory cues, reduced stranding and straying, and other functions. Providing appropriate flow conditions throughout the watershed and throughout the year also would support genetic and life history diversity that allows native species to distribute the risks that disturbances from droughts, fires, disease, food availability, and other natural and anthropogenic stressors present to populations.

As discussed in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*, at least one salmonid run is migrating through, rearing in, or holding in the Sacramento River, its tributaries, or the Delta and its tributaries each month of the year—supporting the need for year-round tributary inflows. Adult salmonids require tributary flows of sufficient magnitude to provide the olfactory cues to find, enter, hold, and spawn in their natal streams (^Moyle 2002). Juvenile salmonids also require tributary flows with adequate temperature and dissolved oxygen levels for rearing and successful emigration. A lack of tributary flow affects hydrologic connectivity between tributaries and the mainstem Sacramento River and Delta and reduces juvenile rearing habitat quantity and quality.

As discussed in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*, flows greater than about 20,000 cfs from February through June on the lower Sacramento River have been found to increase survival and abundance of juvenile fall- and winter-run Chinook salmon. Flows of this magnitude also are expected to aid in emigration of juvenile spring-run Chinook salmon and steelhead. In half of all years, flows in April and May are currently less than 50 percent of unimpaired flows in the lower Sacramento River, reducing the occurrence of flows of 20,000 cfs or more in the lower Sacramento River.

5.4.2.3 Proposed Inflow Objective

To improve ecosystem functions on the tributaries, including by providing appropriate habitat conditions for adult salmonid immigration and holding and juvenile rearing and outmigration, and to connect flows from throughout the watershed with the Delta to support native estuarine species, a new inflow objective is proposed for the Sacramento/Delta tributaries as part of the proposed Plan amendments.

The new inflow objective would be integrated with the cold water habitat protection and Delta outflow objectives for the proposed Plan amendments to provide comprehensive protection of the Bay-Delta watershed ecosystem. As discussed further below, the proposed inflow objective also is intended to provide for increasing the frequency and duration of floodplain inundation for the benefit of native species.

To help guide implementation actions, the proposed new inflow objective includes both a narrative and numeric component. The narrative portion of the inflow objective (1) describes the needs for inflows to provide appropriate conditions in tributaries and to contribute flows to the Delta; and (2) describes the conditions the numeric inflows and other provisions in the Bay-Delta Plan are intended to produce.

As discussed above and in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*, there are salmonid species in the Sacramento/Delta year-round as well as other aquatic species that require adequate flows from the tributaries for their protection. As such, the inflow objective is proposed to be year-round. Inflows from the tributaries also are needed to

contribute to outflows to protect estuarine species. Accordingly, the inflow objectives are intended to contribute to outflows as discussed further in the *Delta Outflows* section. In recognition of the need to provide for an interconnected watershed that promotes genetic, spatial, and life history diversity, the flows would apply on all the Sacramento/Delta tributaries that contribute to salmon protection. In accordance with the holistic instream flow approach discussed in Chapter 3, a percent of unimpaired flow approach is proposed for the numeric portion of the objective that would require a portion of the inflows to the tributaries to be left in the stream for environmental flow purposes, including inflow and Delta outflow purposes.

To provide flexibility to address the unique circumstances of different tributaries and actions that may be taken to implement the inflow objective on those tributaries both initially and over time, the objective is proposed to include a range of possible flows. As discussed in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*, 10-percent increments of unimpaired flows between 35 and 75 percent (referred to as *scenarios*) were evaluated. Those evaluations show that inflows in the 55 scenario (and corresponding outflow) would be expected to provide marked expected improvements in protection of fish and wildlife beneficial uses, including achievement of the flow thresholds associated with protection of various aquatic species and achievement of floodplain inundation acreage. These improvements are greater in the 65 scenario; however, conservation of cold water resources in reservoirs becomes more challenging at this level, and water supply costs increase substantially (discussed more in Chapter 6, *Changes in Hydrology and Water Supply*; Chapter 7, *Environmental Analysis*; and Chapter 8, *Economic Analysis and Other Considerations*). At the 75 scenario, the water supply costs are large, and cold water conservation is very difficult—particularly without significant additional water supply costs. Expected benefits to fish and wildlife are marginal in the 45 scenario but could be increased by implementing complementary ecosystem actions; on some tributaries, it may not be possible to maintain cold water pool protections and any meaningful level of water supplies while meeting a higher flow level.

Based on the above, the proposed flow range is between 45 and 65 percent of unimpaired flow. Because 55 percent of unimpaired flow is the flow level at which more significant improvements to fish and wildlife beneficial uses are expected and cold water supplies can still be maintained, the proposed starting point for the flow level is 55 percent. As discussed further below, the proposed program of implementation provides for adaptive management within the proposed flow range. Flows may be lower in the range in cases (1) where there are successful voluntary implementation plans demonstrating that they achieve the narrative objective using a combination of flow and other measures; or (2) if the State Water Board determines that lower flows are needed to meet the narrative objective, including to preserve reservoir storage supplies needed to maintain water quality and temperature conditions later in the same year or in the following year for the protection of native fish species. Under the proposed inflow objective, inflows would be required to be at least 45 percent of unimpaired flow. Under the proposed inflow objective, flows may be higher in the range on tributaries where flows under current conditions are already higher than 55 percent and where those higher flows are needed to protect fish and wildlife and meet the narrative objective. Required flows also may be higher than the 55 scenario if lower flow levels are not achieving the narrative objective and protecting fish and wildlife beneficial uses–specifically, if biological goals (described further in Section 5.6.1.4, *Effectiveness Measures and Adaptive Management*) are not being met, and monitoring and assessment information indicates that higher flows are needed. Flows would not be required to be higher than 65 percent of unimpaired flow (unless flows are already above that level and those flows are needed to protect fish and wildlife) because those higher flows may not provide for reasonable protection of fish and wildlife, including the ability to

maintain carryover storage for cold water habitat while meeting water supplies (as discussed further in Chapter 6, *Changes in Hydrology and Water Supply*; Chapter 7, *Environmental Analysis*; and Chapter 8, *Economic Analysis and Other Considerations*).

Based on the above, the proposed inflow objective is as follows:

> *Maintain inflow conditions from the Sacramento River/Delta tributaries sufficient to support and maintain the natural production of viable native fish populations and to contribute to Delta outflows. Inflow conditions that reasonably contribute toward maintaining viable native fish populations include, but may not be limited to, flows that more closely mimic the natural hydrographic conditions to which native fish species are adapted, including the relative magnitude, duration, timing, quality, and spatial extent of flows as they would naturally occur.*
>
> *Maintain inflows from the Sacramento/Delta tributaries at 55% of unimpaired flow, within an allowed adaptive range between 45 and 65% of unimpaired flow.*

Compliance points would be established at the confluence of tributaries with the Sacramento River; at the confluence with the Delta for the Cosumnes, Calaveras, and Mokelumne Rivers; and on the mainstem of the Sacramento River at the confluence with the Delta. To ensure that the narrative objective is met and that necessary flow contributions from various stretches of tributaries and the mainstem Sacramento River are achieved, intermediate compliance points also could be established as necessary. Regardless of where various compliance points are established, the inflows under the proposed inflow objective are intended to flow out of the Delta. In recognition that, for some tributaries, actions to achieve reasonable protection of fish and wildlife might be best developed between groups of tributaries, the proposed program of implementation would allow two or more tributaries to work together to meet the numeric objective.

In addition to the above, the existing Sacramento River at Rio Vista inflow objective during September through December would be retained to maintain the minimal level of protection currently provided by these base flows.

5.4.2.4 Implementation

Both the narrative and numeric portions of the inflow objective are proposed to apply throughout the watershed, including on upstream tributaries, on all the Sacramento/Delta tributaries that support or contribute to the protection of anadromous fish species (Figure 1-1a). Under the proposed program of implementation, all water users on these tributaries, except those with a *de minimis* effect on flows (e.g., 10 AF/yr or less), would have responsibility for contributing to achievement of the objective. Subject to possible modifications for drought, public health and safety, public trust obligations for wildlife refuges, or alternative arrangement in a voluntary implementation plan, implementation of the flow objective would be required to be met in order of water right priority. In some year types when water may not be available for all users, shortages would be borne in order of priority, starting with the most junior water rights. Smaller naturally intermittent streams that do not support anadromous fish and have little effect on the Bay-Delta ecosystem would not be subject to the numeric inflow objective at this time.

The compliance points for the inflow objectives would be the confluence of the tributaries with the Sacramento or Feather Rivers or the Delta. Inflows bypassed or released to meet the objective are not available for subsequent diversion past the tributary confluence and through the Delta. In addition to the inflows, water needed to meet more senior water rights past the tributary confluence would need to be bypassed or released. Compliance locations could be refined to account for gaging issues, including backwater effects and other factors, and additional compliance points could be

identified to ensure that the inflow objectives are achieved. The Executive Director would have authority to determine required compliance locations with input from appropriate entities, including the fisheries agencies, DWR, Reclamation, U.S. Geological Survey (USGS), water users, and others as appropriate.

In addition to requiring that the numeric flow levels be achieved on tributaries, the proposed program of implementation would require that existing flows be maintained on tributaries with flows that are already higher than the required numeric levels if those flows are needed to reasonably protect fish and wildlife. Fully Appropriated Stream Systems (FASS) Declaration could be pursued to prevent additional water right permits from being issued on these streams as needed.

The program of implementation for the inflow objective is intended to provide for floodplain inundation to benefit native species. It is not intended to be implemented in a way that contributes to flooding-related public safety concerns and major property damage. The inflow objectives would be required to be implemented in coordination with existing requirements, including FERC license conditions and biological opinion (BiOp) provisions, and to avoid impacts on hydropower production to the extent practical.

No changes are proposed to the existing implementation of the Sacramento River at Rio Vista flow objective that DWR and Reclamation are currently responsible for implementing. The other complementary ecosystem measures would contribute to achievement of the narrative portion of the inflow objective. The existing and proposed inflow objectives also would contribute toward implementing the existing narrative salmon protection and the other proposed narrative objectives.

Default Implementation

Water users on the tributaries would have the opportunity to propose voluntary implementation plans to implement the inflow and cold water habitat objectives and contribute to the inflow-based Delta outflow objective (specific provisions for implementing the cold water habitat objective and inflow-based outflow objective are described below). Absent processes to develop and implement voluntary implementation plans on the time schedules specified below, default implementation provisions would apply. Water users could pursue voluntary implementation plans after the time schedules provided below, but those water users would be subject to the following default implementation provisions until such time as voluntary implementation plans were approved and implemented.

For the most part, all water users would be subject to the inflow objective following the rule of water right priority, unless adjustments are needed to conform to the narrative objectives or exceptions apply. Under the default provisions, water users would be required to limit their diversions to provide 55 percent unimpaired flow, based on a minimum 7-day running average, measured at the confluence of the tributary or other locations determined by the Executive Director to be necessary to ensure compliance with the objective.

Temporary (less than 1 year) adjustments to these requirements within the numeric flow range would be allowed per the flexibilities provided in voluntary implementation plans to maximize the protection of fish and wildlife, if approved by the State Water Board. Specifically, modifications could be made to improve temperature control and to provide for specific functional flows, including for Delta outflow purposes. Any modifications for temperature control purposes would need to be supported by specific modeling or other technical information that demonstrates the need for the change and provides for a comparable assessment of temperatures or other parameters with and

without the change, as well as information regarding the effect of the change on tributary flows for other purposes (e.g., floodplain inundation, passage) and on Delta outflows.

The State Water Board may need to refine the default implementation measures on a tributary basis over time to maximize benefits for native fish and wildlife while avoiding redirected impacts by developing tributary plans. Within 6 months from approval by OAL, the State Water Board would develop and release a schedule for systematic review of tributaries subject to the new requirements, starting with the highest-value tributaries. The schedule for systematic review may be adjusted in light of successful voluntary efforts, or if information suggests that a specific tributary requires earlier review. In addition, the State Water Board may need to conduct short-term evaluations for specific tributaries if the need arises due to temperature concerns, groundwater depletions, health and safety concerns or other relevant factors.

Refinements could be made using the same flexibilities allowed for in the voluntary implementation plans in coordination with CDFW and in consultation with the federal fisheries agencies, water users, and other interested parties. Specific refinements could be made to integrate the inflow and cold water habitat provisions and the inflow and Delta outflow provisions, as described further below; provide for specific functions to support native species; integrate inflows with physical habitat restoration measures and other measures to protect fish and wildlife; and address droughts and provide for minimal health and safety water supplies. Refinements would be prioritized based on the importance of the watershed to protection of fish and wildlife beneficial uses. As discussed in Section 5.6, *General Changes to the Program of Implementation*, specific compliance and effectiveness monitoring, reporting, and evaluation provisions would apply for the default implementation of the inflow objective and responsibilities for water users subject to the default provisions to contribute to these efforts.

Voluntary Implementation

In the voluntary implementation process, water users would have the opportunity to develop and implement voluntary implementation plans for complying with the inflow objective through a combination of flow and complementary actions, provided that those actions conform to the flexibilities provided below. Voluntary implementation plans also would be required to address compliance with the cold water habitat and inflow-based Delta outflow objectives described below. In the case of the Projects, the plans also would be required to address compliance with the Project's existing responsibilities to implement other objectives.

To provide additional flexibility, voluntary implementation plans could be developed for individual tributaries or groups of tributaries. Where two or more tributaries develop a voluntary implementation plan together, compliance with the numeric components of the objective may be shared between the tributaries, but each tributary would be required to comply with the narrative provisions of the inflow, cold water, and Delta outflow objectives. Specific quantitative accounting, including modeling and monitoring data as appropriate, would be required to show that the combined inflows would be at least equal to what would have been provided by individual tributary implementation.

The voluntary implementation plans would be required to provide 55 percent of unimpaired flow unless a lesser flow is necessary to protect cold water resources or complementary habitat restoration and other measures that achieve an equivalent level of protection to 55 percent are provided, in which case flows may be no lower than 45 percent. If flows below 55 percent are proposed, robust scientific information, including quantitative evaluations of the benefits to native

species, would be required to be submitted, indicating that the combined actions included in the agreement achieves at least the same level of protection as 55 percent and are in compliance with the narrative objectives. In tributaries that are already achieving a higher unimpaired flow level than 55 percent, voluntary implementation plans would be required to provide for protection of flows needed for the reasonable protection of fish and wildlife above 55 percent.

As part of the voluntary implementation plans, the required percent of unimpaired flow would be allowed to be managed as a volume or block of water on a seasonal basis and released on an adaptive schedule where scientific information indicates that a flow pattern different from that which would occur by tracking the unimpaired flow percentage would be protective of fish and wildlife beneficial uses based on the specific needs of individual tributaries. Specifically, the numeric requirements could be further sculpted to provide maximum benefits to fish and wildlife, including targeted pulses to cue migration, flows timed to respond to observed presence of native aquatic species, summer cold water releases, minimum flows, floodplain inundation, and other functions.

Seasonal inflows during the January-through-June period would be required to be at least 45 percent to ensure that inflows are provided to achieve outflows during the critical winter and spring period for estuarine species. The total volume of water provided during this time and on an annual basis would be required to be at least equal to the volume of water that would be provided by tracking the required unimpaired flow percentage on a 7-day average. Credit could not be provided from flood flows, hydropower releases, or other uncontrolled flows to reduce the required inflow level below what would have occurred by tracking the percent of unimpaired flow on a 7-day average. The averaging period for the flows must specifically ensure that flows are maintained to support temperature maintenance, passage, and rearing; avoid stranding and dewatering of salmonids; and provide appropriately timed contributions to Delta outflows to protect estuarine species. Modeling and related information would be required to be submitted to support the determination that the quantity of water under the voluntary implementation plan is not less than the quantity of water that would be released by tracking the percent of unimpaired flow.

Voluntary implementation plans that achieve at least 55 percent of unimpaired flow and meet the required time schedules and other provisions could be approved by the State Water Board's Executive Director. Voluntary implementation plans that would provide less than 55 percent of unimpaired flow or that do not meet the required time schedule and other provisions would be required to be approved by the State Water Board.

5.4.3 Cold Water Habitat

5.4.3.1 Existing Requirements

The current Bay-Delta Plan does not include an express requirement to protect cold water habitat downstream of reservoirs. However, the existing narrative salmon objective includes temperature management for the protection of salmonids. There are also some specific cold water habitat requirements in water right orders and decisions as well as FERC licenses, BiOps, and other agreements. In addition, Fish and Game Code section 5937 requires that "[t]he owner of any dam shall allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around, or through the dam to keep in good condition any fish that may be planted or exist below the dam." The Central Valley Water Board's Sacramento and San Joaquin River Basins Plan also includes general and specific temperature objectives, including the

requirement that temperatures not be increased more than 5˚F above natural receiving water temperatures.

While a number of different temperature management requirements exist, these requirements have not been implemented in a way that provides comprehensive temperature protection in the Sacramento/Delta watershed, and temperature control below reservoirs remains a significant concern due to lack of access to upstream cold water habitat, competing water supply demands, climate change, and other issues. For all the tributaries with major on-stream dams in the Sacramento/Delta tributaries, as well as some without major on-stream dams, the NMFS Salmon and Steelhead Recovery Plan identifies temperature management as a high-priority action that is needed to recover salmon and steelhead. Actions identified in the Recovery Plan include minimum reservoir storage levels, instream flow management, planning for temperature management, physical modifications to control temperatures, upstream passage to cold water habitat, monitoring, and other measures. (^NMFS 2014a.) The Scientific Basis Report includes more information about existing temperature requirements on the Sacramento/Delta tributaries, and the NMFS Recovery Plan includes additional information about needed temperature control measures on each of the tributaries.

5.4.3.2 Basis for the Cold Water Habitat Objective

As described in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*, salmonids require adequate cold water and flow conditions throughout their freshwater lifecycle, and particularly during the spawning and rearing period. Before construction of reservoirs and other habitat alterations, salmonids generally had year-round access to cold water habitat in higher altitudes. Since construction of dams and other habitat alterations, this access has been eliminated or substantially reduced to the detriment of salmonid populations. Remaining populations that would otherwise migrate to upstream habitat are now dependent on maintenance of suitable conditions in the downstream reaches below dams. During summer and fall, when air temperatures exert a strong influence on river temperatures, the release of cold water from reservoirs is critical for maintaining suitable cold water habitat. Under current conditions, temperature management is frequently a concern below reservoirs on many tributaries throughout summer and fall for the protection of salmon, especially during droughts and critically dry periods. Some reservoirs currently have cold water management requirements. However, comprehensive requirements do not exist for all tributaries where reservoirs are present or for tributaries without reservoirs, and the Bay-Delta Plan does not include any such requirements.

Temperature control management below reservoirs is dependent on ambient air temperatures, reservoir storage levels, reservoir releases, and operation of temperature control devices (TCD) to the extent they are present. In particular, adequate volumes of cold water storage must be maintained over the year and from year to year, and metered out through summer and fall to provide minimum flows while preserving supplies for sustained cold water management through critical temperature control seasons. Where TCDs are present in reservoirs, they can assist with temperature management by providing access to cold water deep within the reservoir and an ability to selectively withdraw water from varying depths to manage the available volume of cold water to meet downstream water temperature needs. Flows also must be managed to avoid fluctuations that cause stranding and dewatering. Careful planning, monitoring, evaluation, and adaptive management is needed that takes into account fish distributions and timing; reservoir inflows, storage, and thermal dynamics; and meteorological conditions.

There has been increasing recognition of the need for improvements in data collection and modeling to determine the most effective strategies (including both operational and facility modifications) for meeting the downstream temperature requirements of anadromous salmonids (^Anderson et al. 2015). Particularly, improvements are needed to provide more accurate predictions of the spatial and temporal distribution of sensitive life stages (Anderson et al. 2011) and to take into account the effects of other environmental variables (e.g., intergravel oxygen) on thermal stress and tolerances of these life stages (e.g., ^Martin et al. 2016). Data and modeling also are needed to determine the potential roles of other habitat restoration measures (e.g., riparian habitat restoration, gravel replenishment, channel and floodplain rehabilitation) in enhancing cold water habitat (Tompkins and Kondolf 2007).

In addition to the above, evaluation of technological, regulatory, and logistical methods of providing passage and re-introduction of salmonids to historical habitat above existing dams, or into other tributaries where cold water management is less challenging is needed.

5.4.3.3 Proposed Cold Water Habitat Objective

As a complementary measure to the inflow objective to protect salmonids and other native species in the tributaries, the proposed Plan amendments include a new cold water habitat objective for the Sacramento/Delta tributaries. The proposed objective is intended to ensure that there are no redirected impacts on cold water habitat from the new inflow and Delta outflow objectives and to address other existing and potential future temperature management concerns on the tributaries for salmonids and other native species. Because temperature requirements depend on the species of salmonid, the life stage, and other factors and because temperature management actions depend on the specific circumstances of each tributary, a narrative objective is proposed. The proposed objective would require that measures be implemented to provide cold water habitat for salmonids and other native cold water fish species on the Sacramento/Delta tributaries, including management of cold water storage and releases or alternate protective measures (including measures to install and operate TCDs, measures to provide for passage above dams, and other measures) to ensure that fish below dams are kept in good condition consistent with Fish and Game Code section 5937 and the narrative objective. To the extent that existing measures are in place for temperature control, those requirements would be reviewed to determine whether additional or updated measures are necessary to ensure that they are protective and that measures are integrated with the inflow and outflow objectives and implementation measures.

The proposed narrative objective is as follows.

> *Maintain streamflows and reservoir storage conditions on Sacramento River/Delta tributaries to protect cold water habitat for sensitive native fish species, including Chinook salmon, steelhead, and other native cold water fish species. Cold water habitat conditions to be protected include maintaining sufficient quantities of habitat with suitable temperatures on streams to support passage, holding, spawning, incubation, and rearing while preventing stranding and dewatering due to flow fluctuations.*

The narrative objective would apply on all the Sacramento/Delta tributaries that support or contribute to protection of salmonids and other native cold water fish species. As described further in the program of implementation, the owners and operators of rim reservoirs would be responsible for undertaking actions to comply with the narrative objective through voluntary or default processes. As needed, other water users would be required to contribute to these actions or undertake additional actions. Rim reservoirs are the large water supply reservoirs that "rim" the

valley floor and provide water supply, flood control, hydropower, and recreation on tributaries in the Sacramento River watershed and Delta eastside tributaries.

5.4.3.4 Implementation

The narrative cold water habitat objective is proposed to apply throughout the watershed, including upstream tributaries and distributaries, on all the Sacramento/Delta tributaries that support or contribute to the protection of native cold water fish species. Under the proposed program of implementation, all water users on these tributaries, except those with a *de minimis* effect on temperature management, would bear responsibility for contributing to achievement of the objective. Smaller, naturally intermittent streams that do not support cold water fish would not be required to comply with the inflow objective and would not be subject to the cold water habitat objective.

Because inflows and cold water habitat protection are intricately linked, the cold water habitat implementation actions are proposed to be integrated with the inflow implementation actions discussed above through the voluntary or default processes. Specific implementation measures would depend on the circumstances in individual tributaries, including structural, operational, and hydrological characteristics. Cold water management actions could include a variety of different measures depending on these circumstances, including management of reservoir storages and releases and associated TCDs, efforts to establish cold water refugia like riparian revegetation, passage above reservoirs or other impediments to allow access to cold water refugia, and other measures.

Under the proposed program of implementation, all rim reservoir owners/operators on the Sacramento/Delta tributaries, in coordination with the State Water Board and fisheries agencies, would be required to conduct an assessment of the effectiveness of cold water habitat protection measures on their tributaries and needed improvements to those measures for the purpose of complying with the cold water habitat objective. Based on that assessment, reservoir owners/operators would be required to develop a long-term strategy for implementing feasible measures to improve the protection of cold water habitat, in coordination with State Water Board and fisheries agency staff and other appropriate entities as necessary. Upstream water users would be required to participate in development of the strategies to the extent that their operations affect achievement of the narrative objective below the rim reservoirs. The strategies would be subject to approval and modification through the voluntary implementation planning process or by the Executive Director of the State Water Board through the default process.

As determined by the Executive Director of the State Water Board, upstream reservoir operators also may be required to develop their own strategies if their reservoir operations are affecting achievement of the narrative objective for stream segments above the rim reservoirs. Specifically, if stream segments below those reservoirs are not in compliance with the Central Valley Water Board's temperature objectives (including the requirement that temperatures of intrastate waters not be increased more than 5˚F above natural receiving water temperatures) or are otherwise causing elevated temperatures above current conditions, a temperature management strategy would be required. A temperature management strategy also may be required if the Executive Director determines that the stream segment is not otherwise in compliance with the cold water habitat objective based on information from the fisheries agencies and others. For tributaries without reservoirs, the cold water habitat objective would be implemented in concert with actions

to implement the inflow objective, and a separate strategy would not be required unless the Executive Director determines that one is required to comply with the narrative objective.

The strategies would be required to evaluate measures that can be taken to improve temperature management in both the short term and long term and to identify the feasibility and suitability of those measures. The strategies also would be required to include processes for implementing feasible temperature control measures in a timely and effective manner. Temperature control measures that should be evaluated include installation and improvements in TCDs, cold water bypasses, passage, riparian reforestation, operational changes, and other relevant improvements identified by the State Water Board and fisheries agency staff.

In addition to the strategies, annual operations plans would be required to be developed each year, in coordination with the State Water Board and fisheries agencies, identifying how temperature protection and related operations for the protection of salmonids and other native species would be achieved each year. Required elements of the annual operations plans would include provisions for reservoir carryover storage levels; minimum and maximum flow releases and ramping rates to provide appropriate temperature protection, preserve cold water supplies, and avoid stranding and dewatering concerns; reservoir TCD operations; adaptive management; and other relevant provisions, as well as the technical basis for those provisions. The annual plans would be subject to approval and potential modification by the Executive Director. The strategies would be required to include provisions for developing the annual plans, including time schedules that provide for planning and coordination with the State Water Board and fisheries agencies and other appropriate stakeholders, decision-making processes for temperature operations, modeling and monitoring to support development and implementation of the annual plans, adaptive management, and other measures.

Both the strategies and plans would be required to be based on the best available scientific information and to provide for integration with other relevant temperature management requirements, including BiOp and FERC requirements. The plans and strategies also would be required to include appropriate modeling, monitoring, and assessment provisions that would be subject to modification and update as directed by the Executive Director to ensure compliance with the narrative objective. The annual operations plans and long-term strategies should, to the extent possible, avoid or minimize any potential impacts of reservoir management on recreation, terrestrial species, aesthetics, power generation, cultural, and other environmental resources.

The *Habitat Restoration and Other Complementary Ecosystem Measures* described below are expected to contribute to achievement of the narrative cold water habitat objective. The proposed cold water habitat objective would contribute toward implementing the existing narrative salmon protection objective and the other proposed narrative objectives.

Default Implementation

In the absence of voluntary implementation plans, reservoir operators would be required to develop a cold water habitat management strategy within 12 months from adoption of the Plan amendments for approval by the Executive Director. The strategy may be required to be modified or refined as directed by the Executive Director prior to or following approval as needed due to new information or changed circumstances. Annual plans would then be required to be submitted by no later than April 1, or another date approved by the Executive Director, the second year after adoption of the Plan amendments for approval by the Executive Director and possible modification.

Temperature management processes already exist for some reservoirs and tributaries. To the extent that those processes already exist, they could be used to implement the cold water habitat objective as well as the other requirements for which they were developed, as approved by the Executive Director.

Voluntary Implementation

Voluntary implementation plans would be required to include specific provisions for implementing the narrative cold water habitat objective consistent with the above. On tributaries with major on-stream reservoirs, the voluntary implementation plans would be required to include a cold water habitat management strategy that would be considered for approval as part of the voluntary implementation plan. Annual cold water habitat operations plans would then be due beginning the first year of implementation of those voluntary implementation plans and every year thereafter. The annual operations plan would be subject to approval by the Executive Director, unless an alternate implementation approved as part of the voluntary implementation plan is shown to be more effective at planning for and implementing cold water habitat protective measures. Voluntary implementation plans for tributaries that do not have major storage reservoirs should also address how the plans comply with the narrative cold water habitat objective, but annual cold water habitat management plans would not be needed unless determined by the Executive Director to be needed, as described above. The cold water habitat objective would be permitted to be implemented consistent with the time schedules for development and implementation of voluntary implementation plans identified above.

5.4.4 Delta Outflows

5.4.4.1 Existing Outflow Requirements

Existing year-round Delta outflow requirements are set forth in Tables 3 and 4 (including associated footnotes and figures) of the Bay-Delta Plan and D-1641; the requirements vary depending on water year type and season. Outflow objectives include requirements for calculated minimum net flows from the Delta to Suisun and San Francisco Bays (the Net Delta Outflow Index [NDOI]) and maximum salinity requirements (measured as electrical conductivity [EC]). Since salinity in the Bay-Delta system is closely related to freshwater outflows, both types of objectives are indicators of the extent and location of low-salinity estuarine habitat. NDOI is a calculated flow expressed as Delta inflow, minus net Delta consumptive use, minus Delta exports (Bay-Delta Plan Figure 4). Chapter 2, *Hydrology and Water Supply*, discusses various issues associated with the accuracy of this calculated value.

For February through June, Delta outflow objectives are identified in footnote 10 of Table 3 and Table 4. Pursuant to footnote 10, the minimum daily NDOI during February through June is 7,100 cfs calculated as a 3-day running average.[6] This requirement may also be met by achieving either a daily average or a 14-day running average EC at the confluence of the Sacramento and San Joaquin Rivers of less than or equal to 2.64 millimhos per centimeter (mmhos/cm) (Collinsville station C2). Additional Delta outflow objectives also are contained in Table 4 based on the previous month's Eight River Index (ERI), which is an index of unimpaired flows from the eight major tributaries to

[6] An additional requirement applies in February following wetter January conditions that requires 1 day of salinity compliance downstream of Collinsville between February 1 and February 14. There are also exceptions to the February-through-June flow requirements in extremely dry conditions.

the Delta. Specifically, Table 4 requires a certain number of days of compliance with flows of 11,400 cfs or salinity compliance at Chipps Island, or flows of 29,200 cfs or salinity compliance at Port Chicago, with incrementally higher outflows in wetter hydrologic conditions.[7] For July through January, the minimum Delta outflow varies within the range of 3,000 to 8,000 cfs based on month and water year type, as specified below. Pursuant to D-1641, the Projects are solely responsible for meeting Delta outflow and other salinity requirements in the Delta included in the Bay-Delta Plan.

Table 5.2-1. Existing Delta Outflow Objectives from July to January

Water Year Type	Month	Minimum Monthly Average Net Delta Outflow Index (cfs)
Wet and above normal	July	8,000
Below normal		6,500
Dry		5,000
Critical		4,000
Wet, above normal, below normal	August	4,000
Dry		3,500
Critical		3,000
All	September	3,000
Wet, above normal, below normal, dry	October	4,000
Critical		3,000
Wet, above normal, below normal, dry	November and December	4,500
Critical		3,500
All (if Dec ERI < 800 TAF)	January	4,500
All (if Dec ERI > 800 TAF)		6,000

cfs = cubic feet per second; ERI = Eight River Index; TAF = thousand acre-feet

For January, the objective is increased to 6,000 cfs if the December ERI is greater than 800 TAF. For all months, if the value is less than or equal to 5,000 cfs, the 7-day running average shall not be less than 1,000 cfs below the value; if the value is greater than 5,000 cfs, the 7-day running average shall not be less than 80 percent of the value.

DWR and Reclamation have additional outflow obligations under the USFWS 2019 BiOp to improve fall habitat for Delta smelt during September and October following wet and above-normal water years. The USFWS 2019 BiOp requires Delta outflows sufficient to maintain average X2[8] for September and October no greater than 80 kilometers (km) in the fall following wet years and above-normal years.

5.4.4.2 Basis for New and Revised Delta Outflow Objectives

Delta outflows are needed throughout the year to support and maintain the natural production of viable native fish populations residing in, rearing in, or migrating through the estuary. As discussed in Chapter 2, *Hydrology and Water Supply*, Delta outflows have been reduced over time from water

[7] Pursuant to footnote 9 of Table 3 of D-1641, the ERI refers to the sum of the unimpaired runoff as published in DWR Bulletin 120 for the following locations: Sacramento River flow at Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River flow at Smartville; American River, total inflow to Folsom Reservoir; Stanislaus River, total inflow to New Melones Reservoir; Tuolumne River, total inflow to Don Pedro Reservoir; Merced River, total inflow to Exchequer Reservoir; and San Joaquin River, total inflow to Millerton Lake.

[8] X2 is the location in the Bay-Delta where the tidally averaged bottom salinity is 2 parts per thousand. It is expressed as the distance in kilometers from the Golden Gate Bridge.

withdrawals, resulting in reduced suitable habitat for estuarine species. Existing Delta outflow requirements are far below existing Delta outflow levels and are likely to be reduced over time without additional instream flow protection.

The hydrology and other characteristics of the Delta ecosystem have been significantly altered due to development of agriculture and urbanization in the watershed and in other areas of the state that rely on water supplies from the Delta. Every major stream in the watershed includes significant diversions of water for consumptive uses, power production, and flood control; and nearly every major tributary includes several dams for these purposes. These diversions of water and the other alterations have affected the ecosystem; future modifications due to increasing water demands and climate change have the potential to further affect the ecosystem. The combined effects of water exports and upstream diversions have contributed to reduce the average annual net outflow from the Delta over time, with reductions of 33 percent from 1948 to 1968 and reductions of 48 percent from 1986 to 2005 compared with unimpaired conditions (^Fleenor et al. 2010). Since the 1990s, there also has been a significant decline in spring outflow and a reduction in the variability of Delta outflow throughout the year (see Figure 2.4-7 in Chapter 2, *Hydrology and Water Supply*) due in part to water diversions as well as hydrology.

The effects of the flow regime on the ecosystem of the Bay-Delta estuary and several estuarine-dependent species are documented in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*. The distribution and abundance of a diverse array of estuarine species at all levels of the food web respond positively to increased Delta outflow. Several scientifically based mechanisms generally related to reproduction and recruitment have been identified to explain these relationships. Although there is no definitive understanding of these mechanisms, the available scientific information supports the conclusion that greater quantities of Delta outflow are needed to support estuarine processes, habitat, and the species that depend on them. Native species specifically benefit from increasing the area, duration, and frequency of flows that place the low-salinity zone downstream of the confluence of the Sacramento and San Joaquin Rivers.

Outflows are needed to provide for ecological processes, including continuity of flows from tributaries and the Delta to the Bay to protect native estuarine and anadromous aquatic species that inhabit the Bay-Delta and its tributaries throughout the year as juveniles or adults. Those outflows are needed to provide appropriate habitat conditions for migration and rearing of estuarine and anadromous fish species. Flows that more closely mimic the conditions to which native fish species have adapted, including the frequency, quality, timing, magnitude, and duration of flows—as well as the proportionality of flows from tributaries, are expected to provide improved protection. These flow attributes are important to protecting native species populations by supporting key functions such as maintaining appropriate low-salinity zone habitat, migratory cues, reduced stranding and straying, and other functions. Providing appropriate flow conditions throughout the watershed and throughout the year supports genetic and life history diversity that allows native species to distribute the risks that disturbances from droughts, fires, disease, food availability and other natural and anthropogenic stressors present to populations. As with inflows, given the altered physical and hydrologic state of the watershed and its size and complexity, outflow requirements need to be developed in an adaptive and flexible framework in a coordinated fashion with inflows, cold water habitat, and interior Delta flows to maximize the effectiveness of flow measures.

5.4.4.3 Proposed Delta Outflow Objectives

In addition to inflow and cold water habitat objectives, new and modified Delta outflow objectives are proposed. As discussed above, populations of several estuarine-dependent species vary positively with Delta outflow throughout the year (as do other measures of the health of the estuarine ecosystem). Current Delta outflow requirements are far below protective levels. The proposed Delta outflow objectives, working with the inflow objectives, are intended to provide a comprehensive integrated flow regime that protects fish and wildlife from natal streams out to the ocean. The changes are proposed both to enhance Delta outflow protections and to ensure that existing protections are not diminished.

Specific proposed changes to Delta outflow objectives include a new narrative Delta outflow objective, a new inflow-based Delta outflow objective, and a new fall Delta outflow objective. The existing Delta outflow objectives are proposed to be retained, with some minor modifications.

Narrative Delta Outflow Objective

To help inform implementation of the numeric Delta outflow objective, a new narrative Delta outflow objective is proposed. The objective describes the outflow conditions that protect native fish and aquatic species populations and describes the conditions the numeric outflows are intended to produce along with other measures in the watershed. The proposed narrative outflow objective is as follows.

> *Maintain Delta outflows sufficient to support and maintain the natural production of viable native anadromous fish, estuarine fish, and aquatic species populations rearing in or migrating through the Bay-Delta estuary. Delta outflows that reasonably contribute toward maintaining viable native fish and aquatic species populations include, but may not be limited to, flows that connect low-salinity pelagic waters to productive tidal wetlands and flows that produce salinity distributions that more closely mimic the natural hydrographic conditions to which these species are adapted, including the relative magnitude, duration, timing, quality, and spatial extent of flows as they would naturally occur. Indicators of viability include population abundance, spatial extent, distribution, productivity, and genetic and life history diversity. Viability is dependent on maintaining migratory pathways, sufficient quantities of high-quality spawning and rearing habitat, and a productive food web.*

The narrative outflow objective would apply throughout the watershed and would specifically be implemented through implementation of the numeric objectives, as well as other actions described in the program of implementation through the voluntary or default implementation processes.

Inflow-Based Delta Outflow Objective

To ensure that adequate quantities and qualities of outflow are provided to the Delta for the protection of estuarine and other native aquatic species in the watershed, a new inflow-based Delta outflow objective is proposed. In recognition that outflows are largely a product of inflows and that inflows from tributaries are necessary to provide both the quantities of needed outflows as well as functioning migratory corridors, the proposed objective would link the inflow and outflow objectives. To address current concerns related to overreliance on a subset of tributaries and water users to meet the Delta outflow objectives and future concerns in the face of climate change and additional water diversions, the outflows are proposed to be obtained from the entire watershed. Because outflows are needed year-round for the protection of estuarine species, the objective is

proposed to apply year-round but would have the largest effect in the critical winter and spring periods for sensitive juvenile aquatic species, when current flows are reduced the most by water diversions. The proposed objective would require that the inflows required in the Bay-Delta Plan, including the proposed Sacramento/Delta and San Joaquin River flows specified in the Bay-Delta Plan, are provided as outflows. Specifically, the proposed objective is as follows.

> *The inflows required above, including for the Sacramento/Delta tributaries and San Joaquin River, are required as outflows with adjustments for downstream natural depletions and accretions.*

As described further in Section 5.4.4.5, *Implementation* below, under the proposed inflow-based outflow objective, the required outflow would be calculated by adding up the applicable required inflows in the Bay-Delta Plan and making appropriate adjustments for natural losses and gains, including floodplain inundation flows. Provisions for developing accounting and compliance methods for this objective are identified in Section 5.4.4.5, including provisions for voluntary and default implementation.

The proposed Sacramento/Delta tributary inflow objective is 55 percent of unimpaired flow within an adaptive range from 45 to 65 percent of unimpaired flow. As explained in the inflow objective discussion, these inflow levels were developed in large part based on outflow needs. Inflow levels are expected to vary from tributary to tributary, with most at 55 percent of unimpaired flow, some lower, and some higher in the range. The volume of San Joaquin River flow that would contribute to the Delta outflow objective would be consistent with requirements in the Bay-Delta Plan. That volume includes San Joaquin River inflows included in the Bay-Delta Plan.

Other flows to the Delta downstream of the tributaries also would be subject to the inflow-based Delta outflow objective (except diverters determined to have a *de minimis* effect on flows in the Delta), including precipitation that falls in the Delta itself and runoff from minor Delta tributaries and lands in the Delta. To the extent that those flows represent net accretions to the system absent water diversions (which generally would be the case during the wet season), the required contribution to outflows from net accretions would be similar to the inflow objectives, requiring that 55 percent of unimpaired flow be provided within an adaptive range of 45 to 65 percent. To the extent that there are net natural depletions from the Delta without water diversions, including losses due to evaporation and riparian vegetation that are greater than accretions (which generally would occur during summer and fall), those depletions would be deducted from the required Delta outflow levels as discussed further in Section 5.4.4.5, *Implementation*.

Fall Delta Outflow Objective

To ensure adequate outflows during fall to protect Delta smelt and other native aquatic species, a new fall Delta outflow objective is proposed to be added to the Bay-Delta Plan. Given the complexities of the regulatory regime in the Delta, it is proposed that the objective incorporate provisions of the Fall X2 component of the USFWS 2019 BiOp into the Bay-Delta Plan, rather than developing an overlapping set of requirements. Section 7.24, *Alternatives Analysis*, also evaluates an alternative (Exclusion of Interior Delta Flow and Fall Delta Outflow Related Amendments [Alternative 4a]) in which this and other possible BiOp-related provisions are not added to the Bay-Delta Plan to avoid unnecessary duplication and regulatory complexity. While these measures already exist in the USFWS 2019 BiOp, they were established for federal Endangered Species Act (ESA) purposes to avoid jeopardy to Delta smelt, which is a separate standard than reasonable protection of fish and wildlife. In addition, the BiOp requirements change. Specifically, the Fall X2 provisions of the USFWS 2008 BiOp were developed as an adaptive management action, to be tested

and refined, and reconsidered by USFWS. In the 2019 USFWS BiOp, the Fall X2 requirement was modified and made a permanent component of the BiOp until such time that other management actions were determined to provide similar or better protections than the 80-km salinity management action (^USFWS 2019 BiOp). Because the State Water Board has a separate obligation from the ESA (and the California Endangered Species Act) to ensure that fish and wildlife are reasonably protected, these measures are proposed to be added to the Bay-Delta Plan to ensure that needed measures continue even if the BiOp changes. Because the science regarding needed measures for the reasonable protection of fish and wildlife may change, a narrative objective is proposed, with the specific flow and implementation—including adaptive management, provisions identified in the program of implementation. The objective and implementation provisions would then allow for review and possible modification based on new science. Based on the above, the proposed objective is as follows for the September-to-December period of wet and above-normal years.

> *As described in the program of implementation, maintain Delta outflows during fall to provide suitable quantities of quality habitat for sensitive native estuarine species, including the flows identified in the 2019 USFWS Biological Opinion. The State Water Board may approve modifications to these flow levels based on updates to the biological opinion.*

To avoid undue duplication and any conflicts with the 2019 USFWS BiOp, as described further below, the proposed implementation measures would provide for the objective to be implemented in an integrated fashion with the BiOp, relying on the same monitoring, evaluation, coordination, and review processes to the extent possible with incorporation of the State Water Board into these processes.

5.4.4.4 Modifications to Existing Delta Outflow Objectives

The current Delta outflow objectives included in the Bay-Delta Plan are proposed to be retained to ensure that minimum quantities of Delta outflow are provided to the estuary in all months and in all years. Current Delta outflow objectives would be referred to as *base Delta outflows*. Specifically, the proposed Plan amendments would maintain existing year-round Delta outflow objectives currently found in Table 3 of the Bay-Delta Plan that range from 3,000 to 8,000 cfs based on water year type from July through January. In addition, the requirement for February through June Delta outflows of 7,100 cfs would be maintained (footnote 11 to Bay-Delta Plan, Table 3). However, because the methods available for implementing this requirement may not be fully protective, those methods are proposed to be reviewed. Specifically, pursuant to the existing Bay-Delta Plan, in addition to meeting a flow of 7,100 cfs, this requirement may be met by achieving a daily or 14-day running average salinity level (as measured by EC of 2.64 mmhos/cm) at Collinsville in the Delta. As described in Section 5.4.4.5, *Implementation*, the three different ways for meeting this requirement are proposed to be reevaluated to ensure that intended protections are provided, including compliance with the narrative objective.

5.4.4.5 Implementation

The proposed implementation provisions for the new inflow-based and fall Delta outflow objectives are described below as well as proposed changes to the implementation measures for the existing (base) Delta outflow objectives. The narrative Delta outflow objective would be met by implementation of these objectives. The other non-flow actions described below would contribute to achievement of the narrative objectives. These Delta outflow objectives also would contribute

toward implementing the existing narrative salmon protection and Suisun Marsh objectives and the other proposed narrative objectives.

Inflow-Based Delta Outflow

The inflow-based Delta outflow objective and implementation measures take a watershed approach to achieving outflows in recognition of the important functions provided by maintaining riparian corridors and an interconnected flow regime. Specifically, the inflow-based Delta outflow objective would be implemented by requiring that required inflows be provided as outflows, including inflows from the Sacramento/Delta tributaries and the San Joaquin River and its tributaries that are required by the Bay-Delta Plan. Water users downstream of the tributaries, except for *de minimis* water users, also would bear responsibility for achieving the inflow-based outflow objectives through limits on their diversions, including Project diversions and other in-Delta diversions.

The required outflow level would be determined by adding up the required inflows from each tributary as implemented and making adjustments for net accretions or depletions downstream that are not due to water diversions or releases of stored water or other flow manipulations. To the extent that there are net accretions downstream of the tributaries when not accounting for water diversions, those accretions would be treated like inflows, requiring 55 percent within an adaptive range from 45 to 65 percent. To the extent that there are net depletions when excluding the effects of diversions, those depletions would be deducted from the required Delta outflows. State Water Board staff, in consultation with other appropriate entities, including DWR and Reclamation, would develop proposed accounting and compliance monitoring measures for the inflow-based outflow objective (including appropriate assumptions and time steps for accounting), for approval by the State Water Board with the opportunity for public comment within 1 year of approval of the Plan amendments by OAL. The accounting and compliance monitoring measures would provide for integration with the other Delta outflow compliance monitoring efforts described below and would be based on readily available information to the extent possible and allow for refinements as information improves.

Similar to the inflow and cold water habitat objectives, the inflow-based Delta outflow objective could be implemented through a voluntary implementation plan (voluntary Delta outflow plan). In the absence of a voluntary Delta outflow plan, water users downstream of the tributaries would be subject to the default implementation provisions described below.

Default Implementation

Under the default implementation process, inflows would be required as outflows plus accretions or minus depletions not associated with water diversions in real-time accounting for transit times and other factors to be determined through the accounting process described above.

The proposed program of implementation would allow the State Water Board to refine the default implementation measures over time to maximize benefits for native fish and wildlife while avoiding redirected impacts. Refinements could be made using the same flexibilities allowed in a voluntary Delta outflow implementation plan, in coordination with CDFW and in consultation with the federal fisheries agencies, water users, and other interested parties. Specific refinements could be made to integrate the inflow-based outflow objective with other outflow objectives and the inflow and cold water habitat objectives; provide for specific functions to support native species; integrate outflows with physical habitat restoration measures and other measures to protect fish and wildlife; and address droughts and provide for minimal health and safety water supplies.

Implementation of the inflow-based outflow objective requires protecting the tributary inflows out through the Delta. Along with the accounting measures, the proposed program of implementation calls for State Water Board staff to develop a methodology for limiting water diversions to achieve compliance with the inflow-based Delta outflow objective within 18 months of approval of the Plan amendments by OAL, after opportunity for public comment. The proposed process is to develop the methodology in coordination with the process for default implementation of the inflow objective using available information to the extent possible, with refinement over time. This process includes developing appropriate assumptions in lieu of specific data where that data is not readily available for use in implementation of inflow-based Delta outflow objectives.

Voluntary Implementation

Voluntary implementation plans for the inflow and cold water habitat objectives would be required to address those water user's compliance with the inflow-based Delta outflow objective. Provisions also would be needed for junior diverters to bypass flows that are needed to meet senior water right demands downstream of the tributaries while meeting the inflow-based Delta outflow objective. Water users downstream of the tributaries would have the opportunity to develop a proposed voluntary Delta outflow plan for meeting their responsibilities for implementing the inflow-based Delta outflow objective. That plan would be required to be consistent with those described for inflows above, including the time schedules and minimum requirements as they apply to outflows.

Voluntary implementation plans could propose provisions for sharing responsibilities for implementing the inflow-based Delta outflow objective between water users downstream of the tributaries, including responsibilities between in-Delta water users and the Projects. Voluntary implementation plans could include provisions for shaping and shifting of outflows out of time with the provision of inflows to better protect fish and wildlife or to perform experiments to better understand needed outflows for the protection of fish and wildlife, provided that monthly outflows during the January-through-June period are at least 45 percent and the total volume of outflows during the time period is equal to what would have been provided by tracking the inflow-based Delta outflow objective in real time.

Fall Delta Outflow

The proposed program of implementation would require the Projects to provide Delta outflows during fall to protect sensitive native estuarine species, consistent with provisions of the USFWS 2019 BiOp. The specific requirements of the USFWS 2019 BiOp apply in September and October when the preceding hydrologic period was a wet or above-normal year (according to the Sacramento Valley water year hydrologic classification). Pursuant to these requirements, in September and October of or following wet and above-normal years, the Projects are required to ensure that X2 is at or below 80 km.

The proposed program of implementation allows modifications to the specific measures above if USFWS modifies those requirements. If changes to the BiOp provisions result from a subsequent process, the State Water Board would consider whether any changes to the fall Delta outflow implementation actions are warranted pursuant to the State Water Board's regulatory authorities. The proposed program of implementation would allow the State Water Board to make such changes in an expeditious manner if it can be shown that the changes would meet the narrative provisions of the objective to "*provide suitable quantities of quality habitat for sensitive native estuarine species*" during fall and if CDFW concurs with that determination. Short-term (one season or less but not

sequentially) or long-term changes could be made. Short-term changes could be approved by the Executive Director after the opportunity for public comment and consideration of those comments. Long-term changes would require approval by the State Water Board after the opportunity for public comment of at least 30 days and a public workshop or hearing.

5.4.4.6 Base Delta Outflow

The current Delta outflow objectives (base Delta outflow) included in the Bay-Delta Plan are retained. The program of implementation would include provisions for improving implementation of those objectives.

Specifically, the State Water Board would develop improvements to the methods for calculating the NDOI identified in Figure 4 of the existing Bay-Delta Plan, including the accretion and depletion assumptions for net Delta consumptive uses. The assumptions currently being used for accretion and depletion estimates for calculating compliance with the Delta outflow objectives have a large and consistent margin of error that may greatly affect NDOI estimates, warranting improvements to these methods.[9] The State Water Board has undertaken efforts with the Delta Science Program (DSP) and DWR to determine methods for improving these estimates.

As discussed above, the existing footnote 11 Delta outflow objectives provides three methods by which compliance can be achieved, including one flow-based and two salinity-based methods. The proposed program of implementation would direct State Water Board staff to evaluate and recommend any needed improvements to the methods by which these requirements may be implemented to ensure that the implementation measures provide for the protection of fish and wildlife beneficial uses, including compliance with the narrative Delta outflow objective. Based on these evaluations, the proposed program of implementation would allow the State Water Board to consider and approve changes to the allowable implementation measures through a public process with opportunity for public comment.

5.4.5 Suisun Marsh

5.4.5.1 Existing Suisun Marsh Requirements

The Bay-Delta Plan includes a narrative objective for the brackish tidal marshes of Suisun Bay that provides the following.

> *Water quality conditions sufficient to support a natural gradient in species composition and wildlife habitat characteristic of a brackish marsh throughout all elevations of the tidal marshes bordering Suisun Bay shall be maintained. Water quality conditions shall be maintained so that none of the following occurs: (a) loss of diversity; (b) conversion of brackish marsh to salt marsh; (c) for animals, decreased population abundance of those species vulnerable to increased mortality and loss of habitat from increased water salinity; or (d) for plants, significant reduction in stature or percent cover from increased water or soil salinity or other water quality parameters.*

In addition, the Bay-Delta Plan includes numeric salinity (measured as EC) objectives at eight locations in the marsh. The Suisun Marsh numeric salinity objectives were first adopted in the 1978

[9] D-1641 (2001) indicates that DWR was developing new channel depletion estimates. While new channel depletion estimates have been developed for other purposes, those changes have not been implemented for the NDOI calculation.

Bay-Delta Plan, and responsibility for meeting the objectives was assigned to DWR and Reclamation in State Water Board Decision 1485 (D-1485). In 1995, the State Water Board amended the salinity objectives to include the narrative objective for the brackish tidal marsh areas. In D-1641, the State Water Board removed the requirement that DWR and Reclamation meet the objectives at S-35 and S-97 and instead required that DWR and Reclamation conduct monitoring at these stations. Only five of the salinity locations have been implemented. The three that that were not implemented include S-35 (Goodyear Slough), S-97 (Cordelia Slough), and the "water supply intakes for waterfowl management areas on Van Sickle and Chipps Island" that currently are being used as monitoring sites. The objectives are intended to provide for adequate freshwater flow in the marsh, which is influenced by Delta outflows; operations of the Suisun Marsh salinity control gates; and other management and water diversion activities. The current Bay-Delta Plan states that the State Water Board will determine in a future Bay-Delta Plan amendment whether the objectives should be amended or deleted, following completion of the Suisun Marsh Management, Preservation, and Restoration Plan (Suisun Marsh Plan), a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses in the marsh.

5.4.5.2 Basis and Proposed Changes to the Suisun Marsh Objectives

Suisun Marsh is the largest contiguous brackish wetland in the western United States, situated between the freshwater Delta ecosystem and the saline ecosystem of San Francisco Bay. It covers about 470 square kilometers and is adjacent to Suisun Bay near Fairfield and Suisun City. The marsh is strongly influenced both by the tides and by freshwater flows from upstream tributaries and the mainstem rivers (^Moyle et al. 2010; Lund et al. 2008). Suisun Marsh, which includes a combination of tidal wetlands, diked seasonal freshwater and brackish water wetlands, sloughs, and upland grasslands, represents about 10 percent of California's remaining wetlands. These wetlands provide many important ecological functions, including wintering and nesting areas for waterfowl and water birds of the Pacific Flyway; nursery habitat for native fish; and essential habitat for other fish, wildlife, and plants—including several threatened, endangered, or sensitive species (e.g., Delta smelt, splittail, and salt marsh harvest mouse) (^Reclamation et al. 2013; Lund et al. 2008). Many of these species are dependent upon specific estuarine conditions for their survival (^Moyle et al. 2010; Lund et al. 2008). Suisun Marsh has become an important habitat as a food source for smelts (^Hammock et al. 2015).

As a result of Suisun Marsh's location in the Bay-Delta, water quality in the marsh affects, and is affected by, the SWP and CVP export facilities and other upstream diversions (SWRCB 2006). Currently, approximately 200 miles of levees in the marsh contribute to managing salinity in the Delta, including an arrangement of gates at the Morrow Island distribution system, Goodyear Slough, Lower Joice Island, and other units. Management of conditions in the marsh is primarily for duck hunting clubs and waterfowl. Salinity control gates were built at the end of Montezuma Slough to diminish incoming salt water from Grizzly Bay and manage the wetland system in Suisun Marsh (^DWR and Reclamation 2016) for this purpose. The gates control salinity by allowing tidal flow from the Sacramento River into Montezuma Slough during ebb (outgoing) tides but restricting the tidal flow from Montezuma Slough during flood (incoming) tides. Operation of the gates causes a net inflow (about 2,500 cfs) of lower-salinity Sacramento River water into Montezuma Slough and lowers salinity in some marsh channels, primarily those in the eastern marsh; due to a net movement of water from east to west (^Reclamation et al. 2013), primarily from October through May.

The State Water Board committed to review whether changes should be made to the salinity objectives at stations S-97 and S-35, and for Van Sickle and Chipps Islands in the current Bay-Delta Plan following completion of the Suisun Marsh Plan. In 2000, a joint state-federal planning group[10] was formed to develop and implement the Suisun Marsh Plan. In 2014, the *Suisun Marsh Habitat Restoration, Preservation, and Management Plan* was completed. Implementation will be completed over a 30-year period and is intended to balance the benefits of tidal wetland restoration and managed wetland enhancements. Key elements include restoring between 5,000 and 7,000 acres of tidal marsh, enhancing more than 40,000 acres of managed wetlands, maintaining waterfowl hunting, improving water quality for fish and wildlife habitat, and providing other recreational opportunities (Reclamation and USFWS 2014). The Suisun Marsh Plan did not recommend any revisions to salinity objectives, including for stations S-35, S-97, and Van Sickle and Chipps Islands, and did not provide information to indicate that these stations should be made compliance stations.

The State Water Board is not proposing any changes to the Suisun Marsh narrative objective. Modifications are proposed to the existing Suisun Marsh salinity objectives to update those requirements to be consistent with existing conditions. Specifically, stations S-35 and S-97 provide western Suisun Marsh salinity information and have been in continual use as monitoring stations. Accordingly, these locations are proposed to be deleted from Table 3 of the Bay-Delta Plan and are proposed to be maintained as monitoring stations. Van Sickle and Chipps Islands are proposed to be deleted as both compliance and monitoring stations since monitoring at nearby locations is adequate for meeting monitoring needs at these locations.

5.4.5.3 Implementation

Implementation of other proposed Bay-Delta objectives is expected to implement the narrative objective for the brackish tidal marshes of Suisun Bay.

5.4.6 Interior Delta Flows

Operation of the Project pumping facilities and other water diversion projects in the Delta affects salmonids, pelagic fishes, and other species through alteration of circulation patterns, which can lead to adverse transport flows, changes in water quality, changes to Delta habitat, and entrainment of fish and other aquatic organisms. The Bay-Delta Plan includes flow requirements in the interior Delta related to operations of the SWP and CVP that limit exports and require closing of the Delta Cross Channel (DCC) at specified times. The USFWS and NMFS BiOps and the CDFW Incidental Take Permit (ITP) include additional restrictions on exports, DCC gate requirements, and Old and Middle River (OMR) reverse flow constraints that are related to the proposed Plan amendments.

New and modified interior Delta flow objectives are proposed for the reasonable protection of fish and wildlife. Section 7.24, *Alternatives Analysis*, also evaluates an alternative (Exclusion of Interior Delta Flow and Fall Delta Outflow Related Amendments [Alternative 4a]) in which this and other possible BiOp- and ITP-related provisions are not added to the Bay-Delta Plan to avoid unnecessary duplication and regulatory complexity.

The proposed new and modified interior Delta flow objectives, in combination with the inflow and outflow objectives, are intended to provide for functioning migratory corridors. To help inform

[10] Seven principal members of the group include USFWS, NMFS, Reclamation, CDFW, DWR, Delta Stewardship Council (DSC), and the Suisun Resource Conservation District.

implementation of the numeric interior Delta flow objectives, a new narrative interior Delta flow objective is proposed. The objective describes the interior Delta flow conditions that protect native fish and aquatic species populations and the conditions the numeric interior Delta flow objectives are intended to produce, along with other measures in the watershed. The proposed narrative interior Delta flow objective is as follows.

> *Maintain flow conditions in the interior Delta sufficient to support and maintain the natural production of viable native fish populations migrating through and rearing in the Delta. Interior Delta flow conditions that reasonably contribute toward maintaining viable native fish populations include, but may not be limited to, flows that more closely mimic the natural hydrographic conditions to which native fish species are adapted, including the relative magnitude, duration, timing, quality, and spatial extent of flows as they would naturally occur. Indicators of native fish species viability include population abundance, spatial extent, distribution, productivity, and genetic and life history diversity. Viability is dependent on maintaining migratory pathways, sufficient quantities of high-quality spawning and rearing habitat, and a productive food web.*

In addition, specific proposed changes to the interior Delta flow objectives include new and modified numeric objectives. Each of these is described below.

For the most part, the proposed changes to the interior Delta flow objectives and implementation measures involve incorporation of existing BiOp and ITP requirements into the Bay-Delta Plan, including requirements contained in the USFWS and NMFS BiOps and CDFW ITP. While these requirements already exist, it is possible that they will change. To avoid undue complexity in an already complex regulatory regime, these measures are proposed to be built on existing requirements and implemented in an integrated fashion with the BiOps and the ITP. In so doing, implementation of the objectives is proposed to rely on the existing BiOp and ITP processes, including monitoring, evaluation, coordination, and review processes, with incorporation of the State Water Board into these processes. In the event of changes to the BiOps and ITP, as discussed further below, the proposed implementation measures would provide flexibility to adjust the requirements as appropriate.

If there are changes to the BiOp provisions, the State Water Board may approve those changes provided that they are no less protective than the existing requirement in the Bay-Delta Plan, changes would meet the narrative interior Delta flow objective, and CDFW concurs with that determination. Short-term (one season or less but not sequentially) or long-term changes could be made. Changes could be approved after the opportunity for public comment and consideration of those comments.

Implementation of modifications to the interior Delta flow objectives, including DCC gate operations, export limits, and OMR flows, would be the responsibility of the Projects. The narrative interior Delta flow objective would be met by implementation of these objectives. Other complementary ecosystem measures could contribute to achievement of the narrative objective, including through voluntary implementation plans to implement the proposed Plan amendments. Implementation of the interior Delta flow objectives also would contribute toward implementing the existing narrative salmon protection objective and the other proposed narrative objectives.

5.4.6.1 Delta Cross Channel Gates

Existing Delta Cross Channel Gate Requirements and Basis for Proposed Modification

The existing Bay-Delta Plan includes DCC gate closure requirements that help to minimize risk of entrainment of juvenile salmonids from the Sacramento River basin at the export pumps by preventing their migration into the central Delta. The Bay-Delta Plan currently requires the DCC gates to be closed for a total of up to 45 days for the November–January period, from February through May 20, and for a total of 14 days for the May 21–June 15 period to prevent juvenile Sacramento River salmon from migrating into the central Delta. During the November–January and May 21–June 15 periods, the timing and duration of gate closure are based on the need to protect fish. Reclamation is required to determine the timing and duration of gate closures after consultation with the fisheries agencies. The 2019 NMFS BiOp includes a DCC gate closure requirement during October 1 through November 30 to reduce loss of Sacramento River salmonids into the interior Delta that is based on early entry of juvenile salmonids into the Delta and requires the DCC gates to be closed from December 1 through January 31, except to prevent exceeding a D-1641 water quality threshold.

On the Mokelumne River, adult fall-run salmon Chinook salmon return to spawn in October. Pulse flows from the Mokelumne River in combination with closure of the DCC gates in October increases the number of returning Chinook salmon to the Mokelumne River and reduces straying to the American River. CDFW (previously CDFG) (^2012) recommended that the DCC gates be closed for up to 14 days in October in combination with experimental pulse flows from the Mokelumne River to increase salmonid returns and reduce straying.

When the DCC gates are open, Sacramento River water is routed into the interior Delta to support CVP and SWP diversions and to meet interior Delta water quality requirements. With a capacity of 3,500 cfs, the DCC can divert a significant portion of Sacramento River flows into the interior Delta, particularly in fall. As described in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*, when the DCC gates are open, the probability of entraining emigrating Sacramento River juvenile salmon and steelhead into the central Delta is increased. Juvenile salmon drawn into the central Delta through the DCC or Georgiana Slough have a lower chance of survival than fish staying in the mainstem Sacramento River. The survival of juvenile salmon migrating through the central Delta to Chipps Island is about half the survival rate of fish remaining in the Sacramento River (^Kjelson and Brandes 1989; ^Brandes and McLain 2001). Closing the DCC gates reduces the number of salmonids diverted into the central Delta and improves survival to Chipps Island. Closure also redirects a portion of emigrating juvenile salmon into Sutter and Steamboat Sloughs and reduces entrainment at Georgiana Slough (^Perry 2010; ^Perry et al. 2013).

Proposed Modifications to Delta Cross Channel Gate Objective and Program of Implementation

The DCC gate closure objectives and program of implementation included in the Bay-Delta Plan are proposed to be updated to improve protection of salmonids, consistent with improved protections included in the 2019 NMFS BiOp beyond those included in the current Bay-Delta Plan. As discussed in Section 7.2, *Description of Alternatives*, and Section 7.24, *Alternatives Analysis*, an alternative that does not incorporate any of the BiOp- or ITP-related provisions into the Bay-Delta Plan (including additional DCC gate closure measures and other interior Delta flow modifications, as well as fall

Delta outflow provisions) is also under consideration since it may not be necessary or efficient to duplicate these provisions in the Bay-Delta Plan.

The current Bay-Delta Plan requires the DCC gates to be closed for up to 45 days between November and January based on consultation with the fisheries agencies as specified in footnote 23. Under the proposed Plan amendments, October would be added to the period when the gates may be required to be closed, and the gates would be required to be closed based on catch indices related to entrainment risk of salmonids in the interior Delta as specified in the NMFS 2019 BiOp (^NMFS 2019 BiOp). The objective and program of implementation would provide for updating the criteria requiring closure based on updates to the BiOp. The gates would be required to be closed for at least 45 days or longer if the criteria for closure are met more often. In addition, the consultation process specified in footnote 23 of the Bay-Delta Plan would be updated to remove outdated information related to consultation with the CALFED Operations Group. For the February-through-May 20 period, no changes would be made to either the objective or program of implementation. For the May 21–June 15 period, the footnote would be updated to remove outdated information related to consultation with the CALFED Operations Group.

Those requirements include the additional requirements related to alerts, monitoring, and consultation, with the State Water Board added to the consultation and decision-making processes for DCC gate operations.

5.4.6.2 Export Limits

Existing Export Requirements and Basis for Proposed Modification

The Bay-Delta Plan and D-1641 limit exports in two ways. One is based on the combined amount of water that may be exported from the Delta by the SWP and CVP facilities in the southern Delta relative to total Delta inflow. The limit is 35 to 45 percent of Delta inflow for February (depending on total inflow conditions during January), 35 percent from March through June, and 65 percent of Delta inflow from July through January. The second is based on the ratio of San Joaquin River flow at Vernalis to the combined amount of water exported (the import to export ratio [I:E]). From April 15 through May 15 (the San Joaquin River spring pulse flow period in the current Bay-Delta Plan), exports are limited to 1,500 cfs or a 1:1 I:E, whichever is higher. In addition, the 2009 NMFS BiOp included further restrictions on exports during the April-to-May peak outmigration period for San Joaquin River basin steelhead. At that time, the NMFS 2009 BiOp (^NMFS 2009 BiOp) restricted I:E to between 1:1 and 4:1 based on water year type or 1,500 cfs, whichever is greater. The NMFS 2019 BiOp removed the restrictions on exports during April and May. The CDFW 2020 ITP (^2020 ITP) includes similar export restrictions as those identified in the 2009 BiOp, but applicable only to the SWP. The 2020 ITP also includes offramps during wet years or high outflow conditions and it includes a minimum SWP pumping level.

Studies show that tagged San Joaquin River fall-run salmon smolts released downstream of the zone of entrainment created by the export pumps have higher survival indices through the Delta than fish released higher up in the system. Historical data indicate that, when the spring I:E increases, Chinook salmon production increases (^CDFG 2005; ^SJRGA 2007). NMFS concluded in its 2009 BiOp that San Joaquin River basin and Calaveras River steelhead would likewise benefit from such flow conditions in much the same way as San Joaquin River fall-run benefit from increased net flow toward the ocean caused by the reduced influence of the export pumps (as well as higher San Joaquin River flows) (^NMFS 2009 BiOp). NMFS also found that such flows would reduce the

proportion of Sacramento River fish that continue southward toward the pumps and increase the percentage that move westward toward Chipps Island and the ocean. NMFS found that although the real environment is much more complex than this generality, in theory, increasing the speed of migration through a particular reach of river, or shortening the length of the migratory route decreases the extent of exposure to factors causing loss (Anderson et al. 2005).

Proposed Modifications to Export Limits Objective and Implementation

Provisions consistent with the CDFW 2020 ITP are proposed to be added to the Bay-Delta Plan and applied to both the SWP and CVP. As discussed in Section 7.2, *Description of Alternatives*, and Section 7.24, *Alternatives Analysis*, an alternative that does not incorporate any of the BiOp- or ITP-related provisions into the Bay-Delta Plan (including additional I:E provisions and other interior Delta flow modifications, as well as fall Delta outflow provisions) is under consideration since it may not be necessary or efficient to duplicate these provisions in the Bay-Delta Plan.

The proposed additional I:E provisions that include a wet water year offramp for CVP and SWP exports are based on Section 8.17 of the CDFW 2020 ITP (^2020 ITP). Consistent with the ITP, all of April and May would be included in the objective. Footnotes 18 and 19 of the current Bay-Delta Plan that specify the time period the objective applies and the allowable exports of 1:1 during that time period would be removed. The proposed export limit objective is as follows.

> *Combined SWP and CVP exports from the southern Delta shall be limited based on San Joaquin Valley water year type (as defined in Figure 4) to a ratio of San Joaquin River flow at Vernalis to exports of 4 to 1 in wet and above-normal years, 3 to 1 in below-normal years, 2 to 1 in dry years, and 1 to 1 in critically dry years or 1,500 cfs, whichever is greater. Restrictions do not apply when Vernalis flows are above 21,750 cfs and do not apply in wet years beyond 375 TAF of export reductions. Exceptions, no lower than 1 to 1 San Joaquin River flow to export limits, may be approved by the Executive Director upon concurrence of CDFW, including as the result of emergency circumstances or updated incidental take permit provisions. The State Water Board may approve long-term modifications to this objective and associated implementation measures based on updates to biological opinion or incidental take permit provisions.*

The proposed changes to the I:E limits would be implemented by DWR and Reclamation, who operate the SWP and CVP, respectively. Adaptive management provisions are proposed for inclusion in the program of implementation to allow for the export period to be shifted during the larger window of San Joaquin River salmonid outmigration between February and June in coordination with the fish agencies, if agreeable to NMFS.

5.4.6.3 Old and Middle River Reverse Flows

Existing Old and Middle River Flow Requirements and Basis for Proposed Old and Middle River Flow Objectives

The Bay-Delta Plan does not currently include any OMR flow provisions, and no SWP or CVP water right requirements are related to OMR flows. Net OMR reverse flow restrictions were introduced in the USFWS 2008 BiOp (RPA Actions 1 through 3), the NMFS 2009 BiOp (RPA Action IV.2.3), and the CDFW 2009 ITP (Conditions 5.1 and 5.2) to avoid jeopardy to Delta smelt, salmonids, and longfin smelt, respectively. (^NMFS 2009 BiOp, p. 648; ^USFWS 2008 BiOp; ^2009 ITP.). Similar OMR requirements were carried over into the USFWS 2019 BiOp, NMFS 2019 BiOp, and CDFW 2020 ITP (^USFWS 2019 BiOp; ^NMFS 2019 BiOp; ^2020 ITP). These OMR reverse flow limitations apply from as early as November through as late as June 30 and restrict flows to no more negative

than -5,000 cfs, except for high-flow periods when OMR reverse flows may be as high as -6,250 cfs, with increasingly positive limits based on triggers related to entrainment risk of Delta smelt, longfin smelt, and salmonids.

OMR reverse flows are harmful to fish and wildlife throughout the year, but especially in winter and spring when larval and juvenile estuarine species may be present near the export facilities and juvenile anadromous Chinook salmon, steelhead, and green sturgeon are migrating through the Delta to the ocean (Kimmerer 2008). The magnitude and frequency of OMR reverse flows have increased over time as CVP and SWP exports and other diversions have increased. Figure 2.4-5 in Chapter 2, *Hydrology and Water Supply*, shows that, under conditions with today's channel configurations but no water supply development (1925–2000 unimpaired flow conditions), negative OMR flows were estimated to occur about 15 percent of the time. In contrast, between 1986 and 2005, OMR reverse flows occurred more than 90 percent of the time.

As described in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations,* high net OMR reverse flows have negative ecological consequences. First, net reverse flow draws fish, especially the smaller larval and juvenile forms, into the export facilities where they can experience high mortality (^NMFS 2009 BiOp; ^Bennett 2005). Second, net OMR reverse flow reduces the size of the spawning and rearing habitat available for fish in the Delta. Third, net OMR reverse flow leads to disruption of net downstream migration flows for juvenile salmon emigrating from the San Joaquin River basin to the ocean. High OMR reverse flows can redirect emigrating salmon toward the export facilities, resulting in entrainment in the interior Delta and associated direct and indirect mortality. Finally, net OMR reverse flow reduces the natural variability in the Delta by homogenizing the system similar to the water quality in the Sacramento River (^Moyle et al. 2010).

Limits on OMR reverse flows help to reduce the risk of salvage and entrainment. As described in Chapter 3, the risk of salvage and entrainment of fish depends on the location of juvenile and adult individuals relative to the export facilities and the magnitude of OMR reverse flows.

Proposed Old and Middle River Flow Objectives and Program of Implementation

OMR provisions consistent with the 2019 BiOps and 2020 ITP are proposed to be added to the Bay-Delta Plan. As discussed in Section 7.2, *Description of Alternatives*, and Section 7.24, *Alternatives Analysis*, an alternative that does not incorporate any of the BiOp- or ITP-related provisions into the Bay-Delta Plan (including new OMR provisions and other interior Delta flow modifications, as well as fall Delta outflow provisions) is also under consideration since it may not be necessary or efficient to duplicate these provisions in the Bay-Delta Plan.

The following OMR objective is proposed to be added to the Bay-Delta Plan.

> *For SWP and CVP exports greater than 1,500 cfs, Old and Middle River flows shall be no more negative than between -1,250 and -5,000 cfs at times when sensitive native fish species may be impacted by reverse flows in Old and Middle Rivers as described in the 2019 USFWS Biological Opinion, 2019 NMFS Biological Opinion, and 2020 CDFW ITP. The State Water Board may approve modifications to this objective and associated implementation measures based on updates to biological opinion or incidental take permit provisions.*

The program of implementation would include provisions related to determining the applicable OMR flow level, including applicable monitoring, triggers, and action responses consistent with the 2019 BiOps and 2020 ITP, including incorporation of the State Water Board into these processes.

5.5 Habitat Restoration and Other Complementary Ecosystem Measures

The State Water Board's Bay-Delta planning and implementation efforts are part of a multi-faceted approach needed to address the systemic ecological concerns in the Bay-Delta watershed. The State Water Board has responsibility and authority for addressing flow and other water quality impairments, but ecosystem recovery in the Delta depends on more than adequate flows. It also requires implementation of comprehensive complementary measures, including physical habitat restoration, fisheries management, control of waste discharges and invasive species, and other efforts by other agencies and parties in the watershed that are responsible for these actions.

The proposed program of implementation identifies these other actions, including recommendations to other agencies and parties for actions they should take to protect fish and wildlife beneficial uses. The proposed program of implementation includes provisions for the State Water Board to use its authorities to assist with implementation of these actions to the extent possible and includes provisions for reviewing the status of implementation of these other actions on a regular basis as part of the monitoring, reporting, and assessment process.

This section describes these other possible actions that may be included in the program of implementation to address other Bay-Delta ecosystem stressors in conjunction with the possible new and modified objectives. Many of these complementary actions are within the purview of other agencies and entities and should be appropriately further developed and implemented by these agencies and entities. Voluntary implementation plans that are consistent with the updated Bay-Delta Plan objectives are encouraged for their ability to provide large-scale benefits that will amplify the ecological benefit of new and existing flows beyond what the State Water Board could require through flow and water project operations alone. Successful voluntary measures to implement the Bay-Delta Plan could provide comprehensive, enduring, and timely benefits to the ecosystem. To this end, the program of implementation for the proposed Plan amendments provides a framework for accepting voluntary implementation plans that include complementary measures for enhancing fish and wildlife throughout the Sacramento/Delta watershed.

5.5.1 Physical Habitat Restoration

As described in Section 4.2, *Physical Habitat Loss or Alteration*, there has been a dramatic loss in physical habitat suitable for native fish species in the Bay-Delta watershed, including tidal marsh in the Delta and Suisun Marsh, riparian habitat and open channels throughout the Delta and its tributaries, floodplain and wetland habitat, and upper watershed forest and meadow habitat. Scientific information indicates that restoration of natural flow functions is needed to reverse these declines in an integrated fashion with physical habitat improvements. While enhanced flows are the principle means proposed to implement the proposed Plan amendments, physical habitat restoration can amplify the ecological benefit of new and existing flows beyond what the State Water Board can require through flow requirements alone.

There are many types of physical habitat restoration projects that could be implemented to protect and restore native species and physical processes, and individual physical habitat restoration projects should be determined based on tributary-specific habitat restoration needs. For example, in-channel physical habitat restoration projects that would benefit native aquatic species could include placement of large wood or boulder structures, gravel augmentation and other geomorphic

channel modifications, and other projects to enhance in-channel complexity and restore physical habitat in degraded river ecosystems. Riparian restoration projects could include riparian revegetation efforts, levee setback projects, or other measures.

Restoration projects should be designed to incorporate clear, measurable success criteria with associated monitoring tailored to the individual project that can inform implementation outcomes over time. Monitoring is integral to any restoration project because it allows project proponents and reviewers to evaluate whether a project has been implemented according to applicable permit requirements and regulations, identifies whether success criteria are being met over time, and provides a mechanism to inform adaptive management. Monitoring may include qualitative or quantitative metrics, or some combination of both, depending on the project-specific characteristics and objectives. Monitoring programs should be commensurate with the complexity and objectives of the project; they may vary from simple completion reports and photo-point documentation to more complex pre- and post- evaluations of physical habitat or water quality changes, biological responses of aquatic organisms, and/or comparisons to reference site conditions. More information on monitoring requirements can be found in Section 5.6.1, *Monitoring, Reporting, Assessment, Accounting, and Adaptive Management*.

5.5.2 Fish Passage Improvement Projects

As described in Section 4.5.3, *Fish Passage Barriers*, unscreened and poorly screened water diversions in the Sacramento/Delta watershed can result in entrainment of juvenile anadromous salmonids. Many larger water diversions are screened or proposed for screening, but unscreened diversions remain on the Sacramento River and Delta eastside tributaries, and in the Delta. In addition, fish passage impediments, such as dams and culverts, exist throughout the watershed and can impede anadromous salmonid migration and negatively affect native fish populations.

State and federal resource agencies and other entities should continue to implement fish passage improvement projects throughout the Bay-Delta watershed. Tributary-specific fish passage improvement projects should address known fish passage impediments and may include projects that expand fish screening efforts, address fish passage barriers, and contain restoration components. For example, fish passage improvement projects could include constructing fish ladders, replacing insufficient culverts, constructing non-physical barriers to minimize entrainment, and trapping and hauling anadromous salmonids where appropriate. In addition, implementation mechanisms for the proposed cold water habitat objective could include physical solutions (e.g., installation of TCDs) or fish passage solutions (e.g., providing fish passage above rim reservoirs).

The State Water Board may take action to address diversion-related fish passage impediments in coordination with other appropriate agencies and entities through implementation of the cold water habitat narrative objective or other authorities. The State Water Board may use its discretionary authorities to address diversion-related fish passage barriers and impediments. In areas where fish passage impediments are known to affect anadromous salmonid survival, the State Water Board may consider taking appropriate enforcement actions to address fish passage impediments.

5.5.3 Invasive Species Control Measures

As described in Section 4.4, *Nonnative Species*, the Sacramento River, Bay-Delta, and tributaries to Suisun Bay and Suisun Marsh are home to a diverse assemblage of native and nonnative species. There are over 250 introduced species, including fish, invertebrates, and plants, in the Bay-Delta. It

is recognized that nonnative species can serve as an ecosystem stressor. For example, as described in Section 4.4.1, *Fishes*, although the extent of predation by nonnative fish on native fish populations remains largely unknown (see Section 5.6.1.3, *Proposed Changes to Monitoring, Assessment, Special Studies, and Reporting*, for proposed monitoring changes to address this), predation by nonnative species is considered an important factor affecting anadromous salmonids and other native fish species. In addition, the proliferation of nonnative submerged and floating aquatic vegetation significantly decreases open water habitat quantity and quality for native fish. Nonnative aquatic plants can spread rapidly, which can negatively affect native species by displacing them, clogging waterways, and affecting water quality.

Invasive species are very difficult to eradicate once successfully introduced; however, various efforts have been and continue to be made to address the problem. The California Natural Resources Agency has developed the California Aquatic Invasive Species Management Plan to control the invasion and spread of nonnative aquatic organisms. The plan provides a coordinated effort to prevent new invasions, minimize impacts from established nonnative aquatic species, and establish a suite of priority actions. The management plan also lays out a process for annual evaluations of the program.

State and federal resource agencies and other entities implement nonnative species control measures to minimize effects on native fish and wildlife in the Bay-Delta. These efforts may include multiple invasive species control strategies and should be informed by the needs and circumstances of individual tributaries. These invasive species control efforts should be conducted following the best scientific information of their effectiveness and redirected impacts. When information is lacking, control efforts should be conducted under rigorous experimental conditions that would enable evaluation of their effectiveness.

5.5.4 Fishery Management Actions

As discussed in Section 4.5, *Fisheries Management*, fishery management activities, such as harvest and hatchery operations, affect the aquatic ecosystem in the Delta and its tributaries. A potentially unsustainable take of adult breeding stock in commercial and recreational fisheries may be a factor contributing to declines in population abundance of native species, such as salmonids, sturgeon, splittail, starry flounder, and bay shrimp. Poaching, which represents an illegal form of harvest, is also a continued problem in the Delta. Finally, although hatchery production is recognized as an important component of salmon and steelhead conservation and recovery efforts, hatchery production historically has posed a threat to wild Chinook salmon and steelhead stocks through genetic, ecological, and management impacts.

Fishery management actions are largely the purview of other agencies, such as CDFW, California Fish and Game Commission, Pacific Fishery Management Council, USFWS, and NMFS. State and federal fishery agencies should continue to implement fishery management actions in the Bay-Delta watershed. For example, state and federal fishery agencies should continue to periodically review and modify, if necessary, existing harvest regulations to ensure that native aquatic species are adequately protected. State and federal fishery agencies should also continue to improve hatchery management programs for species of concern and conduct appropriate monitoring efforts and special studies to evaluate the effectiveness of changes in hatchery management practices in maintaining the genetic integrity and fitness of fish populations. Other agencies and entities should assist state and federal fishery agencies with fishery monitoring efforts and other related activities.

5.5.5 Species Recovery Plans and Recovery Strategies

At the federal level, USFWS and NMFS develop species recovery plans under section 4 of the ESA, which serve as a guide for activities to be undertaken by federal, state, or private entities in helping to recover and conserve federally listed threatened and endangered species. Species recovery plans are non-regulatory documents that outline the actions to restore and secure self-sustaining wild populations. At the state level, CDFW develops and implements recovery strategy programs intended to improve population measures, such as growth rate and fecundity level, as well as to improve habitat conditions. Once a strategy is in place, CDFW coordinates with partners to fund and implement recovery actions.

USFWS, NMFS, CDFW, and other entities should continue to implement current recovery plans and strategies and to expand efforts toward protecting state- and federally listed species. In particular, USFWS, NMFS, CDFW, and other agencies and entities should implement the actions identified in species recovery plans and recovery strategies to avoid potentially redirected impacts on special-status terrestrial and aquatic species.

5.5.6 Regional Water Board Activities

This section describes regional water board activities related to Bay-Delta watershed regulatory, planning, and monitoring activities. The State Water Board works in coordination with the regional water boards to preserve, protect, enhance, and restore water quality in California. These responsibilities all converge in the Bay-Delta where the State Water Board must balance many responsibilities and interests. State law requires that the State Water Board and the nine regional water boards adopt water quality control plans that ensure beneficial uses of water in an area are protected. The State Water Board and regional water boards establish water quality objectives for the protection of beneficial uses of water and programs of implementation to achieve those objectives that seek to maximize all beneficial uses of water.

The Bay-Delta Plan is complementary to other water quality control plans adopted by the State and regional water boards and state policies for water quality control adopted by the State Water Board. In particular, the Bay-Delta Plan operates in conjunction with the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* adopted and implemented by the Central Valley Water Board and the San Francisco Bay Water Board, addressing point-source and nonpoint-source discharges and other controllable water quality factors.

5.5.6.1 State and Regional Water Board Coordination

Pursuant to the 2008 Strategic Workplan for the Bay-Delta, staff from the State Water Board and the Central Valley and San Francisco Bay Water Boards formed the Bay-Delta Team to improve coordination of the Water Boards activities in the Bay-Delta watershed. The program of implementation for the proposed Plan amendments directs the State Water Board, Central Valley Water Board, and San Francisco Bay Water Board to continue to coordinate on Bay-Delta watershed activities through the Bay-Delta Team and other appropriate forums. The Bay-Delta Team will continue to collaborate on Bay-Delta regulatory programs, monitoring efforts, and other related activities to maximize the use of available Water Board resources and to provide a coordinated approach to Bay-Delta management activities.

Water Quality Protection

The Central Valley and San Francisco Bay Water Boards will continue to develop, implement, and periodically update water quality control plans that establish water quality objectives to ensure the reasonable protection of beneficial uses and a program of implementation for achieving water quality objectives. These water quality objectives address a number of contaminants, such as dissolved oxygen, mercury, and temperature. The San Francisco Bay and Central Valley Water Board basin plans contain narrative objectives that prohibit toxic and biostimulatory substances in concentrations that adversely affect human, plant, animal, or aquatic life. The narrative objectives apply to contaminants, emerging or long known, for which the basin plans do not contain numeric objectives. Reliance on narrative water quality objectives is not considered deficient or less protective. For NPDES permits, impaired waterbody listings, and other regulatory actions, narrative objectives are routinely translated into numeric limits using publicly available scientific information and accept public comment. In addition, USEPA has developed water quality criteria for some harmful algal bloom (HAB) toxins (USEPA 2019) and draft aquatic life criteria for some chemicals of emerging concern (CEC) (USEPA 2022), but there are not yet recommended water quality criteria for most CECs. However, USEPA often has health thresholds or other benchmarks that provide some context for concentrations of concern.

Comprehensive Delta Water Quality Monitoring

As described below in Section 5.6.1.3, *Proposed Changes to Monitoring, Assessment, Special Studies, and Reporting*, a thorough long-term contaminant monitoring and assessment program is needed to ensure that the nature and extent of the effects of existing and new contaminants that may be introduced into the Bay-Delta are understood and addressed as needed through regulatory and other actions. Existing Central Valley and San Francisco Bay Water Board monitoring programs such as the Delta and San Francisco Bay Regional Monitoring Programs (RMP) collect contaminant information that contributes toward fulfilling this need. The Central Valley and San Francisco Bay Water Boards should continue to develop and implement Bay-Delta and San Francisco Bay water quality monitoring and assessment efforts needed to provide information on the protection of fish and wildlife and other beneficial uses. These efforts could continue to be fulfilled through the regional water board RMPs, or through other mechanisms consistent with Water Board authorities.

5.6 General Changes to the Program of Implementation

The proposed Plan amendments are focused on achieving integrated watershed management. As such, the proposed program of implementation provides for integrated implementation of the objectives and other actions in the watershed. This section describes the general proposed program of implementation, including provisions for accounting, monitoring, reporting, assessment, adaptive management, and other actions to assist with implementation of the Bay-Delta Plan.

The actions the State Water Board may take depend in large part on the voluntary actions of others to implement the proposed Plan amendments. Specifically, the majority of the proposed changes to the program of implementation provide for voluntary implementation, including development of voluntary implementation plans to implement the Delta inflow, cold water habitat, and inflow-based Delta outflow objective. In the absence of voluntary implementation, default provisions would apply

for these objectives. For the interior Delta flow objectives and fall Delta outflow objective, provisions are proposed that would allow for flexibility and adaptive management similar to the voluntary processes.

Changes are proposed to update the program of implementation and improve its organization, update and streamline information, remove dated information and avoid information becoming dated, and provide a consistent format. The specific changes to the program of implementation will be developed following receipt of comments on this draft Staff Report and will be subject for public review and additional comment.

5.6.1 Monitoring, Reporting, Assessment, Accounting, and Adaptive Management

The proposed changes to the Bay-Delta Plan represent a significant shift in the geographic scope and methods by which the State Water Board historically has implemented the Bay-Delta Plan that will require additional supporting monitoring, reporting, assessment, accounting, and adaptive management at the watershed scale, including the Bay, Delta, and tributaries. Specifically, measures will be needed to (1) evaluate compliance with specific implementation provisions by responsible parties; (2) evaluate the effectiveness of implementation measures in meeting the narrative and numeric objectives and protecting fish and wildlife beneficial uses; and (3) inform when and how to reevaluate the objectives and program of implementation. To provide for efficient and practical implementation of the objectives, to the extent possible, these measures are proposed to be prioritized and built on existing information and processes and to be refined and improved over time. A general description of existing monitoring and assessment actions is provided in the following sections. A further discussion of these issues is included for each objective in Section 5.4, *Proposed New and Modified Objectives and Implementation*, as appropriate.

5.6.1.1 Introduction to Monitoring, Assessment, Special Studies, and Reporting

Monitoring, assessment, special studies, and reporting (collectively referred to as *monitoring activities*) are necessary for three interrelated purposes: (1) assessing compliance; (2) adaptive management; and (3) long-term planning (e.g., future updates to the Bay-Delta Plan). Objectives and orders are enforceable only if compliance with them can be determined, which requires monitoring data and assessment methods. Adaptive management requires monitoring data, assessment methods, and timely reporting to support ongoing evaluation to determine whether management change is needed. Lastly, long-term planning efforts require scientific knowledge about water quality, flows, ecosystem status and trends, results of special studies, and management assessments—all of which require monitoring data, reliable data management and assessment methods, and regular reporting.

Long-term monitoring is particularly important for all three purposes since it is needed to establish baselines (reference conditions); assess changes over time; and evaluate the status of the water quality, flows, and ecosystem metrics within the natural variability of California climate, hydrology, and ecosystem conditions (Hobbie et al. 2003). Short-term special studies are important for filling information gaps or testing pilot approaches to improving long-term monitoring efforts. Generally, short-term special studies are designed to leverage existing long-term monitoring programs but do not require ongoing long-term data collection.

Monitoring and Special Studies

Monitoring in the Bay-Delta watershed includes collection of physical (e.g., flow), chemical (e.g., salinity, pH, dissolved oxygen), and biological (e.g., chlorophyll, species abundance) data. All three types (physical, chemical, and biological) are important for monitoring waterbodies (USEPA 2003).

For the purposes of the Bay-Delta Plan, monitoring and assessment programs are generally long-term data collection, assessment, and reporting with consistent methods; special studies are shorter-term scientific investigations. Special studies are often targeted to answer a high-priority management question or fill a critical information gap that does not require long-term data. This can be accomplished with short-term field studies or data synthesis studies that analyze data from potentially multiple monitoring programs. Special studies also can be used to pilot potential new monitoring surveys or test methods prior to updating monitoring and assessment methods. Monitoring and special studies in combination provide the foundational scientific information needed to inform management questions.

Regardless of the type of data or the collection method, data management is necessary to ensure the integrity and longevity of monitoring data and associated assessments (Vos et al. 2000; USEPA 2003). Data management is critical to every step of the monitoring process from initial planning through final publication of data (McCord et al. 2021). Data management includes processes such as database design, data documentation, data processing, and quality assurance (QA) and quality control (QC) (referred to collectively as *QAQC*). Quality assurance is the full process, including development of protocols; staff training; calibration; and checks, flags, and fixes to data after collection. Quality control encompasses the latter step (checks, flags, and fixes to data after collection) (McCord et al. 2021). Rigorous QAQC protocols (often documented in Quality Assurance Project Plans) are particularly important to produce reliable and usable data (USEPA 2003). Proper QAQC protocols result in consistent and high data quality to produce management decisions based on valid information and sound science.

Assessment

After data are collected, they must be assessed to inform management needs (USEPA 2003). Assessments can take many forms but often are targeted to specific management questions, numeric compliance requirements, policy targets (e.g., the Central Valley Project Improvement Act doubling for salmonids, biological goals) or other recognized but less formalized benchmarks. Generally, assessments involve averaging over some spatiotemporal frame or conducting a trend analysis, which should be tailored to the period of interest. Outflow and tributary flow requirements may need to be assessed daily or on an appropriate tidal cycle, while species abundance trends may be assessed at longer seasonal to annual time steps. Assessment of compliance points often is tracked over time to keep a record of compliance at each time step. Accounting is a more specific type of assessment often applied to compliance assessments of flow.

Reporting

For monitoring, special studies, and assessment to inform management actions and to maintain transparency, regular reporting must occur. The reporting time step must, at a minimum, align with that of the management decisions it is meant to inform. Real-time data and assessments often are initially released as “provisional” data to minimize delays, though QA protocols should always be applied. When those data or assessments undergo the full QAQC protocol, their historical record should be updated with the higher-quality (“approved” or “validated”) data. This allows real-time

management to occur with timely data while ensuring that the historical record remains a high-quality dataset subjected to rigorous QAQC protocols. As data records are updated, it is important to preserve all past versions of the dataset to ensure the reproducibility of analyses that informed management decisions at the time those decisions were made.

Adaptive Management

The full process of monitoring, assessment, and reporting should be regularly reviewed and updated to ensure current and anticipated future management information needs are met (Vos et al. 2000; Reynolds et al. 2016, USEPA 2003). This is also an opportunity to reevaluate the objectives of the monitoring program, evaluate new monitoring technologies, and assess the collected data to evaluate whether the sampling design continues to provide the information needed for management. While assessment and reporting can and should be regularly updated to reflect current management needs and the latest technologies, particular care must be taken in revisions to monitoring methods given that one of the most valuable components of a monitoring program is its long-term data record. Thus, the potential benefits of changes to monitoring methods or sampling designs must be carefully evaluated against risks to the integrity of the long-term data record (Vos et al. 2000). This can be especially difficult in multi-parameter monitoring surveys in which improvements in sampling one parameter may reduce effectiveness or interrupt the long-term data record in sampling another parameter.

5.6.1.2 Existing Monitoring, Assessment, Special Studies, and Reporting for the Bay-Delta Plan and Watershed

There are many water quality and ecosystem monitoring programs in the Bay-Delta watershed reflecting the importance of the watershed's economic and ecological resources to California; some monitoring was initiated in the 1950s and 1960s. The existing monitoring network and associated datasets are produced by agencies with resource management, science, or monitoring responsibilities (e.g., DWR, CDFW, USGS). Some monitoring is required by water quality, water right, and federal and state endangered species act regulatory requirements, while other monitoring and science activities are conducted to support agency missions. Bay-Delta monitoring programs have produced an unparalleled long-term data record compared with similar systems around the world, documenting and tracking physical, chemical, and biological parameters in the estuary. However, challenges exist with monitoring data and assessment to inform management of emerging and long-term water quality issues such as HABs, nutrient loading, mercury, and pesticides; maintaining and refining monitoring programs to be responsive to management priorities; uncertain and fragmented funding structures; and supporting data collection and science investigations that fill critical information gaps.

The current Bay-Delta Plan and associated water right requirements for monitoring, special studies, and reporting for flow-related water quality and ecological parameters serve multiple purposes, including (1) determining compliance with the Bay-Delta Plan; (2) providing information about flow, water quality, and ecosystem conditions; (3) evaluating the response of aquatic habitat and organisms to Bay-Delta Plan requirements; and (4) increasing understanding of watershed-scale characteristics and ecosystem functions to inform management actions. Responsibility for implementing these requirements is currently assigned to the SWP and CVP through D-1641 and prior orders and decisions.

Other monitoring programs in the Bay-Delta watershed are conducted to fulfill other requirements and information needs. The San Francisco Bay RMP and Delta RMP, for example, are focused on water quality parameters such as contaminants, nutrients, and other discharge-related water quality issues. Monitoring and reporting occur in the Bay, Delta, and upper watershed with individual discharge permits and broad geographic programs such as the Irrigated Lands Regulatory Program. The California State Parks Division of Boating and Waterways (CDBW) monitors aquatic vegetation in the Delta alongside their invasive weed control efforts. Flow and ecological monitoring also is conducted in the upper watershed through other water right and FERC licensing requirements and other watershed monitoring efforts.

Current Bay-Delta Plan Monitoring and Special Study Program

Most of the monitoring and reporting identified in the existing Bay-Delta Plan and D-1641 occurs in the Legal Delta and Suisun Marsh and Bay and is the responsibility of DWR and Reclamation through conditions on their respective water rights for the SWP and CVP. This monitoring is focused on water quality and ecosystem metrics that are affected by Project operations in the Bay-Delta watershed and includes physical, chemical, and biological water quality parameters.

Specific requirements prescribing monitoring locations and measurement parameters are identified in Table 5 of D-1641 and Table 5 of the existing Bay-Delta Plan, referred to as *Water Quality and Baseline Monitoring*. The Project agencies comply with a portion of the Water Quality and Baseline Monitoring requirements through the Environmental Monitoring Program (EMP), jointly funded by DWR and Reclamation. Continuous water quality stations required for Water Quality and Baseline Monitoring also are operated by DWR and Reclamation, and data are posted to the California Data Exchange Center (CDEC).

General monitoring requirements and associated special studies for fisheries and ecological and biological parameters are narratively described in the terms and conditions of the Projects' water right permits, licenses, and associated decisions. D-1641 and D-1485[11] identify the general management questions and ecological and fishery issues that should be addressed but do not include monitoring design specifications. Instead, these monitoring requirements rely on coordination with and recommendations from state and federal fishery agencies (CDFW, NMFS, and USFWS) for the details of fishery and ecological monitoring designs, data assessment, and reporting. The Project agencies historically have complied with general fisheries and ecological monitoring obligations by funding fish and ecosystem monitoring, reporting, and special studies identified in the Interagency Ecological Program (IEP) annual workplan. The existing Bay-Delta Plan monitoring and special studies program is predicated on the ongoing monitoring efforts that have historically been coordinated through the IEP consortium of state and federal agencies including: DWR, CDFW, State Water Board, Reclamation, NMFS, USEPA, USFWS, USGS, and the U.S. Army Corps of Engineers.

Coordination of monitoring and reporting efforts relies on partner agency expertise and scientific collaboration and provides opportunities for efficiency between potentially overlapping monitoring and assessment requirements in BiOps, ITPs, water right permits and licenses, and other purposes. For example, the NMFS and USFWS BiOps and the CDFW ITP include fish distribution and entrainment and other monitoring, special studies, reporting, and adaptive management provisions for ESA-listed species only, while Bay-Delta Plan monitoring is ecosystem focused and includes many species of fish, invertebrates, and primary producers. Some of the BiOp and ITP monitoring

[11] Including, but not limited to Condition 10, page 28 in D-1485 and Condition 11, page 149, in D-1641.

and assessment actions are coordinated through IEP, and others are not. While the general nature of the fishery and ecological monitoring obligations in the Projects' water rights provides flexibility, it can also result in ambiguity.

Monitoring activities coordinated through IEP are concentrated in the Delta and Suisun Marsh and Bay, reflecting the geographic focus of the current Bay-Delta Plan. However, IEP does not coordinate the entirety of monitoring in the Delta, Suisun Marsh, and Bay; and monitoring data collected in different programs are difficult to integrate and use across programs due to monitoring design and data quality differences. The Projects and other organizations conduct monitoring activities in the upper watershed, but those measures are not currently specified in the Bay-Delta Plan or water right requirements. For example, there are ongoing monitoring efforts through various requirements, such as FERC licenses for reservoir operations and water-user agreements, in the tributaries upstream of the Delta. These data are generally less readily available to the public and agency scientists for synthesis studies.

Biological Monitoring Surveys

Biological monitoring in the Bay-Delta watershed includes field sampling of fish species, invertebrates, and primary producers to estimate the abundance and distribution of aquatic species in the ecosystem and to document trends over time. Biological measurements often are paired with habitat water quality measurements such as salinity, turbidity, dissolved oxygen, and temperature. Most Bay-Delta biological monitoring is conducted by IEP member agencies. Surveys sample fish abundance with trawls, seines, and traps; zooplankton abundance with plankton nets; phytoplankton abundance with plankton nets and chlorophyll sondes; benthic invertebrates with ponar grabs; and aquatic vegetation with field surveys and remote sensing.

Phytoplankton, zooplankton, and benthic invertebrate data primarily are collected through the EMP[12] to fulfill requirements for Water Quality and Baseline Monitoring identified in D-1641 and by the USGS San Francisco Bay Survey (1992–2014).[13] Zooplankton also have been collected by several primarily fish-focused surveys and by shorter-term surveys.[14],[15] Aquatic vegetation data are collected by CDBW,[16] UC Davis Center for Spatial Technologies and Remote Sensing,[17] and the Fish Restoration Program (FRP)[18].

Fish data are, or were recently, collected by a number of surveys and programs, including the 20 mm survey[19], USFWS Delta Juvenile Fish Monitoring Program (DJFMP)[20], Fall Midwater Trawl Survey

[12] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/EMP.

[13] https://www.usgs.gov/data/phytoplankton-species-composition-abundance-and-cell-size-san-francisco-bay-microscopic.

[14] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Delta-Juvenile-Fish#62150-larval-and-zooplankton-trawling.

[15] https://www.usbr.gov/mp/bdo/directed-outflow.html.

[16] https://dbw.parks.ca.gov/?page_id=29469.

[17] https://cstars.ucdavis.edu/.

[18] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Tidal-Wetland

[19] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/20-mm

[20] https://www.fws.gov/project/delta-juvenile-fish-monitoring-program

(FMWT) [21], CDFW Smelt Larval Survey (SLS),[22] CDFW Spring Kodiak Trawl (SKT),[23] CDFW Adult Striped Bass Study,[24] CDFW Adult Sturgeon Study,[25] CDFW Summer Townet Survey (STN) [26], CDFW FRP, DWR Yolo Bypass Fish Monitoring Program (YBFMP)[27], UC Davis Suisun Marsh Study,[28] CDFW San Francisco Bay Study,[29] CDFW and Reclamation Fish Salvage Monitoring,[30] USFWS Enhanced Delta Smelt Monitoring (EDSM),[31] Reclamation Directed Outflow Project (DOP), CDFW Fish Diet Study,[32] and USFWS electrofishing survey.[33] While the spatial scope of most of these surveys is the Bay and Delta, DJFMP includes sampling locations in the tributaries upstream of the Delta. A few of the programs listed may be, or have been, closed due to Project funding decisions, including SKT (DWR 2023), Adult Striped Bass Study, and Adult Sturgeon Study.[34]

In the tributaries upstream of the Delta, biological monitoring is less coordinated and data are generally less readily available, creating challenges for producing a complete description of tributary monitoring activities. The relative contribution of hatchery Chinook salmon production to fishery harvest and escapement is monitored with the Constant Fractional Marking Program that tags hatchery-produced fish and recovers tags from harvested or escaped spawning fish. More recently, genetic parentage-based tagging has been employed for the same general purpose. Rotary screw traps and fyke traps are used to collect data on fish (primarily salmonid) abundance and migration in many of the tributaries. Various redd, snorkel, beach seine, carcass, escapement, passage, and electrofishing surveys are also conducted in the tributaries, mostly focused on salmon and steelhead. Lastly, acoustic receivers for tracking tagged fish movement are deployed throughout the tributaries and are coordinated through the Interagency Telemetry Advisory Group (ITAG), which uses the resulting data to estimate migratory fish survival rates.

Monitoring in the tributaries has some coordination through groups such as CalFish[35] and the Sacramento River Watershed Program,[36] although CalFish is primarily focused on sharing data, and funding for the Sacramento River Watershed Program monitoring program ended in 2007.

Better coordination among watershed monitoring would improve the ability to manage the system (Delta ISB 2022). Tributary monitoring efforts are especially in need of coordination to increase the effectiveness and transparency of these monitoring efforts and the availability of their data. This coordination also would help promote science on the drivers of native species abundances and ecosystem services in the watershed more broadly, as IEP has done in the Delta.

---

[21] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Fall-Midwater-Trawl
[22] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Smelt-Larva.
[23] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Spring-Kodiak.
[24] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Striped-Bass.
[25] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Sturgeon.
[26] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Summer-Townet
[27] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Yolo-Bypass
[28] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Suisun-Marsh.
[29] https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/San-Francisco-Bay-Study.
[30] https://wildlife.ca.gov/Conservation/Delta/Salvage-Monitoring.
[31] https://www.fws.gov/project/enhanced-delta-smelt-monitoring-program.
[32] https://wildlife.ca.gov/Conservation/Delta/Special-Studies.
[33] https://www.fws.gov/project/delta-juvenile-fish-monitoring-program.
[34] https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=207807&inline.
[35] CalFish Home.
[36] Sacramento River Watershed Program (sacriver.org).

Physical-Chemical Monitoring

Physical and chemical monitoring for the Bay-Delta Plan includes water quality and ecosystem metrics. Monitoring includes, but is not limited to, measurements and estimates of freshwater inflow; Delta outflow; tidal cycles; unimpaired flow; EC; turbidity; dissolved oxygen; temperature; and meteorological variables such as air temperature, wind speed and direction, and solar radiation.

All of the biological monitoring surveys described above collect water quality data (temperature and conductivity at a minimum, but often Secchi depth/turbidity, dissolved oxygen, pH, or other parameters). There are also some boat-based surveys primarily focused on water quality monitoring that report additional water quality parameters such as nutrient concentrations and more refined chemical constituents such as alkalinity and organic carbon. These surveys include EMP, the DWR Stockton dissolved oxygen monitoring survey, the USGS San Francisco Bay survey, the USGS California Water Science Center monitoring, and the San Francisco Bay and Delta RMPs. While boat-based surveys collect data at a weekly to monthly time step, continuous monitoring stations generally report data every 15 minutes or every hour. All continuous monitoring stations require regular maintenance and calibration to ensure data integrity. There are numerous continuous stations in the Bay-Delta and its tributaries that are maintained by DWR, Reclamation, USGS, and various local water and utility agencies.

Calculated or forecasted flow values such as unimpaired flow that rely on measured parameters such as precipitation, gaged flow, evaporation, and changes in reservoir storage are reported at specific gage locations on CDEC. DWR provides estimates of unimpaired flows (or full natural flows) on a daily and monthly basis for the 11 rivers in the Sacramento/Delta watershed (see Figure 5-1).[37] Many of the smaller rivers and creeks that are proposed to have a flow objective expressed as a percent of unimpaired flow, including locations on the valley floor, do not have flow gages or estimates of unimpaired flow (see Figure 1-1a). The National Weather Service's California Nevada River Forecast Center also provides forecasted flows for various locations in the Sacramento/Delta watershed but not for all locations identified in the proposed Plan amendments.

[37] Figure 5-1 is an illustration of Table A7-2 found Appendix A7, *Modeling Approaches Used to Develop Unimpaired Watershed Hydrology*. Table A7-2 presents a list of active telemetered streamflow gages on Sacramento/Delta tributaries, available through California Data Exchange Center.

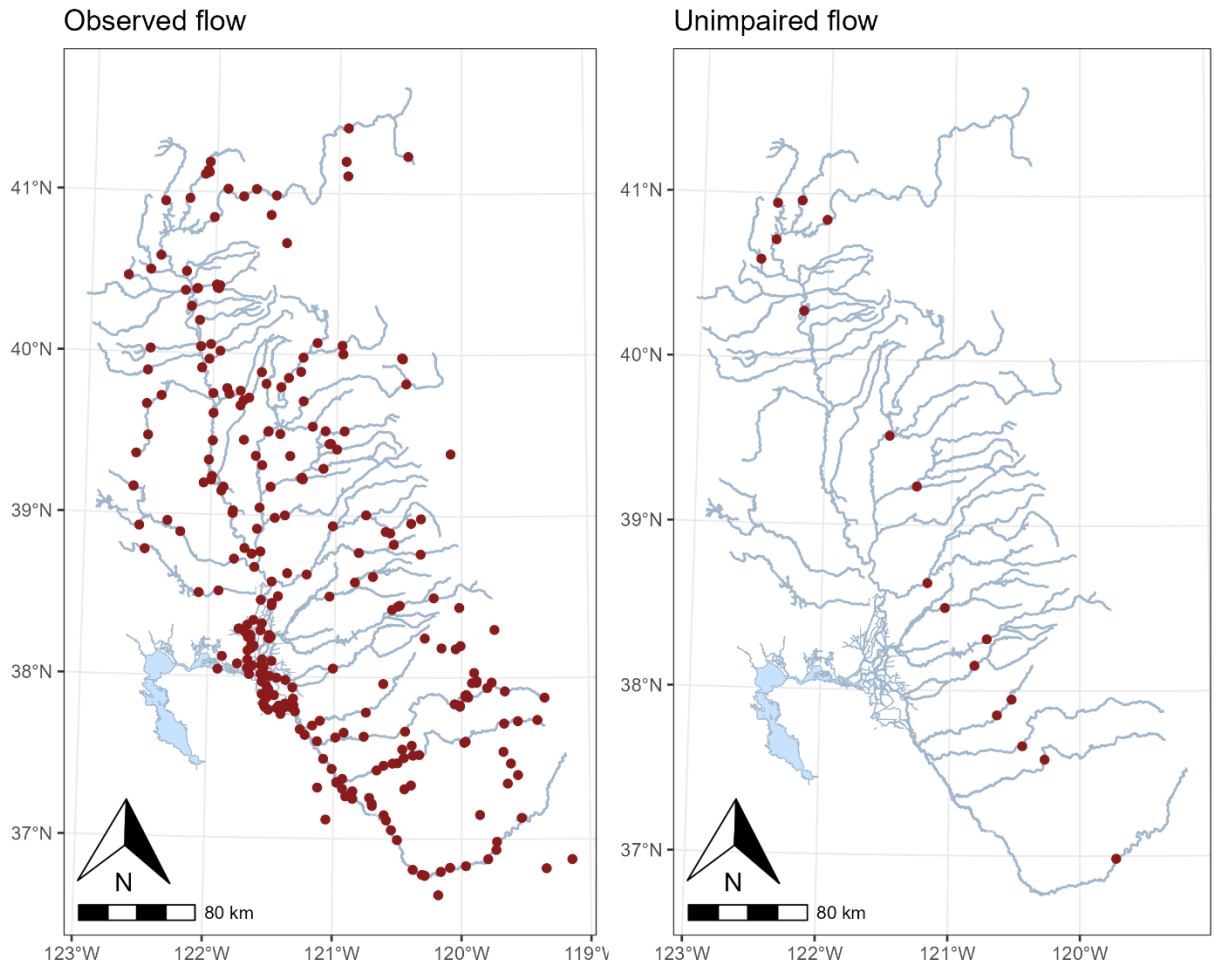

Figure 5-1. Locations of Active Observed and Unimpaired Flow Stations Available on CDEC (California Data Exchange Center), within the Sacramento and San Joaquin Rivers Hydrologic Regions

Monthly surface water diversions are reported annually to the State Water Board for water rights and claimants, but this reporting is not real-time, by point of diversion, or comprehensive. The self-reporting structure of diversion data limits the ability to effectively assess data quality or apply data control requirements. As a result, the quality of diversion data is poor and there are few available tools to improve data quality with the current reporting requirements. Diverters authorized to divert more than 10 AF/year are required to report diversions to the State Water Board under Senate Bill 88, but compliance is low. The reported data are difficult to use since the data are not compiled in a central repository and there are alternate compliance options. Groundwater diversions and some types of surface water diversions also are not compiled or publicly available.

Return flows from agricultural diversions also are not generally required to be measured. As a result, estimations of return flows often are calculated as a simplified water balance of applied water (inflow versus outflow) or apportioning irrigation efficiencies that have a high degree of uncertainty.

Special Studies

Numerous special studies are conducted by local, state, and federal agencies and academic institutions. Examples of special studies that have informed management questions include, but are not limited to, the Pelagic Organism Decline (POD) investigations (e.g., Sommer et al. 2007), the Salmon Assessment of Indicators by Life Stage (SAIL) effort to provide recommendations for improving salmonid monitoring (Johnson et al. 2017), and fish sampling gear efficiency studies (e.g., Mitchell et al. 2019). Some special studies such as the CDFW Diet and Condition Study have been ongoing for many years and provide important data needed for long-term management. When special studies fulfill an ongoing long-term information need, they may be transitioned into monitoring programs.

Reporting

D-1641 requires timely posting of required monitoring results as soon as practicable, as well as submittal of annual reports to the State Water Board by December 1 of each year. Reporting pursuant to these requirements is inconsistent for all Bay-Delta Plan and D-1641 monitoring requirements. Currently, only EMP submits annual reports for a portion of the required Water Quality and Baseline Monitoring Program. Annual reports are not submitted for other continuous monitoring, nor are reports submitted covering the more general requirements for monitoring of food chain relationships and fisheries. The IEP surveys considered to fulfill the general monitoring requirements historically have provided an annual summary of their findings in the IEP newsletter and as part of the annual IEP workshop.

5.6.1.3 Proposed Changes to Monitoring, Assessment, Special Studies, and Reporting

A comprehensive program for monitoring, assessment, special studies, and reporting is necessary to implement the proposed updates to the Bay-Delta Plan. As explained in the previous section, the proposed changes to the Bay-Delta Plan represent a significant shift in the geographic scope and methods by which the State Water Board historically has implemented the Bay-Delta Plan that will require additional monitoring, reporting, assessment, accounting, and adaptive implementation activities. Additionally, stronger connections between Bay-Delta and tributary monitoring programs will be needed to support the Bay-Delta Plan update, which includes potential requirements for tributary flows and cold water management for the reasonable protection of fish and wildlife.

Bay Delta Monitoring and Evaluation Program

Consistent with the 2018 LSJR/SD update, proposed changes to the program of implementation include developing a Bay-Delta Monitoring and Evaluation Program (BDMEP) in coordination with other agencies and stakeholders that includes requirements for monitoring, assessment, special studies, and reporting activities necessary to implement the updated Bay-Delta Plan. The LSJR/SD update includes a requirement to develop a San Joaquin Monitoring and Evaluation Program, which would become part of the BDMEP once it is established. The BDMEP would serve multiple purposes including, but not limited to, evaluating and reporting compliance with water quality objectives (including accounting), informing adaptive implementation, filling critical knowledge and information gaps, and assessing effectiveness of and informing future updates to the Bay-Delta Plan. Development of the BDMEP is proposed to (1) incorporate existing monitoring, assessment, and reporting programs, to the extent possible, to avoid duplication; and (2) identify additional or

revised monitoring, assessment, reporting, and special studies activities in coordination with watershed partners. For example, the BDMEP would incorporate and build on monitoring activities coordinated through IEP and required by ITPs, BiOps, and FERC licenses, once it is established, and the San Joaquin River Monitoring and Evaluation Program (SJRMEP). Water diverters would have responsibilities for contributing to the BDMEP through the voluntary processes or default processes.

Development of the BDMEP would also incorporate recommendations from recent monitoring reviews including, but not limited to, the following: (1) identify priority management and monitoring questions and science needs for Bay-Delta Plan implementation; (2) review and revise or develop, as necessary, monitoring designs, assessment methods, and reporting protocols to address priority management questions and science needs: and (3) strengthen organizational and funding structures.

At a minimum, the following categories of monitoring are proposed to implement the proposed Bay-Delta Plan amendments.

1. **Hydrologic:** Monitoring, special studies, assessment methods, and reporting requirements for flow; flow-dependent metrics including, but not limited to, river flow, tidal flow, salinity, unimpaired flow, diversions, return flows, storage, improvements to forecasting tools, and development of accounting methods.
2. **Fish and Wildlife:** Monitoring, special studies, assessment methods, and reporting requirements that address the effects of flow, hydromodification, and other factors on ecosystem metrics and viability of native Bay-Delta watershed fish populations, including abundance, spatial extent (distribution), diversity (both genetic and life history), and productivity.
3. **Water Quality:** Monitoring, special studies, assessment methods, and reporting requirements for water quality issues that address the combined effects of hydromodification (e.g., diversions, river and tidal channel morphology) and discharges (e.g., wastewater, storm water, return flows) such as HABs and aquatic weeds.
4. **Processes**: Data and information management; reporting timelines; external scientific review of monitoring activities; and changes to monitoring, assessment, reporting, and special studies activities.

Review and Update of Current Bay-Delta Plan Monitoring Requirements

D-1641 requires DWR and Reclamation to review the Water Quality Compliance and Baseline Monitoring Program (Table 5 and Figure 4 of D-1641, partially fulfilled with the EMP) every 3 years to ensure that the goals of the program are being achieved. However, since D-1641 was adopted, the EMP has been reviewed only once. The EMP represents the DWR portion of the Water Quality Compliance and Baseline Monitoring Program but does not include the portion of the monitoring conducted by Reclamation. D-1641 also requires Reclamation and DWR to conduct ongoing and future monitoring surveys as recommended by the fisheries agencies concerning food chain relationships, fisheries impacts, and impacts on brackish tidal marshes as they are affected by operations of the SWP or CVP in the Delta and Suisun Marsh; D-1641 does not include specific requirements for these monitoring surveys. Finally, D-1641 requires annual reporting of monitoring and special studies. These requirements should be reviewed to identify whether data and assessments are answering priority management questions and fulfilling science needs for Bay-Delta planning and implementation purposes. In addition, the management questions and priority

science needs should be updated to reflect current needs under the updated Bay-Delta Plan. This review should identify any known gaps, including those discussed in the next sections.

Monitoring and Information Needs to Implement Proposed Plan Amendments

There are multiple actions the State Water Board and others would need to take to provide data and information needed to implement the proposed Plan amendments. Implementation of the proposed changes to the Bay-Delta Plan can rely to some extent on existing river and tidal gaging and monitoring for initial implementation. However, improvements would be part of longer-term implementation, including gaging on tributaries that do not have flow gages, do not have sufficient flow and water supply monitoring information to estimate unimpaired flow, have inadequate flow gages, or do not have adequate reporting of gaged flows for determining flow requirements or assessing compliance with flow requirements. Similar improvements also would be proposed to implement the cold water habitat provisions.

The proposed program of implementation would direct the State Water Board to identify and require needed gaging, monitoring, assessment, and reporting activities, including updates to the Water Quality Compliance and Baseline Monitoring requirements from the existing Bay-Delta Plan. Identifying all monitoring needs for implementing the plan is especially important when monitoring requirements overlap between regulatory instruments (e.g., BiOps, water right conditions) or monitoring and information provided as part of agency responsibilities (e.g., USGS and DWR flow gaging, reporting, estimates of unimpaired flow) to clearly identify the monitoring activities required for the Bay-Delta Plan and to ensure that information will be available in the future if information produced from monitoring requirements or fulfilling agency responsibilities changes in the future. The program of implementation would allow for those requirements to be updated by the Executive Director on a regular basis as appropriate through the default or voluntary implementation processes without a Plan amendment.

The following sections provide additional information about monitoring, assessment, and reporting needs specific to streamflows, diversions, and water right reporting to inform revisions and potential public comments regarding revisions to the program of implementation on monitoring and assessment of these parameters.

Streamflows, Unimpaired Flows, and Delta Outflow

Methods would be needed to determine required streamflows under the proposed Plan amendments for each tributary and for Delta outflow purposes. The proposed program of implementation would include provisions for development of methods to determine unimpaired flow and required flow levels for applicable tributaries and the Delta, including methods to estimate and account for losses to groundwater and riparian vegetation, including floodplain inundation. The program of implementation also would include provisions for forecasting.

The proposed new inflow-based Delta outflow objective would require methods for determining the required outflow level based on the inflow levels and downstream accretions and depletions that factor in travel times and other relevant factors. The proposed program of implementation would include provisions for development of such methods in coordination with other appropriate agencies.

Water Diversions, Reporting, and Accounting to Achieve the Required Flows

The State Water Board would need to develop provisions for ensuring that water right holders are bypassing water and other actions to meet the proposed Plan amendments, including monitoring, reporting, accounting, and other provisions. The majority of water users in the Bay-Delta watershed do not currently have responsibilities for meeting Bay-Delta Plan water quality or flow objectives. Further, with the exception of drought circumstances, other than the limited subset of water right holders that have Term 91 or similar terms in their water rights, users also have not been required to limit their diversions when water is not available under their priority to meet Bay-Delta Plan instream flow requirements.

The proposed Plan amendments would broaden the responsibility for meeting the proposed Plan amendments beyond the SWP and CVP based on water right priorities. Improvements in water right reporting would be needed to implement this broader responsibility. Improvements include more accurate demand data and accurately reporting diversions under the correct water right.

In addition to improvements to water diversion calculations and reporting, provisions for improving return flow calculations and reporting would be proposed.

Bypass Methodology

The proposed program of implementation would include provisions for developing a methodology and system for identifying and notifying water users when they must reduce or cease diversions (bypass flows) at their priority of right to meet the proposed Plan amendments. Development of a bypass methodology could build on past efforts, including the Water Unavailability Methodology for the Delta Watershed that supported the Emergency Regulation to Protect Water Supplies in the Sacramento-San Joaquin Delta Watershed during the 2021–2022 drought. The emergency regulation authorized the Deputy Director to issue curtailment orders when flows were determined to be insufficient to support all diversions.

A bypass methodology for implementing Bay-Delta Plan updates would limit diversions sufficient to achieve instream flow requirements in addition to ensuring that water right holders were not diverting outside of their water right priority.

Traditional Ecological Knowledge

Information needed to inform the proposed Plan amendments encompasses not only western ecological knowledge but also Traditional Ecological Knowledge (TEK). TEK is indigenous knowledge of historical and lived experiences in the environment, passed down through many generations. TEK from California Native American tribes can help inform protection of beneficial uses, improve monitoring and assessment, and inform adaptive implementation of Plan amendments. TEK has been described by Yurok tribal members as a “way of life” that includes aspects of science, spirituality, and cultural traditions (^Ramos 2021). Whereas western ecological knowledge is often quantitative, TEK is often qualitative, incorporating knowledge, teaching, practices, and spiritual beliefs (^Tolowa Dee-ni’ Nation et al. 2017).

When incorporated with western ecological knowledge, TEK can improve the spatial and temporal resolution of environmental monitoring data and provide knowledge that predates that obtained through western science. For example, TEK can provide knowledge about native fish species like Chinook salmon and native vegetation that are culturally significant to tribes and were prevalent prior to the arrival of European settlers (^Tolowa Dee-ni’ Nation et al. 2017), as well as provide

information about environmental conditions prior to and during human development of the landscape (^Usher 2000). Indigenous knowledge may provide historical information about geographic distributions of native species (^Tolowa Dee-ni' Nation et al. 2017) and how they are influenced by environmental conditions. TEK also may help to refine priority management questions and facilitate a heuristic approach to monitor and improve Bay-Delta fish and wildlife management. In addition to improving environmental monitoring and assessment, inclusion of TEK in science-based decision making can benefit tribes if effects on tribal cultural resources are explicitly considered in environmental policy and resource management (^Runge et al. 2015; ^Zedler and Stevens 2018).

When combined with western ecological knowledge, TEK can provide a more holistic and effective approach to adaptive management and habitat restoration (^Zedler and Stevens 2018). TEK could also inform biological goals (Section 5.6.1.4 *Biological Goals*) for the proposed Plan amendments.

TEK may inform adaptive implementation of the proposed Plan amendments and voluntary implementation plans. For the default implementation process, TEK could improve adaptive management of unimpaired flow to achieve a functional flow regime. For example, TEK about how culturally significant species, such as willow, cottonwood, and salmon, respond to environmental flows could help shape the magnitude and timing of tributary inflows and Delta outflows within an adaptive range (Moloney 2023). Section 5.4.2, *Inflows,* and Section 5.4.4, *Delta Outflows*, describe the importance of magnitude and timing of flows that mimic conditions to which native species are adapted. Indigenous knowledge provides additional information about the importance of flow timing for reasonably protecting fish and wildlife (Moloney 2023). Attributes that TEK could inform include the frequency, quality, timing, magnitude, and duration of flows and the proportionality of flows from specific tributaries. Similarly, TEK may provide knowledge to help manage cold water habitat to protect salmon, by informing riparian restoration or timing of dam releases (see Section 5.4.3, *Cold Water Habitat*).

The proposed program of implementation would include provisions for incorporating TEK into monitoring, assessment, and adaptive management processes for the proposed Plan amendments.

State Water Board staff have engaged in efforts to document TEK. Part of these efforts include a literature review of TEK. However, the availability of TEK in the literature is limited (^Huntington 2000; ^Carroll et al. 2021). The proposed program of implementation would include additional provisions for documenting TEK, including possible contracting with tribes to document TEK.

Biological, Ecological, and Water Quality Monitoring and Information

The proposed program of implementation would call for the development of biological, ecological, and water quality monitoring, assessment, special studies, and reporting activities needed to implement and evaluate updates to the Bay-Delta Plan. The program of implementation would direct State Water Board staff to identify priority management questions and science needs for biological, ecological, and water quality components of Bay-Delta Plan implementation and to review and revise or develop, as necessary, monitoring designs, assessment methods, and reporting protocols to address priority management questions and science needs in coordination with watershed partners.

The proposed general provisions include, but are not limited to, the following.

- Monitoring, assessment, reporting, and special studies to assess the viability of native Bay-Delta watershed fish populations, including assessment of abundance, spatial extent (distribution), diversity (genetic and life history), and productivity.
- Monitoring, assessment, reporting, and special studies of the effects of flow, water quality, and related habitat conditions on fish and wildlife and on subsistence and cultural uses of waterways and aquatic resources.
- Coordination and integration of existing monitoring efforts and recommendations from entities with relevant existing monitoring programs to improve standardization of methods and precision.
- Regular external scientific review of monitoring, evaluation, and reporting and updates based on those reviews, if recommended.

The following paragraphs identify information to support development of monitoring designs, assessment methods, and reporting protocols to implement and evaluate the proposed Plan amendments. While some monitoring and information gaps are generally known, a comprehensive assessment of monitoring and information gaps has not been conducted with a scope spanning the proposed scope of the updated Bay-Delta Plan As a result, there may be additional monitoring-related information needs beyond those identified below.

Tributary Fish, Invertebrate, and Food Web Communities

Biological monitoring on the tributaries is not as extensive as monitoring in the Bay and Delta. Additional monitoring of indicator fish species and food web indicators would need to be identified for tributaries included in the proposed Plan amendments.

Adult Fish Species

The fish monitoring programs coordinated through IEP and in the upper watershed are primarily focused on small fishes (i.e., larvae and juveniles) (Dahm et al. 2019) and limited data are available on large fishes (i.e., adults). Since large fishes are also the major fish predators, this limits available data and knowledge on fish predators, which are thought to be a factor in determining fish abundance and distribution but are difficult to quantify without appropriate data (^Grossman 2016). Lack of data on large fishes also makes it difficult to develop life-cycle models for any but the small fish species (e.g., longfin and Delta smelt).

Planktonic Food Web Communities

Phytoplankton have been monitored in the Bay and Delta since the 1970s; however, changes in sampling methods limit the usefulness of this dataset (Cloern et al. 2014) and thus understanding of the phytoplankton community and how it has changed over time. This in turn limits understanding of the food web and its drivers. Similarly, zooplankton monitoring is focused on open water species. The detrital food web, while potentially a significant contributor to food resources for fish species, is not well measured or understood. Finally, lower food web monitoring is primarily conducted in the Bay-Delta and is not regularly conducted in the tributaries, limiting understanding of food availability in freshwater habitats.

Microplankton such as ciliates are not currently monitored (Dahm et al. 2019). These plankton can be autotrophic (photosynthetic), heterotrophic (consumers), or both. They provide a key link from primary productivity and detritus to the zooplankton that are consumed by fishes. Without data on

these key links in the food web, we cannot fully understand the food web and the resulting energy transfer that determines how primary productivity is translated into fish biomass and productivity.

Harmful Algal Blooms

Delta communities have expressed significant ongoing concerns regarding proliferation of HABs in the Delta and requested that the Water Boards take actions to address these concerns. HABs are a component of the phytoplankton community with potentially severe impacts on fish and wildlife, as well as on human and pet health and safety. HABs have been increasing in recent years, especially in the Bay-Delta, although different species and toxins tend to occur in the more saline San Francisco Bay than in the fresher Delta (^Kudela et al. 2023). HAB occurrence is related to flow such that HABs benefit from lower flows, higher residence times, and higher stratification (^Kudela et al. 2023), as well as temperature, and nutrients. For more information on HABs and their drivers, see Chapter 4, *Other Aquatic Ecosystem Stressors*. Under the current monitoring regime, understanding of the specific triggers for HABs and possible control mechanisms is limited. Additional HABs monitoring in the Delta, including monitoring of their associated toxins, is needed to produce predictive models of HABs (Delta ISB 2022) and actionable management information to work toward reducing or mitigating HABs. HABs have been only intermittently monitored, and monitoring efforts are not currently fully coordinated (^Kudela et al. 2023).

To fulfill the need for more information on HABs within the Bay-Delta watershed and possible control mechanisms, actions should be taken to implement the Freshwater Harmful Algal Bloom (FHAB) Monitoring Strategy produced pursuant to Assembly Bill 834 (Freshwater and Estuarine Harmful Algal Bloom Program) within the Bay-Delta watershed. The Delta Stewardship Council (DSC) is in the process of preparing a Delta HABs Monitoring Strategy that identifies existing HABs monitoring and gaps in monitoring in the Delta that can guide additional investments in Delta HABs monitoring to improve understanding of the environmental conditions, such as flow, nutrients, and water temperature, that contribute to HABs formation. As a first step toward implementing needed coordination and monitoring, the State Water Board will coordinate with DSC and the Divisions and Offices at the State Water Board and the Central Valley and San Francisco Bay Water Boards, DWR, and USGS. This group will also include coordination with tribes, Delta community groups, and other interested entities. The goals of this group will be to coordinate existing and future monitoring efforts to ensure that the highest priority monitoring is being conducted in a coordinated fashion to better understand the precise drivers of HABs, develop tools (i.e., models) to assess possible control mechanisms, coordinate on any control mechanisms that could be implemented, and ensure clear and consistent communication with decision makers and the public. This coordination can ensure the efficient use of existing resources by limiting duplication of efforts across entities and ensuring that the most critical issues are addressed.

In addition to coordination among agencies, the State Water Board is pursuing special studies and synthesis of HABs in the Delta in collaboration with USGS to help fill gaps in knowledge about how flows and other environmental conditions (e.g., salinity, water temperature, nutrients) contribute to HABs formation. These efforts would inform possible management actions by the Water Boards and others. These efforts also will produce a monitoring design that could be implemented to help fulfill components of the Delta HABs Monitoring Strategy.

Specific goals for HABs monitoring would be to extend monitoring spatially and temporally beyond individual bloom incidents; generate sufficient information to characterize cyanobacterial risks to human health and water contact; conduct monitoring before, during, and after the cyanobacteria

bloom season; conduct monitoring of residence time, nutrients, temperature, turbidity, and other basic parameters for characterizing eutrophic conditions; and incorporate sample collection and data management methods that are compatible with existing Bay-Delta monitoring programs.

Complementary monitoring measures could include satellite remote sensing for monitoring blooms over the full spatial extent of the Sacramento/Delta paired with field monitoring. An existing satellite imagery tool (Harmful Algal Blooms Analysis Tool[38]) covers more than 100 lakes and reservoirs in the Sacramento and San Joaquin River basins. Recommended uses of satellite remote sensing are to show current bloom status and to track seasonal and annual trends of planktonic cyanobacteria blooms. Satellite imagery can be used to determine which waterbodies require field sampling for toxins and bloom drivers. However, satellite imagery does not indicate cyanotoxin concentrations or benthic blooms, which require complementary field monitoring. Field monitoring could include continuous monitoring using fluoroprobes to detect cyanobacterial species and sensors to measure other conditions that may contribute to HABs formation. Discrete field sampling also is needed to monitor nutrient concentrations, water clarity (e.g., Secchi depth), and other conditions; and to monitor phytoplankton communities, including their biomass, composition, and taxonomy of cyanobacterial species. Other important field metrics to measure are visual observation scores, concentrations of microcystins, and other cyanotoxins when conditions suggest potential risks. Measurement of cyanotoxins in passive samplers, benthic mats, and toxin gene counts also could be included to address specific questions. The State Water Board will consider whether additional monitoring sites are needed in areas where HABs commonly occur.

In addition to monitoring and consideration of management actions, to help address public safety concerns resulting from Delta HABs, the State Water Board will coordinate with other state and local agencies, including counties in the Delta, to inform the public of the occurrence of HABs and the associated health risks. This coordination will help to provide appropriate notice and public education and outreach, including signage at HABs-contaminated waterways informing the public about the risks of cyanotoxin exposure. Coordination of public education and outreach will utilize existing processes such as the California Water Quality Monitoring Council's California Cyanobacterial and Harmful Algal Bloom Network that tracks HABs and provides information about how to respond to HABs, including information from USEPA on measures that should be implemented to prevent and respond to HABs in surface waters and drinking water supplies.

Aquatic Weeds

Invasive aquatic vegetation has been an issue in the Bay-Delta for decades. It impedes boat traffic and recreational uses and alters ecosystem processes that can cascade to changes in the biological community (Conrad et al. 2023). While CDBW has a budget to combat invasive aquatic vegetation, results have been mixed (Conrad et al. 2023). A consistent monitoring program for invasive aquatic vegetation is needed to improve adaptive management of eradication and control efforts (Conrad et al. 2023). A combination of remote-sensing and field-based surveys would produce data with the required spatial scope and accuracy (Conrad et al. 2023). This monitoring program would have the added benefit of enabling early detection of new invaders (Conrad et al. 2023).

[38] https://fhab.sfei.org/

Near-Bed Salinity

Most continuous monitoring of salinity (or EC as it is often measured before being converted to salinity) is conducted at the surface of the water column. However, the Bay-Delta low-salinity zone experiences occasional vertically stratified two-way flows (gravitational circulation) that can drive processes such as sediment transport, benthic grazing, and rates of primary productivity (Monismith et al. 1996), which subsequently can affect the abundance and distribution of invertebrates and fish species. To understand these processes, mechanisms, and relationships, a better understanding of water column stratification is needed, which requires salinity measurements at both the top and bottom of the water column.

Contaminants

For a detailed discussion of contaminant issues, see Chapter 4, *Other Aquatic Ecosystem Stressors*. Currently, contaminants are intermittently monitored in selected locations through regional programs such as the Delta and San Francisco Bay RMPs. However, a comprehensive long-term contaminant monitoring program integrating the Bay and Delta does not currently exist (^Fong et al. 2016; Delta ISB 2022).

A thorough contaminant monitoring and assessment program would be needed to ensure that the nature and extent of the effects of existing and new contaminants that may be introduced into the Delta are understood and addressed as needed through regulatory and other actions (^Healey et al. 2016). Designing a contaminant monitoring program that is integrated with biological monitoring programs would provide more information about aquatic life exposure to contaminants and answer long-term questions about the relative influences of hydrologic modification versus other stressors (such as contaminants) on the decline of native species. To answer these questions, regular data collection at the time scale of population processes (i.e., seasonally at a minimum) would be needed. This also would help evaluate the potential impacts of wetland restoration and floodplain inundation on contaminant inputs.

In the past, water quality monitoring has emphasized acute bioassays coupled with toxicity identification evaluations and chemical analysis. Future monitoring should also include an evaluation of biochemical and molecular end points that are linked to sub-lethal effects (^Fong et al. 2016). Lastly, water, sediment, and organismal tissue contaminant concentrations should be monitored to determine whether they exceed pre-determined threshold concentrations identified from the literature or determined locally with targeted special studies. TMDL control programs have been developed for several contaminants, including bioaccumulative substances such as legacy pesticides, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, mercury, and selenium. However, there is no regular (at least with an annual frequency) long-term fish tissue monitoring program to ascertain whether fish tissue concentrations are declining as expected. Periodic special studies may be needed to answer short-term management questions. A monitoring and assessment program would be needed for CECs and endocrine-disrupting chemicals to determine whether the chemicals are present in the Bay-Delta estuary at concentrations of concern for human and wildlife health (^Anderson et al. 2010). The San Francisco Bay RMP has a CEC monitoring and assessment program (Miller et al. 2020), but this does not extend through the Delta.

Processes for Monitoring, Assessment, Special Studies, and Reporting

Establishing the BDMEP would require identifying processes for implementing monitoring, assessment, special studies, and reporting identified in the BDMEP. This could be accomplished

through default processes or voluntary implementation plans. Issues that should be considered in development of the BDMEP include, but are not limited to, the following.

- Management and Monitoring Questions: The proposed program of implementation would call for development of management questions to guide establishing and revising monitoring, assessment, reporting, and special studies to implement the proposed Plan amendments. State Water Board staff would draft management questions for consideration of approval by the Executive Director. Management questions would be reviewed and revised consistent with review cycles of the BDMEP.
- Coordination and Transparency: The proposed program of implementation would call for increased coordination among monitoring efforts, including coordination across watersheds and making data publicly available, in a timely fashion.
- Quality Assurance/Quality Control: The proposed program of implementation would call for data and assessments to be subject to QAQC protocols, including protocols for public transparency, and timely posting of data and assessments.
- Procedures and Best Practices for Updating Monitoring Activities: The proposed program of implementation would include provisions for required monitoring programs to be regularly reviewed and evaluated at least every 5 years to ensure that they are continuing to provide the information needed for management in an efficient and transparent manner. Proposed changes to monitoring design would consider the impacts of such changes on the integrity of the long-term data record (Vos et al. 2000). Where proposed changes would break the long-term data records, provisions would be included for special studies to calibrate the past against proposed future methods.
- Process for Approval of Changes to Monitoring Surveys: Consistent with D-1641, the proposed program of implementation would require that changes to monitoring surveys be presented to the State Water Board and subject to Executive Director approval. Analyses of the impacts of monitoring survey changes, justifications of such changes, and plans for additional calibration studies or other actions to preserve the long-term data record would be required.

Voluntary Implementation Plans

Where voluntary implementation plans apply, those plans would be required to include monitoring and evaluation provisions to demonstrate that voluntary implementation plan commitments are being met and to assess the effectiveness of those commitments toward achieving the proposed Plan objectives. Effectiveness monitoring should be structured around quantitative performance standards tailored toward the project goals and Plan objectives that the restoration project is meant to fulfill, and the collection of data necessary to assess progress toward ecosystem and related outcomes. Performance standards should be specific, measurable, achievable, relevant, and time bound (SMART) (Woodward and Hollar 2011) and should incorporate TEK to the extent possible (see 5.6.1.3, *Traditional Ecological Knowledge*).

5.6.1.4 Effectiveness Measures and Adaptive Management

The proposed changes to the Bay-Delta Plan encourage adaptive management and flexibility to address the complexities of the watershed and changing information and circumstances and to provide space for voluntary implementation plans that will necessitate regular monitoring,

reporting, and assessment to ensure that the Plan is effectively protecting fish and wildlife. This would include assessing the effectiveness of implementation of the numeric and narrative objectives. Measures such as biological benchmarks are proposed to be added to the Bay-Delta Plan to ensure that the proposed Plan amendments are being implemented effectively, including for adaptive management purposes.

Biological Goals

A component of evaluating the effectiveness of the proposed Plan amendments is development and use of biological goals. Biological goals are quantitative metrics that are intended to be used to inform adaptive management and future changes to the Bay-Delta Plan, including assessment of both the proposed voluntary and default implementation provisions at achieving narrative objectives and reasonably protecting fish and wildlife. Biological goals are specifically proposed to assess the health of the Bay-Delta ecosystem for representative anadromous and estuarine fish species, including measures to assess the abundance, productivity, genetic and life history diversity; and the population spatial extent, distribution, and structure for native species. Reasonable contributions to these biological goals include meeting temperature targets and other measures of quality and quantity of spawning, rearing, and migration habitat; juvenile production; and juvenile outmigrant survival. The proposed program of implementation calls for State Water Board staff, in consultation with other appropriate entities, to further develop biological goals for approval by the State Water Board. The biological goals would be proposed to be subject to appropriate update based on new information.

The biological goals are proposed to include tributary goals that contribute to meeting the overall goals for each population, including the salmon doubling objective established in state and federal law, and goals for the Delta. The biological goals are proposed to be consistent with the best available scientific information, including information regarding viable populations, recovery plans for listed species, and other appropriate information.

In December 2018, the State Water Board adopted amendments to the Bay-Delta Plan for the reasonable protection of fish and wildlife in the LSJR and its three eastside tributaries, the Stanislaus, Tuolumne, and Merced Rivers. The 2018 LSJR/SD update required development of biological goals to monitor the effectiveness of adaptive management and the program of implementation. The State Water Board contracted with DSP to convene an Independent Science Advisory Panel (ISAP) to provide recommendations on development of biological goals and sought input from other agencies and interested parties through the Stanislaus, Tuolumne, and Merced Working Group identified in the 2018 updates to the Bay-Delta Plan, as well as other public input. The State Water Board approved the initial biological goals for the LSJR on September 6, 2023. The initial biological goals are based on the four viable salmonid population (VSP) parameters—abundance, life history and genetic diversity, productivity, and spatial structure—for Chinook salmon, with an emphasis on abundance and productivity as the most important and intuitive metrics for setting biological goals (McElhany et al. 2000).

Biological goals for the Sacramento/Delta would be based on the same principles for developing initial biological goals in the LSJR, such as utilizing scientific information to establish a numeric value or range of values for biological goals, expressing goals in terms that are SMART (specific, measurable, achievable, relevant, and time-bound), and developing goals that are based on the VSP parameters for salmonids. Initial biological goals for the Sacramento/Delta would be subject to

refinement based on monitoring activities and new scientific information and understanding of the Bay-Delta watershed.

Assessment and Review

To ensure that the objectives are being implemented effectively, the proposed program of implementation calls for the State Water Board to regularly review and assess the actions to implement the Plan amendments over time in coordination with other appropriate entities. On an annual basis, after approval of the Plan amendments by OAL, the State Water Board would review compliance with the voluntary and default implementations for the prior year, including progress toward implementation actions for the flow and other measures. Annually, the State Water Board would determine whether course corrections are needed and other necessary planning for the coming year. Within 5 years of approval of the Plan amendments by OAL, the State Water Board would conduct an interim review and assessment to determine progress on implementation to date (including progress toward achieving the biological goals and flow and other measures included in the Plan) and whether changes should be made to implementation measures (including the voluntary and default provisions). Within 10 years of approval of the Plan amendments by OAL, the State Water Board would conduct a comprehensive review, including outside peer review if appropriate and necessary, of the implementation actions to date to determine whether amendments should be made to the Plan or other course corrections are needed. This review would not limit the State Water Board's abilities to consider changes before that time as needed.

5.6.2 General Measures to Assist with Implementation of the Bay-Delta Plan

This section provides a general description of additional actions to further the goals of the Bay-Delta Plan, achieve reasonable protection of beneficial uses of water in the Bay-Delta watershed, and minimize and avoid redirected impacts on other beneficial uses to the extent possible that could occur as a result of the proposed Plan amendments.

California water resource management is complex, and the proposed Plan amendments cover a large area of the state. The proposed Plan amendments would increase instream flows and reduce the availability of surface water supplies throughout the study area under certain circumstances or conditions. These waters support many important beneficial uses (e.g., municipal, industrial, agricultural, hydropower, recreation) and other environmental uses (e.g., wetlands and refuge water supplies) that must be considered carefully when determining regulatory flow requirements for fish and wildlife. Implementation mechanisms in the proposed Plan amendments are intended to be flexible to encourage innovative solutions by various parties and to accommodate a variety of different watershed circumstances and needs. The reasonable protection and restoration of the Bay-Delta ecosystem will require significant coordination and cooperation with interested parties, including other agencies, tribes, water users, environmental groups, and other parties.

5.6.2.1 State Water Board Discretionary Approvals

The State Water Board is responsible for allocating surface water rights and protecting water quality, including drinking water, surface water, and groundwater, while protecting the public trust and public interest and preventing the waste and unreasonable use of water. The State Water Board applies its various discretionary authorities in its water right and water quality decision-making

processes and considers all beneficial uses of water when making water management decisions. Numerous water right and water quality activities are subject to State Water Board discretionary approvals, such as applications to appropriate water, water right change petitions, temporary and long-term transfer petitions, water quality certifications, water right registrations, wastewater change petitions, and applications for WDRs and NPDES permits. The State Water Board also exercises its discretionary authorities when issuing water right and water quality orders, decisions, and judgements.

The State Water Board would exercise its discretionary authorities when taking water right and water quality actions to further the goals of the Bay-Delta Plan, such as taking action to protect flow and water quality and to minimize Bay-Delta ecosystem stressors. The State Water Board would also use its discretionary approvals to minimize and avoid potential redirected impacts on other beneficial uses associated with the proposed Plan amendments, including potential impacts on special-status aquatic and terrestrial biological resources and groundwater resources.

Groundwater storage and recovery projects can reduce exposure to drought, reduce groundwater overdraft and land subsidence, maximize water availability, protect water quality, and sustain ecological needs and aesthetic and recreational values. Conjunctive management or conjunctive use involving the coordinated management of surface water and groundwater resources can also maximize the availability and reliability of water supplies in a region. Even without the coordination with surface supply, water received from surface streams during high runoff, treated wastewater, storm water, and agricultural runoff can be used to augment or recharge groundwater reserves. For example, Executive Order (EO) B-39-17, issued in 2017, directs the State Water Board to prioritize the processing of temporary water right permits for projects that enhance the ability of a local or state agency to capture high-runoff events for local storage or recharge. Storm water discharges regulated through NPDES permits also may be used for groundwater recharge to groundwater when properly managed. The Water Boards are actively involved in initiatives to improve the management of storm water. (See Strategy to Optimize Resource Management of Storm Water [STORMS][39]). In 2019, Governor Newsom issued EO N-10-19 for development of the state's Water Resilience Portfolio aimed at addressing water insecurities. In response, the State Water Board created a streamlined permitting process for groundwater sustainability projects; with direction provided by EO N-7-22 during the 2020–2022 drought, the State Water Board has prioritized groundwater recharge permits.

Water transfers are an important component of water resource management in California. Water can be transferred from a seller to a buyer through networks of rivers, canals, aqueducts, and pipelines. In addition to the SWP and CVP, the most extensive storage and conveyance projects involved in transfers, many local and regional conveyance projects are used to convey transferred water, especially for in-basin transfers. Many, but not all, transfers require approval by the State Water Board. The State Water Board approves water transfers in the public interest if the change does not initiate a new water right; the change can be made without injury to other legal users of water; and the change can be made without unreasonable effect upon fish, wildlife, or other instream beneficial uses. Many water transfers become a form of flexible system reoperation linked to many other water management strategies, including surface water and groundwater storage, conjunctive management, conveyance efficiency, water use efficiency, water quality improvements, and planned crop shifting or crop idling for the specific purpose of transferring water.

[39] https://www.waterboards.ca.gov/water_issues/programs/stormwater/storms/docs/storms_strategy.pdf.

Use of recycled water is part of the state's larger strategy to develop more resilient water supplies and increase regional self-reliance. Recycled water use can be a cost-effective way to help reduce local water scarcity. The California Legislature has expressed its intent that the state undertake all possible steps to encourage development of water recycling facilities so that recycled water may be made available to help meet the state's growing water needs. (Wat. Code, § 13512.) The State Water Board's General Order for Water Reclamation Requirements for Recycled Use (WQ 2016-0068-DDW) serves as a statewide Order for non-potable use of recycled water by (1) producers of recycled water; (2) entities that distribute recycled water to users; and (3) users who take possession of the recycled water for an approved beneficial recycled water use. When used in compliance with the Recycled Water Policy, Uniform Statewide Recycling Criteria in title 22 of the California Code of Regulations, and all applicable state and federal water quality laws, recycled water is safe for approved uses; the State Water Board strongly supports recycled water as a safe alternative to potable water for such approved uses.

Water conservation is an efficient and cost-effective way to quickly reduce water demand and extend supplies. The Water Conservation Bill of 2009 (SBX7-7) required the state to reduce urban water consumption by 20 percent by 2020 and encourages both urban and agricultural water providers to implement conservation strategies, monitor water usage, and report data to DWR. Recent droughts have prompted concerted conservation efforts. Governor Brown's May 2016 EO B-37-16 required state agencies to develop a long-term plan to better prepare the state for future droughts and make conservation a California way of life. Consistent with this order, several state agencies (DWR, State Water Board, the Public Utilities Commission, California Department of Food and Agriculture, and the Energy Commission) released a draft public report titled *Making Water Conservation a California Way of Life, Implementing Executive Order B-37-16* in November 2016 that describes recommendations to (1) use water more wisely; (2) eliminate water waste; (3) strengthen local drought resistance; and (4) improve agricultural water use efficiency and drought planning. In 2023, the State Water Board began the *Making Conservation a California Way of Life* rulemaking. This is the culmination of the legislation and process identified in the 2016 report of the same name and would establish efficiency goals for urban retail water suppliers. In 2020 and 2022, the State Water Board adopted two additional regulations concerning urban water suppliers. The first requires monthly water conservation reports, and the second establishes water loss performance standards. Multiple water conservation emergency regulations also were passed between 2014 and 2023, targeting specific water uses and water use practices in response to drought conditions or to preserve the state's water supply.

Desalination facilities represent an alternative source of water for coastal areas, many of which have limited groundwater and surface water availability. Desalination of ocean or brackish water could provide a reliable water supply regardless of the water year type or other surface water supplies. In 2015, the State Water Board adopted an amendment to the Water Quality Control Plan for the Ocean Waters of California to address effects associated with construction and operation of seawater desalination facilities (Desalination Amendment). The Desalination Amendment supports the use of ocean water as a reliable supplement to traditional water supplies while protecting marine life and water quality. It provides a uniform, consistent process for permitting of seawater desalination facilities and provides specific implementation, monitoring, and reporting requirements.

5.6.2.2 Financial Assistance Programs

The State Water Board administers implementation of numerous financial assistance programs, including loan and grant funding for construction of municipal sewage and water recycling facilities, remediation for underground storage tank releases, watershed protection projects, nonpoint-source pollution control projects, and other projects. Other state and federal agencies also administer grant and loan funding for drinking water, wastewater, water quality, water supply, water conservation and water use efficiency, and other water-related projects.

The State Water Board would coordinate with state and federal funding agencies and other appropriate entities to distribute grant and loan funds for projects that protect the beneficial uses of water, support the goals of the Bay-Delta Plan, and avoid potential redirected impacts associated with the proposed Plan amendments to the extent possible. Many financial assistance programs administered by the State Water Board and other agencies could be leveraged to provide financial support for implementation of complementary measures to address Bay-Delta ecosystem stressors under voluntary implementation plans and other efforts, such as habitat restoration projects that would benefit special-status aquatic and terrestrial resources. Financial assistance programs also could be leveraged to support water use efficiency and conservation programs that would minimize impacts associated with potential water supply reductions and to address other potential issues related to implementation of the proposed Plan amendments.

5.6.2.3 Climate Change, Drought, and Public Safety

State Water Board Resolution No. 2017-0012 directs a proactive approach to climate change in all State Water Board actions. As described in Section 4.6, *Climate Change*, climate change is already bringing warmer temperatures and longer and more severe droughts that present challenges for water supplies. The proposed objectives and implementation measures for those objectives would include measures to address these effects in accordance with Resolution 2017-0012, including required planning for drought and minimum health and safety supplies (in accordance with Water Code section 106.3, establishing the policy of the state that every human being has the right to safe, clean, affordable, and accessible water), a significant degree of flexibility and adaptive management, and other measures to encourage and support water use efficiency and diversification of water supplies.

To the extent that there are public safety needs and needs to address drought circumstances after maximum conservation efforts have been employed and alternate supplies have been fully explored, the proposed changes to the Bay-Delta Plan would include additional provisions to ensure that minimum health and safety water supplies are met, including appropriate timeline and offramps.

5.6.2.4 Groundwater Management

The proposed modifications to the Bay-Delta Plan are linked to groundwater management, both in the Sacramento/Delta and in the areas that receive water exported from the Sacramento/Delta. In the Sacramento/Delta, surface water flows recharge the groundwater basin and groundwater accretions contribute to surface water flows. Similarly, groundwater diversions can deplete surface water flows and reduced surface water flows can result in a lack of recharge of groundwater basins over both the short and long term. In the areas that receive Sacramento/Delta export supplies, those supplies can offset groundwater pumping and recharge depleted groundwater basins. As discussed in Chapter 7, *Environmental Analysis*, the proposed changes to the Bay-Delta Plan have the potential

to affect these issues. In many areas, Sacramento/Delta supply has been used to alleviate already declining groundwater levels. Decreases in Sacramento/Delta supply could cause reductions in active groundwater recharge and could affect planning for future increases in the volume of water available for groundwater storage and recovery projects. Recharging aquifers with surface water can be an effective approach in long-term water supply planning, so long as it does not impair the quality and sustainability of surface water resources. Even without the coordination with surface supply, water received from surface streams during high runoff, treated wastewater, storm water, and agricultural runoff can be used to augment or recharge groundwater reserves. The proposed changes to the program of implementation would include measures to reduce or minimize impacts on groundwater from implementation of the new objectives.

Specifically, voluntary implementation plans would be required to include measures to coordinate implementation of the Bay-Delta Plan with groundwater management activities, including with implementation of SGMA to ensure that implementation activities do not contribute to groundwater overdraft, dewatering of groundwater-dependent ecosystems, and surface/groundwater interaction. Under default implementation provisions, the State Water Board would use all available tools under its authorities to prevent additional impacts on groundwater from implementation of the Bay-Delta Plan as appropriate and necessary, including the use of financial assistance programs; authorities to prevent the waste, unreasonable use, unreasonable method of use, and unreasonable method of diversion of water (Cal. Const., art. X, § 2; Wat. Code, §§ 100, 275); authorities to enforce SGMA (Wat. Code, § 10720 et seq.); regulations of municipal drinking water systems; conditioning of regulatory approvals over water right and other actions, including transfers; and other tools that may be available to the State Water Board to reduce or avoid groundwater-related impacts. The State Water Board would also continue efforts to expedite water right permitting for groundwater recharge.

5.6.2.5 Fully Appropriated Streams

The proposed changes to the Bay-Delta Plan are meant both to restore flows that are needed to protect fish and wildlife and to prevent additional reductions in instream flows that are needed for the protection of fish and wildlife. To ensure that additional water rights are not granted in streams where these flows are needed to protect fish and wildlife and where water is not available, the proposed program of implementation would call for the State Water Board to update its FASS Declaration. The State Water Board has adopted and periodically revised the FASS Declaration pursuant to Water Code sections 1205 through 1207, most recently updated in 1998 (State Water Board Order WR 98-08.) The FASS Declaration includes a list of stream systems found to be fully appropriated for all or part of the year. Water Code section 1206 provides that the State Water Board shall not accept any new applications to appropriate water from watercourses listed on the FASS Declaration, except in accordance with the provisions of the Declaration and applicable regulations.[40] The Sacramento-San Joaquin Delta is listed on the Declaration as fully appropriated from June 15 to August 31 pursuant to State Water Board Decision 1594 (1983-84).[41] In addition,

[40] Order 89-25 provides that a stream system listed on the FASS Declaration encompasses all upstream sources contributing to the listed stream system. In addition, if a tributary stream system and a downstream stream system to which the tributary contributes are both declared fully appropriated, the declaration containing the more restrictive conditions should govern the tributary stream system if, and to the extent that, the tributary is hydraulically continuous to the downstream system. (Order 89-25 at 38-39; Order 98-09 at 21.)

[41] Consistent with Decision-1594, the FASS Declaration specifies that additional small water right applications (less than 1 cfs or 100 AF of storage) from the Delta and its tributaries are not allowed from June 16 to August 31.

many Sacramento/Delta tributaries are on the FASS list independently and pursuant to their own specific orders that contain certain seasonal limits or other criteria for new water right applications. The FASS Declaration list has not been updated in a number of years and has not been updated comprehensively for the Bay-Delta watershed. The proposed program of implementation would call for the State Water Board to consider additional FASS determinations for the Bay-Delta watershed to assist with implementation of the proposed changes to the Bay-Delta Plan. The State Water Board also would undertake efforts to modify the FASS Declaration to allow for the diversion of flood flows that are not needed to protect fish and wildlife so that those flows can be used for groundwater recharge and possibly other purposes.

5.6.2.6 Refuge Water Supplies and Other Wildlife Protection Measures

As discussed in Chapter 7, *Environmental Analysis*, implementation of the proposed Plan amendments has the potential to result in unintended consequences to terrestrial species and refuges that rely on supplies from the Sacramento/Delta. The proposed Plan amendments would include measures to reduce or minimize these effects. The proposed program of implementation would require voluntary implementation plans to include provisions for addressing potential impacts on terrestrial species and refuges that may be affected by those plans. Also, the proposed program of implementation identifies habitat restoration actions, as well as other complementary ecosystem actions, to protect fish and wildlife and contribute toward implementation of the new and existing narrative objectives. In addition, the proposed program of implementation would include provisions to prioritize water supplies deliveries to refuges.

5.7 References Cited

5.7.1 Common References

^2009 ITP: California Department of Fish and Wildlife (CDFG). 2009. Endangered Species Act Incidental Take Permit No. 2081-2009-001-03. Bay Delta Region. Yountville, CA.

^2020 ITP. California Department of Fish and Wildlife (CDFW). 2020. California Endangered Species Act Incidental Take Permit No. 2081-2019-066-00, Long-Term Operation of the State Water Project in the Sacramento-San Joaquin Delta.

^Anderson, P., N. Denslow, J. E. Drewes, A. Olivieri, D. Schlenk, and S. Snyder. 2010. *Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water: Recommendations of a Science Advisory Panel*. State Water Resources Control Board Final Report.

^Anderson, J. J., J. Gore, R. Kneib, N. Monsen, G. Schladow, and J. Van Sickle. 2015. Independent Review Panel (IRP) Report for the 2015 Long-Term Operations Biological Opinions (LOBO) Annual Science Review. A report to the Delta Science Program. December.

^Bennett, W. A. 2005. Critical assessment of the Delta smelt population in the San Francisco Estuary, California. *San Francisco Estuary and Watershed Science* 3(2):1–71.

Diversions greater than that amount usually are processed, and the State Water Board may issue permits subject to the inclusion of Term 91 in the permit.

^Brandes, P. L. and J. S. McLain. 2001. Juvenile Chinook salmon abundance, distribution, and survival in the Sacramento–San Joaquin Estuary. In R. L. Brown (ed.). Contributions to the Biology of Central Valley Salmonids. *Fish Bulletin* 179.

^CALFED 2000. *Ecosystem Restoration Program Plan Strategic Plan for Ecosystem Restoration*. CALFED Bay–Delta Program. July. Sacramento, CA.

^California Department of Fish and Game (CDFG). 2005. Final Draft 11-28-05 San Joaquin River Fall-Run Chinook Salmon Population Model.

^California Department of Fish and Game (CDFG). 2012. Written Information Responsive to the Workshop Questions for the Bay-Delta Workshop-2. September 20. Bay-Delta Fishery Resources. Ecosystem Conservation Division/Water Branch. Sacramento, CA.

^California Department of Water Resources and U.S. Bureau of Reclamation (DWR and Reclamation). 2016. *Final Environmental Impact Report/ Environmental Impact Statement for the Bay Delta Conservation Plan/California WaterFix*. Volume I. Prepared for California Department of Water Resources and U.S. Bureau of Reclamation. Prepared by ICF International. December.

^ Carroll, S. R., E. Herczog, M. Hudson, K. Russell, and S. Stall. 2021. Operationalizing the CARE and FAIR Principles for Indigenous data futures. Scientific Data 8:108.

^Dahm, C. A. Parker, A. Adelson, M. Christman, and B. Bergamaschi. 2019. Nutrient dynamics of the delta: Effects on primary producers. *San Francisco Estuary and Watershed Science* Special Issue: State of the Bay-Delta Science 2016, Part 3 14 (4).888

^Delta Stewardship Council (DSC). 2013. *The Delta Plan: Ensuring a Reliable Water Supply for California, a Healthy Delta Ecosystem, and a Place of Enduring Value*. May. Sacramento, CA.

^Fleenor, W., W. Bennett, P. Moyle, and J. Lund. 2010. *On Developing Prescriptions for Freshwater Flows to Sustain Desirable Fishes in the Sacramento–San Joaquin Delta.* Delta Solutions, Center for Watershed Sciences, University of California, Davis.

^Fong, S., S. Louie, I. Werner, J. Davis, and R. E. Connon. 2016. Contaminant Effects on California Bay–Delta Species and Human Health. *San Francisco Estuary and Watershed Science* 14(4):5.

^Grimaldo, L. F., T. Sommer, N. Van Ark, G. Jones, E. Holland, P. Moyle, P. Smith, and B. Herbold. 2007. Factors affecting fish entrainment into massive water diversions in a freshwater tidal estuary: Can fish losses be managed? *North American Journal of Fisheries Management* 29(5):1253–1270.

^Grossman, G. D. 2016. Predation on Fishes in the Sacramento–San Joaquin Delta: Current Knowledge and Future Directions. *San Francisco Estuary and Watershed Science* 14(2):8.

^Hammock, B., J. Hobbs, S. Slater, S. Acuna, and S. Teh. 2015. Contaminant and food limitation stress in an endangered estuarine fish. *Science of the Total Environment* 532:316–326.

^Healey, M., M. Dettinger, and R. Norgaard. 2016. Perspectives on Bay-Delta Science and Policy. *San Francisco Estuary and Watershed Science: The State of Bay-Delta Science 2016, Part 3*.

^Huntington, H. P. 2000. Using Traditional Ecological Knowledge in Science: Methods and Applications. Ecological Applications 10(5):1270–1274.

^Kjelson, M. A. and P. L. Brandes. 1989. The use of smolt survival estimates to quantify the effects of habitat changes on salmonid stocks in the Sacramento–San Joaquin River, California. In C. D.

Levings, L. B. Holtby, and M. A. Henderson (eds.). Proceedings of the National Workshop on the Effects of Habitat Alteration on Salmonid Stocks*. Canadian Journal of Fisheries and Aquatic Sciences* 105:100–115.

^Kudela, R. M., M. D. A. Howard, S. Monismith, and H. W. Paerl. 2023. Status, Trends, and Drivers of Harmful Algal Blooms along the Freshwater-to-Marine Gradient in the San Francisco Bay–Delta System. *San Francisco Estuary and Watershed Science* 20(4):6.

^Martin, B. T., A. Pike, S. N. John, N. Hamda, J. Roberts, S. T. Lindley, and E. M. Danner. 2016. *Phenomenological vs. biophysical models of thermal stress in aquatic eggs*. Ecology Letters 2016.

^Moyle, P. B. 2002. *Inland Fishes of California*, Second Edition. University of California Press, Berkeley, CA. 502 pp.

^Moyle, P. B., J. R. Lund, W. A. Bennett, and W. E. Fleenor. 2010. Habitat variability and complexity in the Upper San Francisco Estuary. *San Francisco Estuary and Watershed Science* 8(3).

^NMFS 2009 BiOp. National Marine Fisheries Service (NMFS). 2009. Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. June 4. Endangered Species Act Section 7 Consultation. Southwest Region.

^NMFS 2014a. National Marine Fisheries Service (NMFS). 2014a. Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. West Coast Region, Sacramento, CA.

^NMFS 2019 BiOp. National Marine Fisheries Service (NMFS). 2019. Biological Opinion on Long Term Operation of the Central Valley Project and the State Water Project.

^Perry, R. W. 2010. Survival and Migration Dynamics of Juvenile Chinook Salmon *(Oncorhynchus tshawytscha)* in the Sacramento–San Joaquin River Delta. Ph.D. dissertation. University of Washington. Seattle, WA.

^Perry, R. W., P. L. Brandes, J. R. Burau, A. P. Klimley, B. MacFarlane, C. Michel, and J. R. Skalski. 2013. Sensitivity of survival to migration routes used by juvenile Chinook salmon to negotiate the Sacramento–San Joaquin River Delta. *Environmental Biology of Fishes* 96:381–392.

^Ramos, S. C. 2021. Understanding Yurok Traditional Ecological Knowledge and Wildlife Management. The Wildlife Society DOI: 10.1002/jwmg.22140.

^Runge, M. C., K. E. LaGory, Kendra Russell, J. R. Balsom, R. A. Butler, L. G. Coggins, Jr., K. A. Grantz, John Hayse, Ihor Hlohowskyj, Josh Korman, J. E. May, D. J. O'Rourke, L. A. Poch, J. R. Prairie, J. C. VanKuiken, R. A. Van Lonkhuyzen, D. R. Varyu, B. T. Verhaaren, T. D. Vesekla, N. T. Williams, K. K. Wuthrich, C. B. Yackulic, R. P. Billerbeck, and G. W. Knowles. 2015, Decision Analysis to Support Development of the Glen Canyon Dam Long-Term Experimental and Management Plan: U.S. Geological Survey Scientific Investigations Report 2015–5176, 64 pp. Available: http://dx.doi.org/10.3133/sir20155176.

^State Water Resources Control Board (SWRCB). 2017. *Scientific Basis Report in Support of New and Modified Requirements for Inflows from the Sacramento River and Its Tributaries and Eastside Tributaries to the Delta, Delta Outflows, Cold Water Habitat, and Interior Delta Flows*.

^State Water Resources Control Board (SWRCB). 2018. *July 2018 Framework for the Sacramento/Delta Update to the Bay-Delta Plan.*

^San Joaquin River Group Authority (SJRGA). 2007. 2006 *Annual Technical Report on Implementation and Monitoring of the San Joaquin River Agreement and the Vernalis Adaptive Management Plan*. Prepared for the California Water Resources Control Board in compliance with D-1641.

^Tolowa Dee-ni' Nation, InterTribal Sinkyone Wilderness Council, Cher-Ae-Heights Indian Community of the Trinidad Rancherία, and Wiyot Tribe (Tolowa Dee-ni' Nation et al.). 2017. *Informing the North Coast MPA Baseline: Traditional Ecological Knowledge of Keystone Marine Species and Ecosystems.* May. Available: https://caseagrant.ucsd.edu/sites/default/files/39-Rocha-Final.pdf. Accessed: September 20, 2023.

^U.S. Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG). 2013. *Suisun Marsh Habitat Management, Preservation, and Restoration Plan*. May.

^USFWS 2008 BiOp. U.S. Fish and Wildlife Service (USFWS). 2008. Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP), (Biological Opinion). December 15.

^USFWS 2019 BiOp. U.S. Fish and Wildlife Service (USFWS). 2019. Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP).

^Usher 2000. Traditional Ecological Knowledge in Environmental Assessment and Management. Arctic 53(2):183–193.

^Voluntary Agreements Parties. 2022. Memorandum of Understanding Advancing a Term Sheet for the Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan, and Other Related Actions.

^Zedler J. and M. L. Stevens. 2018. Western and Traditional Ecological Knowledge in Ecocultural Restoration. *San Francisco Estuary and Watershed Science* 16(3):2–15. https://doi.org/10.15447/sfews.2018v16iss3art2.

5.7.2 Section References

Anderson, J. J., E. Gurarie, and R. W. Zabel. 2005. Mean free-path length theory of predator-prey interactions: Application to juvenile salmon migration. *Ecological Modelling* 186: 196-211.

Anderson, J. J., J. A. Gore, R. T. Kneib, M. Lorang, and J. V. Sickle. 2011. *Report of the 2011 Independent Review Panel (IRP) on the Implementation of Reasonable and Prudent Alternative (RPA) Actions Affecting the Operations Criteria and Plan (OCAP) for State/Federal/ Water Operations*. Delta Science Program. December.

Biedenweg, K., J. Sanchirico, H. Doremus, R. Johnston, J. Medellín-Azuara, and C. M. Weible. 2020. *A Social Science Strategy for the Sacramento-San Joaquin Delta*. Prepared for the Delta Stewardship Council, Sacramento, CA.

Biber, E. 2011. The Problem of Environmental Monitoring. *University of Colorado Law Review* 83(1):1-82.

California Department of Water Resources (DWR). 2023. Spring Kodiak Trawl close out Memorandum to the California Department of Fish and Wildlife.

Cloern, J. E., A. Malkassian, R. Kudela, E. Novick, M. Peacock, T. Schraga, and D. Senn. 2014. The Suisun Bay Problem: Food Quality or Food Quantity? *IEP Newsletter* 27(1):15–23.

Conrad, J. L., M. Thomas, K. Jetter, J. Madsen, P. Pratt, P. Moran, J. Takekawa, G. S. Darin, and L. Kenison. 2023. 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. *San Francisco Estuary and Watershed Science* 20(4):4.

Dahm, C., W. Kimmerer, J. Korman, P. B. Moyle, G. T. Ruggerone, and C. A. Simenstad. 2019. *Developing Biological Goals for the Bay-Delta Plan: Concepts and Ideas from an Independent Scientific Advisory Panel*. Sacramento, CA. Prepared for Delta Science Program, Sacramento, CA.

Delta Independent Science Board (Delta ISB). 2022. *Review of the Monitoring Enterprise in the Sacramento-San Joaquin Delta*. Sacramento, CA. Prepared for the Delta Stewardship Council. Sacramento, California.

Healey, M. C., M. D. Dettinger, and R. B. Norgaard. 2008. *The State of Bay–Delta Science, 2008*. Prepared for the CALFED Science Program. Sacramento, CA.

Hobbie, J. E., S. R. Carpenter, N. B. Grimm, J. R. Gosz, and T. R. Seastedt. 2003. The U.S. Long-Term Ecological Research Program. *BioScience* 53(1):21–32.

Johnson, R. C., S. Windell, P. L. Brandes, J. L. Conrad, J. Ferguson, P. A. L. Goertler, B. N. Harvey, J. Heublein, J. A. Israel, D. W. Kratville, J. E. Kirsch, R. W. Perry, J. Pisciooto, W. R. Poytress, K. Reece, and B. G. Swart. 2017. Science Advancements Key to Increasing Management Value of Life Stage Monitoring Networks for Endangered Sacramento River Winter-Run Chinook Salmon in California. *San Francisco Estuary and Watershed Science* 15(3):1.

Lund, J., E. Hanak, W. Fleenor, W. Bennett, R. Howitt, J. Mount, and P. Moyle. 2008. Comparing Futures for the Sacramento-San Joaquin Delta. Public Policy Institute of California.

McCord, S. E., N. P. Webb, J. W. Van Zee, S. H. Burnett, E. M. Christensen, E. M. Courtright, C. M. Laney, C. Lunch, C. Maxwell, J. W. Karl, A. Slaughter, N. G. Stauffer, and C. Tweedie. 2021. Provoking a Cultural Shift in Data Quality. *BioScience* 71(6):647–657.

Miller, E., M. Mendez, I. Shimabuku, N. Buzby, and R. Sutton. 2020. Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations 2020 Update. SFEI Contribution No. 1007. San Francisco Estuary Institute: Richmond, CA.

Mitchell, L., K. Newman, and R. Baxter. 2019. Estimating the Size Selectivity of Fishing Trawls for a Short-Lived Fish Species. *San Francisco Estuary and Watershed Science* 17(1):5.

Moloney, Emily. Water Program Coordinator. Buena Vista Rancheria of Me-Wuk Indians. June 7, 2023—Presentation on Tribal Beneficial Uses and Environmental Flow Concepts, State Water Resources Control Board Meeting.

Monismith, S. G., J. R. Burau, and M. Stacey. 1996. Stratification dynamics and gravitational circulation in northern San Francisco Bay. Pages 123–153 *in* J. T. Hollibaugh, editor. *San Francisco Bay: the Ecosystem: Further Investigations into the Natural History of San Francisco Bay and Delta with Reference to the Influence of Man*. First edition. Pacific Division of the American Association for the Advancement of Science, San Francisco, CA.

Monsen, N. E., J. E. Cloern, and J. R. Burau. 2007. Effects of Flow Diversions on Water and Habitat Quality: Examples from California's Highly Manipulated Sacramento-San Joaquin Delta. *San Francisco Estuary and Watershed Science* 5(3).

Reynolds, J. H., M. G. Knutson, K. B. Newman, E. D. Silverman, and W. L. Thompson. 2016. A road map for designing and implementing a biological monitoring program. *Environmental Monitoring and Assessment* 188(7):399.

Sommer, T. R., C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga, and K. Souza. 2007. The Collapse of Pelagic Fishes in the Upper San Francisco Estuary: El Colapso de los Peces Pelagicos en La Cabecera Del Estuario San Francisco. *Fisheries* 32(6):270–277.

State Water Resources Control Board (SWRCB). 2006. Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary. December 13. Sacramento, CA.

Tompkins, M. R. and G. M. Kondolf. 2007. Systematic post-project appraisals to maximize lessons learned from river restoration projects: Case study of compound channel construction projects in northern California. *Restoration Ecology* 15(3):524–537.

U.S. Bureau of Reclamation (Reclamation). 2015. Reclamation Managing Water in the West, Shasta Dam Fish Passage Evaluation, Draft Pilot Implementation Plan. September.

U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service (Reclamation and USFWS). 2014. Record of Decision, Suisun Marsh Habitat Restoration, Preservation, and Management Plan.

U.S. Environmental Protection Agency (USEPA). 2003. *Elements of a State Water Monitoring and Assessment Program*. EPA 841-B-03-003. Prepared by USEPA, Washington, DC.

Vos, P., E. Meelis, and W. J. Ter Keurs. 2000. A Framework for the Design of Ecological Monitoring Programs as a Tool for Environmental and Nature Management. *Environmental Monitoring and Assessment* 61(3):317–344.

Woodward, A. and K. Hollar. 2011. *Monitoring Habitat Restoration Projects: U.S. Fish and Wildlife Service Pacific Region Partners for Fish and Wildlife Program and Coastal Program Protocol*. U.S. Geological Survey Techniques and Methods 2-A11, U.S. Geological Survey, Reston, VA.