Appendices A1 – A10

Table of Contents

Appendix A1: Sacramento River

1.1 Sacramento River

Parties diverting water from the Sacramento River mainstem are proposing a coordinated suite of flow and non-flow measures that are intended to provide a holistic and integrated approach to improve populations of native fish species, especially steelhead and the four runs of Chinook salmon, on the Sacramento River mainstem. These flow and habitat measures build on the regulatory requirements imposed on the parties to the voluntary agreement since 2000, both of which contribute to the implementation of the narrative objective for salmon protection, and the numeric objectives for Delta outflows and Sacramento River inflows.[1]

As a general matter, the measures described in this Project Description are intended to augment flows and implement habitat measures to provide the opportunity for juvenile fish to successfully spawn, shelter, forage, rear, and migrate out of the Sacramento mainstem (as measured at the confluence of the Feather River). By providing additional habitat and working to improve watershed health, these measures are intended to better meed the needs of fish species and thereby help those populations move towards the narrative salmon doubling goal and other metrics of robust and viable populations. Finally, because of the inherent variability within each year, there is a measure to allow, in dry, below normal and above normal years, for at least an additional 100,000 acre-feet of water that may be used for the benefit of fish and wildlife, for instance, (i) as additional flows to augment the natural signals for outmigration conveyed in storm events for Spring and Fall run Chinook salmon, (ii) as additional flows to augment minimum flows or (iii) for any other purpose deemed to be biologically beneficial under the governance and adaptive management plan.

1.1.1 Flow Measures, including interaction with Shasta and CVP Operations

1.1.1.1 Proposed Flow Commitments

The parties to the voluntary agreements on the Sacramento River mainstem are prepared to make a series of additional flow commitments that are intended to augment the existing flow regime during specific seasons of the year, intended to provide additional pulse flows at biologically sensitive periods, and preserve cold-water pool to ensure viability of fish species during the warm summer months. Those additional flow commitments are as follows:

1.1.1.1.1 Fall Flow Stabilization (All Years)

As the irrigation season closes during the late summer and winter-run chinook salmon emerge from redds, releases for, water demand and instream flows move from the peak summer rates to lower winter rates which results in decreased storage releases from Shasta Reservoir. The winter releases are

[1] As to flow and habitat measures that have been adopted since 2000, Exhibit 1 hereto ("Sacramento Valley Salmon Recovery Program – Completed Projects – 2000-2017") lists the various Sacramento Valley Salmon Recovery Program projects that were completed during 2000 through 2017. These projects have contributed to the implementation of the narrative objective for salmon protection. These projects form a strong foundation for the additional habitat measures proposed under the voluntary agreements. It is noteworthy that, of the almost 150 projects completed since 2000, almost half of those are on the Sacramento River mainstem.

lower not only because the growing season is completed and downstream diversions decrease accordingly but also so that Reclamation can rebuild storage in Shasta Reservoir during the winter season to create enough cold-water assets needed to protect winter-run salmon in the following spring and summer months. As releases from Shasta and downstream diversions decrease, there is the potential to dewater early spawned fall-run Chinook salmon redds. There is also a need for additional rearing habitat for juvenile salmonids and the need to reduce fluctuations in demands due to rice straw decomposition.

To address these concerns, the parties propose to modify releases from Shasta during October so as to stabilize flows in the Sacramento River mainstem and operate so those flows smoothly transition to the wintertime base flows in the Sacramento River. In coordination with the Bureau of Reclamation, the Sacramento River Settlement Contractors (SRSCs) and other parties diverting water from the Sacramento River mainstem would coordinate their diversions for rice straw decomposition from October 1 through November 30 to lower peak diversion rates and spread the period for rice straw decomposition over a longer time. The target for winter releases would be established based on end of September (EOS) storage in Shasta Reservoir. Such winter base flow releases would be set to improve refill capabilities for Shasta Reservoir to build cold-water pool storage for the following year.

Here are examples of potential Keswick releases based on Shasta Reservoir EOS storage condition. These examples would be refined through modeling efforts under the guidance of the governance structure described below.

1.1.1.1.1.1 If EOS Shasta Reservoir storage is:	**Then, winter base flow releases would be:**
Less than 2.2 MAF	3,250 cfs
2.2 MAF to 2.8 MAF	4,000 cfs
2.8 MAF to 3.2 MAF	4,500 cfs
More than 3.2 MAF	5,000 cfs

Reclamation would determine these winter base flow release rates after the majority of emergence of winter-run Chinook salmon, prior to the majority of fall-run Chinook salmon spawning in any specific year and Shasta EOS storage, in coordination with parties to Voluntary Agreements and consistent with legal and regulatory requirements. The SRSCs, upstream Sacramento Valley CVP contractors and Reclamation propose that they will work together to smooth Sacramento Valley diversions so as to improve the likelihood of reaching winter base flow targets. Nothing in this coordinated effort would limit Reclamation's discretion over all CVP operations and its obligation to operate the CVP to meet regulatory requirements and all contractors' needs (including in the Lower Sacramento River, the Delta and export areas). It is understood that Reclamation will make its operational decisions based on the needs of the CVP as a whole and in accordance with any requirements under then-applicable State Water Resources Control Board decisions, Biological Opinions issued by the National Marine Fisheries Service and/or the U.S. Fish & Wildlife Service, and flood control requirements.

1.1.1.1.2 Actions in Wet Years

In wet years, there may be opportunities for Reclamation to make additional releases that would have the hypothesized benefits of cleaning spawning gravels, creating/restoring/enhancing floodplain habitat, and creating pulse flows that build on natural signals (e.g. storm turbidity). All of these initiatives would require the reoperation of Shasta Reservoir, which is subject to Reclamation approval. All of these initiatives also must be done in a manner that does not create any additional risk to public safety, human health or property damage. These initiatives would only occur in wet years when the action does not result in a water cost to the CVP or the SWP, as determined by Reclamation and DWR, respectively.

The SRSCs propose that, in the event of a wet year, they will collaborate with Reclamation and other parties diverting water from the Sacramento River mainstem to identify the opportunities to engage in activities that will benefit fish and wildlife in the Sacramento River mainstem.

All such activities are subject to the sole and complete discretion of Reclamation, recognizing Reclamation's responsibilities for public safety, the preservation of human health and the prevention of property damage or reductions in the water supplies available to the CVP and/or SWP. Within those constraints, however, the SRSCs will work to coordinate operations with Reclamation to divert additional water into floodplains (including but not limited to the Sutter and Yolo Bypasses) and/or to create other spawning and rearing habitat, depending on the time of year. Particular attention will be paid to the opportunities to enhance outmigration of juvenile salmonids through targeted pulse flows synchronized with natural storm events.

1.1.1.1.3 Actions in Above Normal, Below Normal and Dry Years

The SRSCs propose that during above normal, below normal and dry years, which cumulatively total about 58% of all years according the Sacramento Valley 8-station index, they would make available 100,000 acre-feet through land fallowing/crop shifting (or limited groundwater substitution) within their service areas. This supply would be made available to Reclamation and Reclamation would be responsible for reoperating Shasta Reservoir and passing water through the Delta as outflow, in coordination with DWR. During these years, there is a hypothesized need for additional flows in April and May to enhance spring-run juvenile salmon outmigration survival. There is also a need in these years for additional Delta outflow while also balancing the potential impacts to the cold-water pool storage at Shasta Reservoir. In above normal years and below normal years when there is an adequate cold water pool in Shasta Reservoir to protect winter run salmon, there would be a target base flow during April and May of 8,000 cfs at Wilkins Slough that would be met through the combination of natural side channel flows; releases from Shasta Reservoir for legal and regulatory requirements and other project purpose;, and, to the extent that Shasta releases need to be increased to meet the Wilkins Slough target, those water costs would be charged to the 100,000 acre-feet asset. To the extent that combination of water sources does not support the target base flow throughout the entire two-month period, a shorter period or an alternative flow target will be utilized under the governance and adaptive management plan. In dry years, it is unlikely that there would be enough cold water pool assets in Shasta Reservoir, so no spring flows would be available, but rather the 100,000 acre-foot asset would be available on the delivery pattern of the fallowed land through reoperation of Shasta Reservoir for augmentation of instream flows and Delta outflow, to the extent such reoperation does not create an additional water supply impact, as determined by Reclamation. The water may alternatively be used to augment cold water pool storage in Shasta Reservoir for the benefit of winter-run Chinook salmon.

The SRSCs believe that there will be an enhanced ability for Reclamation to make water available for targeted spring pulse flows if there is a land fallowing/crop shifting program for 100,000 acre-feet in place at the time that Reclamation makes operational decisions in the spring. If, however, Reclamation is not able to make such spring releases relying on the commitment for the production of 100,000 acre-feet (e.g., based on concerns relating to cold-water pool storage levels during the late summer/early fall period), then Reclamation would retain the discretion to add the 100,000 acre-feet to water releases during the summer or fall for other ecosystem benefits. Reclamation, at all times, retains sole discretion for the operation of the CVP and the release of the 100,000 acre-feet will not be used in a manner that causes changes to water supply allocations and or the timing of such allocations to CVP contractors north or south of the Delta or otherwise adversely affects CVP system-wide operations. The 100,000 acre-feet of water based on land fallowing/crop shifting is included within the water cost dependent on year-type.

While Reclamation retains sole discretion in the manner in which it operates the CVP, Reclamation would participate in the proposed Voluntary Agreement governance structure to solicit input on CVP operations and the manner in which Reclamation can include the provision of this additional 100,000 acre-feet for environmental benefits without adversely affecting CVP contractors or CVP system-wide operations. The proposed governance structure includes collaboration on planning and accountability through reporting on outcomes.

1.1.1.1.4 Actions in Critically Dry Years

In critically dry years, there is limited water to meet limited beneficial uses. During such years, the inflow into Shasta Reservoir is substantially lower than average and the necessary flows at Wilkins Slough are at times equal to Shasta Reservoir inflow, meaning that Reclamation is unable – as a practical matter – to store water in Shasta Reservoir to accumulate a cold-water pool. Finally, there are few significant storms that increase base flows in the Sacramento River mainstem.

Parties diverting water from the Sacramento River mainstem would cooperate with Reclamation provide a single spring pulse flow of 30,000 acre-feet in March, with a focus on last two weeks of the month. The water would be made available from Shasta or Whiskeytown reservoirs at Reclamation's sole discretion. The pulse flow event would be timed to ensure that the water is 100% recoverable by the CVP and SWP through Delta exports (or other mechanisms at the discretion of Reclamation) as addressed through Coordinated Operations Agreement (COA) accounting. The pulse flow event would be coupled with a storm event when possible, likely as an extension of the recession limb of the rainfall runoff hydrograph so as to ensure exportability.

The pulse flow event would not occur under any of the following conditions:

- The action causes any impact to the amount or timing for Reclamation's allocations to any CVP contractors (in any CVP Division, north or south of the Delta).
- The critical year in question immediately follows another critical year or follows a dry year.
- Any new or additional RPMs, RPAs, or other regulatory actions affecting CVP operations occur as a result of this action.

The pulse flow event would also be conditioned on temperature management considerations for the remainder of the year. Thus, if the pulse flow were to be considered for April, Reclamation would need to consider its projection for EOS storage at Shasta Reservoir, the need for water during the fall to prevent redd stranding and to encourage migration, etc.

In the event that a pulse flow event occurs and then the year type turns from critical to dry, then any water released for the pulse flow event would be credited towards the 100,000 acre-foot requirement described above in future above normal, below normal and dry years.

1.1.1.2 Biological Rationales for Flow Commitments

1.1.1.2.1 Fall Flow Stabilization

The fall flow stabilization will have the effect of smoothing the transition from summer diversion and release patterns to the lower base flow needed to protect fall-run Chinook salmon redd spawning and prevent redd dewatering, and to maintain constant water elevations and temperatures. Such reduced releases are consistent with the need for rice straw decomposition water that benefit avian species and the Pacific Flyway and are further consistent with protecting carryover storage for cold-water pool storage that benefits winter-run Chinook salmon and other species. Finally, such reduced diversions minimize the water cost of these measures.

1.1.1.2.2 Winter Flow Releases

The winter flows regime will maintain side channel tributary inflows from hydrologic events and also maintain bypass and weir operations/inundation. This flow regime would benefit fall-run Chinook salmon by providing constant flows, temperature and velocities to incubating redds and early rearing habitat in the upper Sacramento River system. It would, similarly, provide these same benefits to late fall-run Chinook salmon. It would further continue to provide benefits to avian species using the Pacific Flyway, benefit winter-run Chinook salmon by protecting cold-water pool storage, and protecting consumptive uses of water my minimizing the water cost of these measures.

1.1.1.2.3 Spring Flow Releases

In the spring, Keswick releases are typically steady until flows are needed to support instream demands on the mainstem Sacramento River and Delta requirements. As a standard practice, Reclamation operates Shasta in the spring to have storage in the reservoir high enough (e.g., 3.7 million acre-feet) to use the Shasta temperature control device (TCD) upper gates to maximize the cold water pool potential for winter Chinook egg incubation management.

If this condition is met, releases from Shasta, initially focused on April and May, for the primary purpose of increasing spring-run Chinook outmigration and survival in the lower Sacramento River would be made, incorporating science, monitoring, and decision making and testing the hypothesis of flow and survival.

If Reclamation determines that projected inflows to Shasta Reservoir are likely less than sufficient for summer temperature management pursuant to its ESA obligations, and/or taking the spring action will cause changes to water supply allocations and/or the timing of allocations (to each CVP division north or south of the Delta), or the action impacts other system-wide operations, the water would be added to releases during the summer or fall for other ecosystem benefits, and would serve to augment Delta outflows at those times. Under certain circumstances, the water may be utilized to augment cold-water pool resources.

1.1.1.2.4 Summer Flow Releases

During the June through September summer period, flows in the Sacramento River mainstem and the releases from Shasta Reservoir would be established so as to meet the temperature and other downstream requirements in the then-current Biological Opinion(s), State Water Resources Control Board decision(s), and to meet CVP contract deliveries. This would primarily benefit winter-run Chinook salmon redds.

If a spring action in not taken or only a portion of the 100,000 acre-foot asset is used to meet the Wilkins Slough target, the water asset could also be using in the summer for delta outflow on the fallowing schedule that the water is made available.

1.1.2 Non-Flow Measures

1.1.2.2 Spawning Habitat (Keswick to Red Bluff Diversion Dam)

Reclamation and the SRSCs propose annually to place 40,000 to 55,000 tons of gravel at the Keswick and/or Salt Creek injection sites. For comparison purposes, over the past 17 years, there has been a total of approximately 90,000 tons of gravel placed at various locations on the Sacramento River mainstem. Within five years, Reclamation and the SRSCs would create at least three site-specific gravel restoration projects upstream of Bonnyview Bridge.

1.1.2.3 Rearing Habitat (Keswick to Red Bluff Diversion Dam)

Reclamation and the SRSCs propose to create a total of 40-60 acres of side channel habitat at no fewer than 10 sites in Shasta and Tehama County.

1.1.2.4 Rearing Habitat (Red Bluff Diversion Dam to Verona)

The SRSCs believe that, at present, they can create 3,225 acres of floodplain habitat in existing areas. The additional spring flows described would inundate another 650 acres of rearing habitat within the current Sacramento River levee system. In-river restoration projects (of the type undertaken by River Garden Farms) would amount to 225 acres of rearing habitat over 15 years. Inundation of the lower portion of the Colusa Basin Drain would yield another 300 acres of floodplain habitat. The inundation of CDFW's Tisdale property would add another 500 acres of floodplain habitat while levee setbacks would add a further 200 acres. Finally, the inundation of the Sutter Bypass would provide 2,000 acres of floodplain habitat. That quantity of habitat is sufficient to support a population of 70,000 to 80,000 fall-run Chinook salmon adults, which is three times more than the current returns.

1.1.2.5 Man-Made Structures (Keswick to Verona)

Finally, the SRSCs propose to undertake a number of projects to modify man-made structures to reduce their impacts on salmonid populations. These projects would include completing the remaining high-priority fish screen projects and reducing lighting on all bridges crossing the Sacramento River within five years.

1.1.3 Funding Commitments and Regulatory Assurances

1.1.3.1 Included in the Planning Agreement

The Sacramento River mainstem element is based on a number of key terms in the Planning Agreement that provide regulatory and management conditions that are essential to the coordinated suite of flow and non-flow measures being proposed by the SRSCs. Those key terms are: (i) governance structure, (ii) the safe harbor/no surprises policy, (iii) compliance with the California Environmental Quality Act, (if) the strategy for the issuance of other necessary permits such as section 404 permit, and (v) a robust science program. Those terms are described in detail in the Planning Agreement.

1.1.3.2 Water Code section 1707 Petition and Related Operations Agreement

The 100,000 acre-feet of water made available by the SRSCs in above normal, below normal and dry years will be dedicated to fish and wildlife beneficial uses for the term of the voluntary agreement pursuant to a Water Code section 1707 petition for change process. Reclamation and CDFW will develop and approve an operations plan/agreement, subject to review and consultation with the SRSCs, to ensure that the 100,000 acre-feet of water made available by the SRSCs shall be used for the WQCP program of implementation to protect fish and wildlife beneficial uses.

1.1.3.3 NRDC v. Zinke

If the *NRDC v. Zinke* litigation results in a reduction in SRS Contract supplies via changes to contracts or constraints on performance, then any additional amounts of water made available for fish and wildlife purposes from such an outcome shall be offset against the 100,000 acre-foot quantity of water to be made available in above normal, below normal or dry years. In the alternative, such an outcome shall serve as an “off-ramp” that would allow any or all of the SRSCs to withdraw from the voluntary agreement.

1.1.3.4 Funding Commitments

The Parties propose to work with state and federal agencies to utilize dedicated funds consisting of: (a) contributions based on deliveries to or diversions by the Parties, and (b) repurposing of existing funding. The Parties believe that these sources, in combination, provide a sustainable and long-term funding stream that will be sufficient to support the projects being conducted under the auspices of the Voluntary Agreement.

- The Parties propose that contributions based on deliveries to or diversions by the Parties of water from the Bay-Delta watershed would be collected annually during the term of the Agreements. Through the contributions, the Parties expect to secure funds totaling approximately $425 million for the additional flows, and $345 million for the science program, over the term of the Agreements.

Specifically, a fund would initially be established using reprogrammed Proposition 1 funds and subsequently funded through the collection of a surcharge on water diverted within the Bay-Delta watershed for the duration of the fifteen-year term of the Voluntary Agreement. Such a surcharge would not apply to agencies diverting water under their own water rights, provided that those agencies contribute water as part of the Voluntary Agreement.

- The Parties also propose that the State and Federal governments would seek to repurpose or reprogram existing funds and seek new funds in order to support this important effort. The State of California agrees that it will pursue repurposing/reprogramming State bond money and seeking any necessary legislation to provide additional monetary funds. This includes potential directed and competitive funding opportunities from various State sources. Up to approximately $1.3 billion in bond funding is available for instream flows, restoration, multi-benefit flood projects, and other activities

1.1.4 Timing

New water will be made available for environmental purposes primarily during the spring period when juvenile spring-run chinook salmon migrate out from spawning and rearing grounds to the Delta. As described in more detail above, in wet years, there will be collaboration with Reclamation to release water in ways that benefit fish and wildlife. In above normal, below normal and dry years, the parties will make available 100,000 acre-feet of water, most likely for one or more pulse flow events in the April to May period, ideally timed to coincide with the receding leg of the storm hydrograph. That timing would complement and accentuate the instinct of salmonids to outmigrate during periods of high flows and high turbidity, which is thought to contribute to increased survival rates. In summer months if the asset is not used in the Spring, it would be available for summer or fall outflow augmentation. In critically dry years, any water made available would likely be timed so as to be fully recoverable under COA accounting and would likely be made available in the last two weeks of March, which are likely the last period of any substantial precipitation.

1.1.5 Expected Outcomes

The Sacramento River provides spawning, migration, and/or rearing habitat for all runs of Chinook salmon, steelhead, and sturgeon. Improvements in spawning, migration and rearing will occur, as noted above, through improved access to and reactivation of floodplains throughout the Sacramento River basin, along with carefully timed flow management to promote improved conditions along the Sacramento River. CVP and upper Sacramento water users will work to stabilize fall flows to minimize risk of dewatering and stranding. In wet years, and in consideration of cold-water pool management, early initiation of storage management releases for the purposes of spawning gravel cleaning functions, floodplain habitat, general fish migration flows and moderation of flood control-related pulse flows would be implemented. In critical years, a single spring pulse flow in March, with a focus on last two weeks of the month, and coupled with a storm event when possible, will be implemented to aid migration under dry conditions.

1.1.5.1 Rearing habitat

This proposal would substantially improve rearing habitat through the implementation of several landscape level and area-specific improvements in rearing habitat access and conditions. Habitat enhancements to improve rearing and migration conditions for salmonids throughout the Sacramento River basin, including more than 7,000 acres of improved floodplain rearing habitat in Sutter Bypass, Yolo Bypass, as described above, will provide important ecological functions in combination with ongoing operations. Together, the large increase in landscape-level rearing habitat access will substantially improve rearing conditions. Several other projects address passage, spawning habitat, and predation. These structural habitat improvements will accrue benefits to all runs of Chinook, steelhead, and sturgeon.

1.1.5.2 Migration Conditions

In combination with the rearing habitat improvements expected to occur from November through March throughout the basin, and in consideration of cold-water pool management, real-time migration patterns, and rearing habitat conditions, Sacramento River flows will be pulsed in April and May to support successful migration of spring-run Chinook. Sacramento River flows would be coordinated to provide maximum benefits and to ensure protection of cold-water in Shasta.
Increased in-stream flows using the 100 TAF block of water described above would be provided in above normal, below normal and dry years to augment existing flows and improve overall migration conditions. Working with the regulatory agencies and other parties the interface between these flow changes and structural habitat for rearing benefits would be managed and further explored through the application of testable hypotheses and adjustments to actions. All such actions would be subject to the “safe harbor/no surprises” provisions of the Planning Agreement.

1.1.5.3 Spawning habitat

The substantial gravel placement throughout the Upper Sacramento River described above will provide rearing benefits for spring-run and fall-run Chinook, green sturgeon, and steelhead.

1.1.5.4 Terrestrial habitat

This proposal includes approximately 23,300 acres of land fallowing to generate the water that would be used for in-stream and Delta outflow purposes. It was developed in consideration of minimizing terrestrial species effects, through both the amount of land fallowing that would occur and the ability to provide winter wetland area where possible. The SRSCs expect that federal and state wildlife agencies will permit and not require any mitigation associated with this land fallowing action.

Appendix A2: Feather River

1.2 Feather River, Including Interaction with Oroville and SWP Operations

1.2.1 Flow Measures

This proposal includes three components: a water transfer program to generate an additional 50,000 acre-feet of water for environmental benefit, including instream flow and Delta outflows, implementation of revised Feather River flow schedule, and a reoperation of Thermalito Afterbay to improve spawning habitat conditions in the low-flow channel of the Feather River.

Water users on the Feather River propose, in coordination with DWR, to make water available in above normal, below normal and dry years. 50,000 acre-feet would be made available predominantly through land idling/crop shifting and limited groundwater substitution and/or reservoir reoperation within their service areas. This supply would be made available to DWR. To further adaptive management during the 15-year VA period and to allow for potential shaping/shifting of this water, DWR under its water rights for the SWP would deliver the water to the system as a block or released pursuant to a schedule that best integrates with the non-flow measures and other flow measures to improve conditions for native fish. The determination of the timing and schedule of the water made available would be made as described in Section 1.2.4 below.

The water made available by the Feather River water users would be delivered to DWR and would, as applicable, either reimburse DWR and Lake Oroville storage for the advance release of the 50,000 acre-feet or would be stored in Lake Oroville for later use by DWR for ecosystem purposes. The water delivered to DWR by Feather River water users making water available via land idling/crop shifting would be made available under the pattern of evapotranspiration for the crop idled/shifted (typically rice). The water delivered to DWR by Feather River water users making water available via groundwater substitution, not to exceed 10,000 acre-feet, would be made available during the irrigation season as it is produced after deducting the applicable assumed streamflow depletion factor, which will be fixed for the 15-year term of the Voluntary Agreement. Finally, the water delivered to DWR by Feather River water users making water available via reservoir reoperation would be delivered on a schedule agreed upon by DWR and the water users and would be subject to a reservoir refill criteria.

The goal in providing 50 TAF of additional managed flows on the Feather River is to reestablish functionality of habitat for native fishes. These additional managed flows can be adaptively managed during the term of the VA to maximize environmental benefit and will be provided on top of current flow regimes during Dry, Below Normal, and Above Normal water year types. These flows would be utilized for the primary purpose of testing Delta outflow and other hypotheses, and increasing wetted acres throughout the Feather River and lower Sacramento River, including in floodplain and other habitat areas improved or developed as part of this proposal.

DWR would also reoperate the Oroville Facilities to maximize spawning and rearing in the Feather Fiver for salmonids. Instead of routing flows through the Thermalito power generation plant and Thermalito Afterbay and the power generation facilities at the Oroville Facilities, a pulse flow would instead be routed directly through the low-flow channel to create optimal conditions for fish in the upper Feather River. This proposed pulse flow would bypass up to 43 TAF of power generation at the Thermalito Power Generating Plant in order to provide additional flow in the low flow channel. Releases from the Oroville complex would be shifted from the Thermalito Afterbay river outlet to the Thermalito Diversion Dam release into the low flow channel. This would occur at flow rates up to 2,000 cfs for 14 or more continuous days between January 1 to April 15 during Dry, Below Normal, and Above Normal water year types.

Additionally, contingent upon FERC's issuance of a new license for the Oroville Facilities, DWR proposes to provide an adjustment to river flow in the Feather River, as provided under the FERC

Settlement Agreement (SA) for the Licensing of the Oroville Facilities, FERC Project No. 2100, to create additional spawning and rearing habitat by increasing useable area for adult and juvenile salmonids. DWR would be able to implement this described action immediately upon issuance of the license by FERC and implementation would occur for the duration of the new license. Future adjustments to meet temperature criteria identified in the FERC SA would potentially require infrastructure modifications at Oroville Dam after the FERC license is issued. The minimum flow in the Low Flow Channel from April 1 through September 8 would be 700 cubic feet-per-second (cfs) and from September 9 through March 31 would be 800 cfs.

1.2.2 Non-Flow Measures

Non-flow measures for the Feather River will consist of restoration of at least 2,883 acres of restored habitat. This primarily includes improved access for salmonid species to floodplain habitat. Non-flow measures also include gravel augmentation to improve spawning conditions, activities to control predators, removal of passage impediments to allow upstream fish passage, improvements in the Feather River Hatchery stock's genetic fitness, and improved habitat complexity and riverine shading.

Habitat actions on the Feather River are parsed into two general categories: 1) Projects identified under the FERC SA; and, 2) Projects independent of a regulatory regime. Projects identified under the FERC SA are required, however, the VA provides for a significantly accelerated timeline to implement habitat actions. The implementation of these projects on an enhanced timeline will allow them to start functioning and providing benefit for fish species more quickly than identified in the FERC SA, subject to DWR obtaining a FERC license for Oroville operations. Projects independent of regulatory regimes are projects that have been identified in the Feather River system to address specific limiting factors for fish. Many of these projects have been identified in multiple public documents over the years and have been recognized as having value, but they have not been able to be implemented because they lacked project advocates or funding. One such project involves removal of an existing barrier at the Sutter Extension Water District's Sunset Pumps diversion facility on the Feather River and re-configuration of the District's water conveyance system. The California Department of Fish and Wildlife has previously indicated strong support for the latter project.

1.2.3 Funding

Funding for Feather River Flow Measures

<u>The 50,000 acre feet made available by Feather River</u> water users in above normal, below normal, and dry year types will be compensated. The funding mechanisms described above for Sacramento River apply also to funding of the Feather River flow measures, with Prop 1 funds used to start the fund, and surcharges collected by water users to fund subsequent water years for the term of the agreement.

The reoperation of the Oroville complex to bypass Thermalito Power Generating Plant would result in lost power revenues to the State Water Project, which would not be compensated.

Funding for Feather River Non-flow Measures

Non-flow measures on the Feather River could be funded by a range of state funds, including but not limited to, the science fund generated from surcharges associated with the VAs, the Department of Water Resources, Proposition 1, Central Valley Improvement Act, or other sources.

1.2.4 Timing

50,000 acre-feet of Feather River flows included in this proposal could begin immediately after the State Water Board approves the VA project alternative and certifies the SED. Non-flow measures would start as soon as funding is available and approvals are granted for site work.

1.2.5 Expected Outcomes

Non-flow projects on the Feather River associated with this proposal include a broad range of gravel supplementation, fish passage, and habitat restoration projects. Combined with 50,000 acre-feet of flow contribution in Above Normal, Below Normal, and Dry water years, and the reoperation of the Oroville facilities to bypass power generation in the spring to provide a pulse flow in the low-flow channel, it is anticipated that these actions will provide marked benefits for aquatic ecosystems. These benefits will come in the form of increasing suitable spawning habitat, improved fish passage for salmon and sturgeon, improvement of river morphology, significant increases in floodplain habitat, improved riparian habitat, providing instream cover and channel complexity, and improvements to salmon genetic diversity.

Appendix A3: Yuba River

1.3 Yuba River

Introduction

This Appendix C describes the flow, habitat enhancement and funding measures that the Yuba Water Agency (YWA) would undertake under the proposed Voluntary Settlement Agreement Project (YWA VSA Project) among YWA, the California Department of Fish and Wildlife (CDFW) and the California Department of Water Resources (DWR). (Defined terms are set forth in the Glossary at the end of this document.)

As of the date of this Project Description, certain details of the YWA VSA Project, and analysis of potential benefits from proposed flow and habitat enhancement measures, have not been resolved among YWA, CDFW, DWR and other potential parties to the YWA VSA. These potential parties will continue discussions to further develop, revise and finalize the YWA VSA Project proposals, and analysis of their potential benefits, in mutually-agreeable form for the purpose of refining both project-level analyses and the YWA VSA.

YWA's VSA Project includes these major elements during its 15-year term:

- a Delta flow component of up to 50,000 ac-ft per year of water to be provided during Above-Normal, Below-Normal and Dry-years, as measured at the Marysville Gage, to be managed for additional Delta outflows
- 100 acres of habitat enhancement in the lower Yuba River for Chinook salmon and steelhead juvenile rearing
- a Yuba River Science Program of measurement, monitoring, adaptive management and reporting
- $10 million from YWA for funding habitat enhancement measures
- $7.8 million from YWA for funding the Science Program
- collaboration with CDFW, DWR and NGO representatives (and other stakeholders)

The purpose of this Project Description is to assist the SWRCB in its preliminary evaluation of the YWA VSA Project, which will be part of a set of VSAs that together will comprise a comprehensive proposed project for contributions to the implementation of the Bay-Delta Plan's water quality objectives and related measures to improve conditions in the Delta and Sacramento River watershed for fisheries and aquatic habitat.

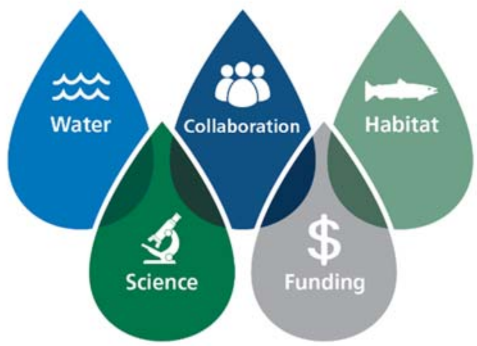
The Yuba Accord Fisheries Agreement flows and related provisions that were implemented beginning in 2006 currently enhance Chinook salmon spawning and holding habitats in the Yuba River between the USACE's Englebright Dam and the Yuba River's confluence with the Feather River. The YWA VSA Project would build on the foundation of the Yuba Accord by providing additional outflows to the Bay-Delta and enhancing juvenile salmonid rearing habitat in the lower Yuba River.

This Project Description provides the following information:

- Background information on the development and implementation of, and potential benefits from, the Yuba Accord-based flow and related provisions.
- A summary of the proposed flow, habitat enhancement and funding provisions of the YWA VSA Project.
- Methodologies for evaluating the benefits of the flow and habitat enhancement measures of the YWA VSA project.
- Other information to assist in the SWRCB's environmental evaluation of the YWA VSA Project.
- A summary of the Yuba River Science Program.
- Goals of the YWA VSA Project.

- A summary of other important provisions of the YWA VSA Project.
- A summary of proposed YWA VSA Project administration and governance provisions.
- A summary of guiding principles for implementing the YWA VSA Project

YWA's VSA Project would be a collaborative, interest-based, science-driven project that can achieve and implement the SWRCB's coequal goals of water-supply reliability and ecosystem restoration. The YWA VSA Project is a preferred alternative project for contributing to the implementation of the Bay-Delta Plan's water quality objectives because it includes not only water for Delta outflows, but also habitat measures, a science program and funding and collaboration, in a combination that would achieve key objectives for increases in Bay-Delta outflows and enhancement of Chinook salmon and steelhead juvenile rearing habitat in the lower Yuba River.



1.3.1 Flow Measures, including interaction with Yuba Water Accord

Development and Implementation of the Yuba Accord

The Yuba Accord-based flows and related provisions provide a contemporary "functional flow" program for anadromous salmonids in the lower Yuba River. As shown in **Exhibit 1 – Yuba Accord**, overall, implementation of the Yuba Accord-based flows provides suitable flows and water temperatures for all lifestages of anadromous salmonids in the lower Yuba River. The Yuba Accord-based flows are the foundation for the proposed flow and habitat enhancement measures of the YWA VSA Project.

YWA VSA Project Flow Proposal

YWA developed the flow proposal of the YWA VSA Project through: (a) an examination of stated objectives by CDFW for lower Yuba River flows and Bay-Delta inflow; (b) an examination of the recommendations for voluntary agreements in the SWRCB Staff Framework; and (c) development of flow measures that would achieve these recommendations, but with significantly less adverse impacts to water-supply reliability and other important aspects of YWA's mission, and with significantly-less impacts to the fishery benefits achieved with the Yuba Accord, than would occur under the proposed objectives in the SWRCB Staff Framework.

Exhibit 2 – Flow Project describes the YWA VSP Project flow-related elements of the proposed measures, YRDP operations, accounting principles and results of analysis of the proposal and an early implementation proposal for spring 2019.

The flow proposal in the YWA VSA Project is founded on the Yuba Accord-based flows, including the requirements for instream flows specified in the Yuba Accord Fisheries Agreement and the SWRCB's Corrected Order WR 2008-0014, and transfer operations and accounting provisions of the Yuba Accord Water Purchase Agreement (WPA). YWA VSA Project operations would be supplemental to the Yuba Accord flows and associated Yuba River Development Project (YRDP) operations.

The YWA VSA Project includes two quantifiable water components that would provide up to 50,000 ac-ft of additional Bay-Delta inflows in Above-Normal, Below-Normal and Dry year types[1] through the following changes in YRDP operations: (a) all Yuba Accord transfer releases in April, May and June that cannot be backed into Lake Oroville or exported by DWR would be repurposed from potential exports to Bay-Delta outflows (YWA VSA Project Component A); and (b) additional storage releases from New Bullards Bar Reservoir would occur by operating to a new target September 30 storage level of 600,000 ac-ft, which is 50,000 ac-ft below the Yuba Accord target September 30 storage level of 650,000 ac-ft (YWA VSA Project Component B).

The YWA VSA Project includes accounting for refill of storage releases from YWA VSA Project Component A and B that exceed 9,000 ac-ft annually in Above-Normal, Below-Normal and Dry year types.

The flow proposal of the YWA VSA Project would be implemented on behalf of YWA and YWA Member Units, and not on behalf of other water users in or diverters of water from the Yuba River Watershed.

The following CDFW objectives were considered in the preparation of the YWA VSA Project flow measures that are specific to higher springtime flows:

- Provide high spring flows in Yuba Accord Schedule 1, 2 and 3 years (i.e., increased flows in late March and April).
- Increase lower Yuba River floodplain inundation.

Through extensive modeling studies, YWA developed the YWA VSA Project flow to meet these CDFW flow objectives:

- The YWA VSA Project flow proposal to release up to 50,000 ac-ft of additional storage from New Bullards Bar Reservoir in the springtime addresses CDFW's objective for higher spring flows in Yuba Accord Schedules 1, 2 and 3 years.
- The YWA VSA Project flow proposal would increase the numbers of annual acre-days of inundation of floodplain-related Chinook salmon and steelhead juvenile rearing habitat in the lower Yuba River to meet CDFW's objective to increase lower Yuba River floodplain inundation. YWA's VSA project flow proposal would dovetail with its habitat enhancement measures, resulting in greater durations of inundation and increased effectiveness of constructed rearing habitat.

In summary, the YWA VSA Project flow proposals would meet these CDFW's objectives.

The SWRCB Staff Framework proposed a numeric objective for maintenance of tributary outflows as percentages of unimpaired flows, with targets of 55%, and ranges of 45% to 65%. Previous SWRCB staff reports identified the January to June period as the focus for this flow, but the SWRCB Staff Framework proposes that this objective apply year-round.

YWA examined Yuba River outflow under existing conditions, and determined that Yuba River outflow in Wet Years for the January to June period already equals or exceeds 65% for each month, on average, and YWA therefore is not proposing any measures for additional Yuba River outflows in Wet Years.

YWA's examination of Yuba River outflow under existing condition included an examination of each month of

---

[1] Unless otherwise specifically identified, all water year types are defined using the Sacramento Valley Index (SVI).

the year in the full range of hydrologic conditions. That examination showed that Yuba outflows equaled or exceeded 55% of unimpaired outflows in most all months, except for late March of some years, and April, May and sometimes June of the drier half of all years. Therefore, YWA focused the YWA VSA Project on developing additional Yuba River outflows for the April through June periods of Above-Normal, Below-Normal and Dry Years.

YWA's VSA Project flow proposal does not include a Critical-Year flow component. In Critical Years (when runoff is limited), YWA already releases large volumes of water from storage in New Bullards Bar Reservoir to meet the Yuba Accord flow requirements. The team of biologists who developed the Yuba Accord flows allocated all of the water available in each year type, which includes an increased springtime flow component. In Critical Years, Yuba Accord flows already are greater than 100% of unimpaired flows during about half of each year (from sometime in June through December). The June through September Yuba Accord flow requirements were developed to maintain enhanced holding habitat flows and temperatures, which provide better conditions than would occur under natural conditions. Fall flows are above natural flow rates under the Yuba Accord, and target creating optimal spawning conditions. These flow enhancements above unimpaired conditions already require large amounts of releases of water from storage in New Bullards Bar Reservoir in Critical Years. Including a Critical Year flow component in the VSA would significantly compromise YWA's ability to use stored water to meet Yuba Accord flow requirements, and to meet these requirements during multi-year droughts.

The YWA VSA Project flow proposal would minimize impacts to YWA's mission and to the fishery benefits of the Yuba Accord. A strict 55% of unimpaired flow requirement, even if proportionately implemented by all of the major diverters in the Yuba River Watershed, would have significant adverse impacts to YWA's water deliveries to its Member Units, and, as a result, would have associated groundwater impacts, would adversely impact Yuba Accord summer and early fall flows and water temperatures, and would significantly reduce Yuba Accord revenues that fund YWA flood protection and other activities.

In addition, the SWRCB Staff Framework proposals would decrease annual acre-days of inundation of floodplain-related Chinook salmon and steelhead juvenile rearing habitat in the lower Yuba River, while the YWA VSA Project flow proposal would increase the numbers of annual acre-days of inundation.

In summary, the YWA VSA Project flow proposal would meet the SWRCB Staff Framework goals for voluntary agreements, and would have significantly lower adverse impacts to water-supply reliability and other aspects of YWA's mission than would occur with adoption and implementation of the proposed unimpaired flow objectives in the SWRCB Staff Framework.

YWA is committed to achieving the flow-related benefits of the YWA VSA Project as soon as feasible. YWA is coordinating with DWR and CDFW on early implementation of the YWA VSA Project flow measures in 2019. Under the early implementation project, YWA would release up to 50,000 ac-ft this spring for increased Bay-Delta inflows (to be managed by DWR and CDFW for increased Bay-Delta outflows).

1.3.2 Non-Flow Measures

The YWA VSA Project habitat enhancement measures would provide 100 acres of new high-value rearing habitat for Chinook salmon and steelhead in the lower Yuba River in areas that would be inundated at flows ranging from 1,500 cfs to 3,000 cfs. This is the predominant flow range for the salmonid rearing time period of February to June. This measure would result in extended inundation of this rearing habitat in most years. A combination of existing in-channel areas (inundated below 5,000 cfs) and currently low-value floodplain (inundated above 5,000 cfs) would be selected for terraforming and terrain lowering through a collaborative design process.

This terraforming and terrain lowering would: (a) increase inundation frequency and duration; (b) support the establishment of riparian vegetation; (c) increase production of benthic macroinvertebrates; and (d) increase the availability of off-channel rearing habitat. Other YWA VSA Project proposed habitat enhancement measures would involve: (a) riparian planting; (b) bioengineering features (e.g., boulders, large woody material and engineered log jams) to increase site stability and reinforce planting areas; and (c) grading or lowering to facilitate improved survival of riparian vegetation, which would support juvenile salmonid growth and survival by providing more complex and diverse physical habitat.

In addition, YWA may conduct pilot studies as part of the YWA VSA Project: (a) to investigate the potential for enhancing Waterway 13[2]; and (b) to test the potential for using flooded agricultural fields to improve aquatic food web productivity and enhance fish growth to produce larger juvenile anadromous salmonids.

The YWA VSA Project habitat enhancement measures would be expected to provide conditions that would produce larger juvenile anadromous salmonids in better condition and with higher expected survivorship rates by providing: (a) physical habitat structure (i.e., complexity, sinuosity, diversity, instream object and over-hanging cover); (b) high food availability, quality and diversity; (c) refugia from predators; and (d) refugia from high flows.

The YWA VSA Project proposed habitat enhancement measures are preliminarily identified and described in detail in **Exhibit 3 - Habitat Enhancement Measures**).

Background information on lower Yuba River fisheries resources, which supports the purpose and need for the YWA VSA Project habitat enhancement measures, is contained in **Exhibit 4 – Fisheries Background**.

YWA would contribute $10 million for habitat enhancement measures during the term of the YWA VSA. The habitat enhancement measures would be implemented on behalf of YWA and YWA Member Units, and not on behalf of other water users in or diverters of water from the Yuba River Watershed.

The YWA VSA Project would include provisions regarding the process for, and respective obligations of, the parties to identify, select, fund, develop, operate, maintain and repair habitat enhancement measures, without requiring an amendment to the YWA VSA.

YWA VSA Measurement, Monitoring, Adaptive Management and Reporting Program

The proposed Yuba River Science Program would be developed and implemented by the YWA VSA parties after execution of the VSA. This Science Program would include: (a) identification of Yuba River salmonid

---

[2] Due to the high permeability of the Yuba Goldfields, water from the Yuba River freely migrates into and through the Goldfields, forming interconnected ponds and canals throughout the undulating terrain (DWR 1999). Waterway 13 is an outlet canal of unknown origin that drains water from the Yuba Goldfields into the lower Yuba River. Past observations by USFWS and CDFW have indicated that the potential exists for adult Chinook salmon to be attracted into Waterway 13 and migrate into the interconnected ponds and canals of the Yuba Goldfields to spawn. Such attraction of adult fall-run Chinook salmon was of concern because there is a general lack of spawning habitat in the Yuba Goldfields and water temperatures in the Yuba Goldfields can be unsuitable, especially in the lower ends of the Goldfields where water discharges into the lower Yuba River (SWRCB 2000). Fish habitat within the ponds and canals is not conducive to anadromous fish survival because food supplies are limited, predator habitats are extensive and water quality conditions (especially water temperature) are poor (DWR 1999). There have been several past attempts to take actions (i.e., large grate, temporary aggregate berm, a “leaky dike” barrier) to preclude anadromous salmonids from entering the Yuba Goldfields via Waterway 13 (SWRCB 2000). Most recently, high flows (about 30,000 cfs) in the lower Yuba River and high flows through the Yuba Goldfields caused the “leaky-dike” barrier at the entrance to Waterway 13 to wash out again in 2011. Because Waterway 13 receives flow augmentations from Yuba Goldfields return flows, it has been identified for additional study to determine whether the outlet canal entrance could be stabilized, and habitat enhanced to create a side-channel within an existing stand of riparian vegetation that would extend from the main channel into a current off-channel backwater area.

juvenile rearing habitat enhancement goals and objectives; (b) an outline of the management actions that could be undertaken to achieve the goals and objectives; (c) a clear statement of the metrics and indicators by which progress toward achieving the goals could be assessed; (d) identification of quantitative (e.g., conceptual ecological model) and qualitative (e.g., Yuba River Operations Model) tools to be used to assess metrics and indicators; and (e) a description of monitoring and evaluation procedures to be used to assess progress.

Adaptive management would rely on monitoring, and would involve the development of mechanisms to incorporate monitoring results into the decision-making processes that would be used to determine if the YWA VSA Project goals and objectives are being achieved, and to bring measured YWA VSA Project performance criteria in conformance with desired project outcomes.

Additional information about the proposed Yuba River Science Program is provided in **Exhibit 7 - Monitoring and Adaptive Management** Program.

YWA would make annual payments of $520,000 to the Yuba Watershed Structural Science Fund during the term of the YWA VSA, in lieu of a tax, fee or other charge levied or assessed against YWA's water rights or water diversions or use. This fund would be used in the Yuba River Watershed for the Yuba Science Program. The YWA VSA parties would develop procedures setting forth their respective rights and obligations for establishing, administering and making expenditures from the Yuba Watershed Structural Science Fund.

1.3.3 Funding

Funding for Yuba River flow measures

YWA would not be compensated for 9,000 acre feet of water provided under this proposal. The remaining 41,000 acre feet would be compensated at $290/acre-foot. Funding for this water would come from either the water purchase fund described for the Sacramento River, other water users who will make their water contribution using the Bullards Bar reoperation, and/or public funding.

Funding for Yuba River non-flow measures

YWA would pay $10 million for the habitat enhancement measures and $7.8 million for the Yuba Watershed Structural Science Fund Program, during the 15-year term of the YWA VSA. The YWA VSA parties will develop procedures setting forth their respective rights and obligations for establishing, administering and making expenditures from the Yuba Watershed Structural Science Fund.

1.3.4 Timing

YWA is committed to achieving the flow-related benefits of the YWA VSA Project as soon as feasible. YWA is coordinating with DWR and CDFW on early implementation of the YWA VSA Project flow measures in 2019. Under the early implementation project, YWA would release up to 50,000 ac-ft this spring for increased Bay-Delta inflows (to be managed by DWR and CDFW for increased Bay-Delta outflows).

YWA, CDFW and DWR will establish the process for determining their respective obligations to identify, select, schedule, fund, develop, operate, maintain and repair habitat enhancement measures during the 15-year term of the YWA VSA.

1.3.5 Expected Outcomes

Summary of Benefits of Proposed Flow Measures

The following are key observations from **Exhibit 5** - **Methodology for Evaluating Fisheries Benefits** regarding the benefits of the proposed flow measures:

- During all years, for January, February, and July through December (a total of 8 months), modeled Accord Yuba River outflow is within or above the range shown for the SWRCB Staff Framework percent-of-unimpaired flow proposal.
- During March and June, with the exception of Critical Years, modeled Accord Yuba River outflow also is within or above the range for the SWRCB Staff Framework percent-of-unimpaired flow proposal (for a total of 10 months in all but Critical Years).
- The previous two bullets points demonstrate that any focus for changes in Yuba River outflows should focus on April and May, and for a few years, on June and late March.
- During Wet and Above-Normal years (which constitute approximately 1/2 of all years), modeled Accord Yuba River outflow exceeds 55% of unimpaired flow during April and 50% during May.
- The YWA VSA Project would provide more water than YWA's comparable and proportionate share of a 55% of unimpaired flow requirement during April and May of Above-Normal and Below-Normal years (with no need to provide any supplemental water in Wet years due to sufficient existing flows), and more than YWA's proportionate share of a 55% of unimpaired flow requirement during June in Dry years. Additionally, the YWA VSA Project would provide more than YWA's proportionate share of a 45% of unimpaired flow requirement during April and May.
- During Critical years, there would be no additional YWA VSA releases, and YWA's operations would provide about 10,000 AF less than YWA's proportionate share of a 45% of unimpaired flow requirement for March, April and May. The total volume would, on average, be approximately 36,000 AF less than under the 45% of unimpaired flow requirement for YWA's proportionate share for March through June. However, during July through October, operations to the Yuba Accord flow schedules would result in releases of 46,000 AF more than the100% of unimpaired flow of the Yuba River.
- Most of the modeled deficit compared to the percent-of-unimpaired flow requirements (45% or 55%) during Critical years is due to upstream diversions during April and May.
- During all years, modeled lower Yuba River flows for the July through October period are more than 65% of unimpaired flow, and most of the time are more than 100% of the unimpaired flow, due to YWA operations to meet the Yuba Accord instream-flow requirements for anadromous salmonid spawning flows, juvenile rearing flows, and to maintain cool water temperatures.

Summary of Benefits of Proposed Non-Flow Measures

Figure 6 from **Exhibit 5** - **Methodology for Evaluating Fisheries Benefits** presents the averages of annual floodplain and constructed rearing habitat inundation area and duration in acre-days during February 1 to June 15 for: (1) the existing condition (Yuba Accord); (2) conditions with a 55% of unimpaired flow requirement; and (3) conditions with 100 acres of floodplain habitat enhancement. Averages are shown for the wettest, middle and driest one-third of years, using annual unimpaired flow for determination of the three categories and the years contained in each. **Table 1** presents the same information shown in the Figure 6 for annual inundation of floodplain and constructed rearing habitat in acre-days.

- Under current conditions (blue bars) the average of middle hydrology years inundation-duration of existing floodplain is 914 acre-days, representing an average of 7 days of floodplain inundation annually of 130 acres.

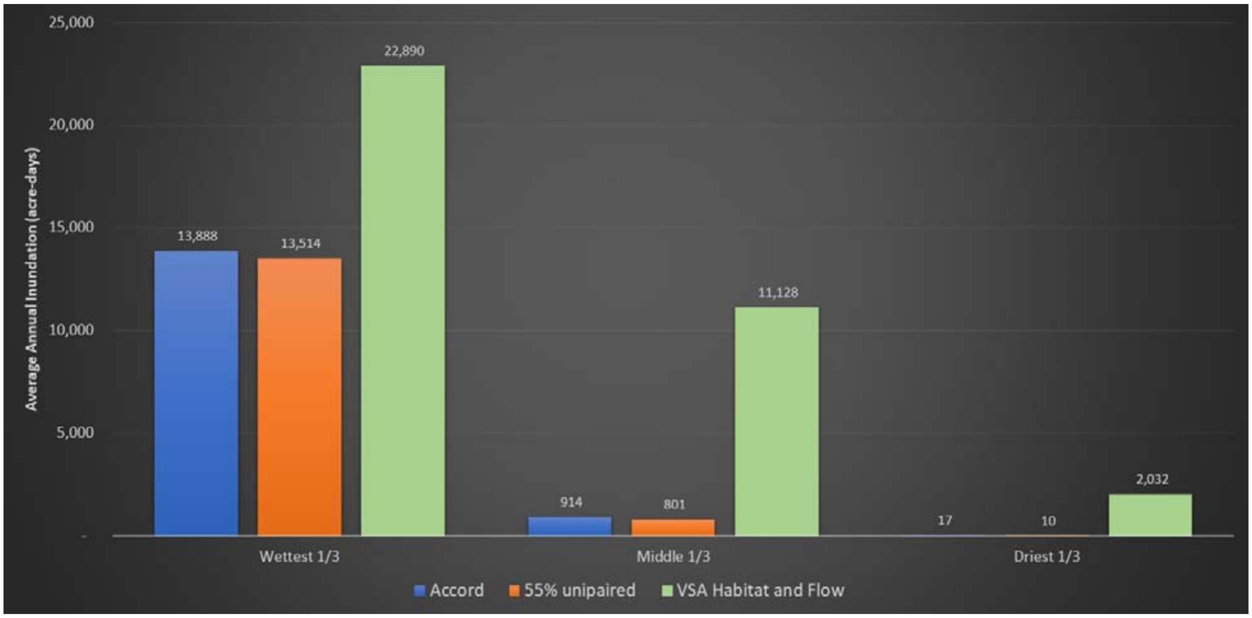


Figure 6. Averages of annual floodplain and constructed rearing habitat inundation area and duration in acre-days during February 1 to June 15 for the existing condition (Yuba Accord), conditions with a 55% unimpaired flow requirement and conditions with 100 acres of floodplain habitat enhancement.

- A 55% of unimpaired flow requirement (orange bars) would reduce floodplain inundation at the average of middle hydrology years inundation-duration by 12% or an inundation of 801 acre-days, representing average of 7 days of floodplain inundation annually of 113 acres.
- Alternative analysis was done to examine YRDP operation to a full 55% of unimpaired Yuba River outflow (not proportionately shared within the watershed), and does not significantly change the resulting inundation shown in the plotted scenario with YWA operating to its proportional share of the 55% unimpaired flow.

Table 1. Annual inundation of floodplain and constructed rearing habitat in acre-days.

	Existing Conditions (Yuba Accord)	55% Unimpaired	VSA Habitat and Flow
Wettest 1/3	13,888	13,514	22,890
Middle 1/3	914	801	11,128
Driest 1/3	17	10	2,032

- The theoretical VSA constructed rearing habitat, as described above, when modeled under YWA's VSA Project flow proposal, would result in a total (natural and constructed habitat) average of middle hydrology years inundation-duration of 11,128 acre-days, more than 12 times the existing floodplain inundation.
- The theoretical VSA constructed rearing habitat described above, when modeled under YWA's VSA Project flow proposal, would result in a total (natural and constructed habitat) average of the driest one-third of years inundation-duration of 2032 acre-days, where under existing conditions and with a 55% of unimpaired flow requirement there would be almost no floodplain inundation.
- In the driest one-third of years, floodplain inundation would occur under existing conditions or under the 55% of unimpaired scenario only during 1 day for each of 6 years of the 32 years in the driest one-third of years, while the theoretical VSA constructed habitat would be inundated an average of 15 days annually in the driest one-third of years, and there would be some inundation during 24 of the 32 one-third driest years.
- The reason the theoretical VSA constructed habitat would be such a large improvement is that the 100 acres of constructed habitat would be at elevations that would be inundated at river flows of 2,000 cfs, which occur annually on average 82 days out of the 136 days in February 1 through June 15.

- In the YWA FERC relicensing, USFWS estimated the amount of floodplain habitat inundation that would have occurred if the YRDP had not been constructed (the "without YRDP" condition), and determined that the estimated median amount would be 2,598 acre-days (USFWS FERC Project 2246 10(j) Conditions Appendix 3). In contrast, the YCWA VSA Project would provide 11,073 acre-days of inundation, which is over 4 times greater. The "without YRDP" analysis consisted of the natural flow conditions with only the upstream projects present in the Yuba River Watershed.
- The YWA VSA Project would provide inundated natural floodplain and constructed rearing habitat in 9 out of 10 years equal to or greater than the inundation that would occur under existing or 55% of unimpaired flow conditions during only one-half of all years (86% exceedance inundation for the YWA VSA is greater than the 50% exceedance existing condition and 55% unimpaired inundation).

In summary, the preceding information shows that there would be a very large increase in the amounts of anadromous salmonid rearing habitat in the lower Yuba River with implementation of the YWA VSA Project.

YWA VSA Project Goals

Protection and enhancement of native fish species and wildlife beneficial uses in the Sacramento River and San Joaquin River watersheds and the Bay-Delta require a comprehensive approach to management of habitat, flow and other factors that affect the viability of such uses. Past Bay-Delta Plans have required changes in flow in isolation from the numerous other factors affecting fish and wildlife beneficial uses, including invasive species, ocean conditions, physical modifications of riverine channels and wetlands and floodplain activation.

If implemented through an update of the Bay-Delta Plan, the flow, habitat enhancement and other measures described in the YWA VSA Project, together with other measures in and outside of the Sacramento River and San Joaquin River watersheds, would: (a) significantly contribute to the achievement of overall viability of Sacramento Valley salmonids by promoting measures that address specific life-stage stressors for the viability of fish and avian, terrestrial and aquatic wildlife species in the Bay-Delta Estuary; and (b) substantially contribute to the doubling of the natural production of Central Valley salmon (under the CVPIA Salmonid Doubling Objective and the Bay-Delta Plans narrative Chinook salmon doubling objective) by providing substantial contributions to the creation of conditions that would support viable populations of native fish in the affected rivers and the Bay-Delta.

The YWA VSA Project would include development and implementation of a Science Program for measurement, monitoring, adaptive management and reporting to assist in evaluating whether the VSA is succeeding in achieving those outcomes.

The YWA VSA Would Meet the Recommended Implementation Measures of the SWRCB Staff Framework

The SWRCB Staff Framework for the Bay-Delta Plan Update (July 2018) acknowledges that the SWRCB encourages parties to develop settlement agreements that may be a preferred implementation pathway for the Bay-Delta Plan Update.

> "Such voluntary agreements 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 agreements may also reduce the volume of water that needs to be dedicated for instream purposes, and therefore reduce the potential impacts associated with decreased consumptive water uses, such as impacts to agriculture. To this end, the proposed program of implementation provides a framework for accepting voluntary agreements that

> include alternative methods for enhancing fish and wildlife throughout the Sacramento/Delta watershed." (Section 5.1.2.2 at page 23)

The SWRCB Staff Framework recommends (in sections 5.1 and 5.2) implementation measures to encourage voluntary settlement agreements to implement the Bay-Delta Plan Update. The YWA VSA Project would include each of these recommended provisions:

- CDFW would be a party to the YWA VSA
- provisions for transparency and accountability, monitoring and reporting, and planning and adaptive management
- provisions to ensure enforceability
- measures that would contribute to implementing Bay-Delta Plan water quality objectives and provide protection of fish and wildlife beneficial uses
- flows that would comply with the unimpaired flow targets for voluntary plans
- flows that would contribute to Delta inflows, which would be managed to contribute to Delta outflows
- measures to provide robust scientific information regarding the benefits of the habitat enhancement measures
- a 15-year timeframe for implementation
- measures to contribute to the implementation of cold-water habitat objectives for the lower Yuba River
- consistency with SGMA
- protection of aquatic beneficial uses during sustained dry conditions

Suggested Methodology for Evaluating the Benefits from Flow and Habitat Enhancement Measures

Evaluation of the benefits of the YWA VSA Project flow proposal should be based on two methods: (a) quantification and assessment of the changes in Yuba River outflows, which would be conducted to evaluate flow-related benefits (as well as potential impacts) over the period of record for the YWA VSA Project and the alternative approaches included in the SWRCB Staff Framework, compared to exiting conditions; and (b) quantification and assessment of the YWA VSA Project proposed flow measures and habitat enhancement measures to evaluate their benefits (as well as potential adverse impacts) to juvenile anadromous salmonid rearing habitat[3] in the lower Yuba River, compared to exiting conditions, and the alternative approaches included the SWRCB Staff Framework.

To assess potential benefits to juvenile anadromous salmonid rearing habitat in the lower Yuba River, an inundation-duration analysis similar to that developed by the USFWS for application in the YRDP relicensing could be used, in combination with a quantification of fry and juvenile rearing habitat suitability and availability, expressed as weighted usable area WUA. An inundation-duration analysis would help to determine benefits associated with the longer residence time of water on the floodplain in relation to increases in primary and secondary productivity and, therefore, prey availability for salmonids. Because inundation duration amounts are not necessarily an indicator of habitat suitability, additional considerations must be given to species and lifestage-specific biological preferences regarding depth, velocity and cover. Fisheries benefits will be estimated in terms of the net gain in fry and juvenile rearing WUA (yd^2 per year) based on a comparison of pre-project and post-project WUA on an annual basis.

Exhibit 5 - **Methodology for Evaluating Fisheries Benefits** is a detailed discussion of these methodologies and preliminary analysis results.

[3] Available information indicates that fry and juvenile rearing physical habitat structure (complexity, sinuosity, diversity, instream object and over-hanging cover, nutrients) is an ongoing stressor and limiting factor for anadromous salmonids in the lower Yuba River.

The YWA YSA Project would contribute to implementation of the CVPIA Chinook Salmon Doubling Goal and the narrative Chinook salmon doubling objective in the 2006 Bay-Delta Plan. It therefore is important to accurately describe these goals for the lower Yuba River. For the reasons explained in **Exhibit 6 - Doubling Goal for the Yuba River**, assumptions pertaining to achievement of the CVPIA Chinook Salmon Doubling Goal for naturally-produced adult Chinook salmon, and any use of the CVPIA Doubling Goal in the YWA VSA process, should be based on the spawning stock escapement (annual spawner abundance) of 26,000 adult Chinook salmon for the lower Yuba River.

As the SWRCB evaluates the efficacy of the YWA VSA flow and habitat measures, the SWRCB should take into consideration numerous enhancements to Bay-Delta flows and Bay-Delta and tributary habitats that have occurred since the SWRCB adopted D-1641. A summary of these habitat enhancement measures that have been preliminarily identified by YWA is provided in **Exhibit 3 - Habitat Enhancement Measures**.

1.3.6 Miscellaneous Provisions

Other Provisions of the YWA VSA

Exhibit 8 describes other provisions of the YWA VSA including the following;

- Compensation for Supplemental Flow Contributions.
- Support for the YRDP FERC License AFLA.
- Consistency of YRDP License and Bay-Delta Plan Update implementation.
- Amendment of the Yuba Accord WPA.
- Extension of the authorized place of use, purpose of use and points of rediversion for Yuba Accord Transfer Water through the term of the Yuba Accord WPA and the YWA VSA.
- YWA's contributions to the Yuba Watershed Structural Science Fund under the YWA VSA would be on behalf of YWA and YWA Member Units, and not on behalf of other water users in or diverters of water from the Yuba River Watershed.
- CDFW and DWR would not seek contributions from, or regulatory requirements applicable to, YWA Member Units for habitat enhancement measures for the purposes described in the YWA VSA.
- CDFW and DWR would not seek contributions from, or support charges to, YWA or any of its Member Units for the Yuba River Watershed Habitat Enhancement Fund or any comparable fund established for a similar purpose.

Relationship of YWA's VSA to the Bay-Delta Plan Update

The YWA VSA parties intend that the YWA VSA would specify all of YWA's obligations to provide water and to take other actions to contribute to the implementation of the Bay-Delta Plan's water quality objectives. Accordingly, the YWA VSA parties will ask the SWRCB to include in the Bay-Delta Plan amendments provisions confirming that: (a) the SWRCB will not take any water-quality or water-right actions that would affect YWA beyond the actions described in the YWA VSA, or any other actions that would increase any of YWA's burdens to contribute to the implementation of any of the Bay-Delta Plan's water-quality objectives, during the terms of the YWA VSA; and (b) if the SWRCB takes any such actions, then YWA may terminate or withdraw from the YWA VSA.

YWA VSA Proposed Governance Provisions

The YWA VSA would include provisions for YWA, CDFW and DWR:

- To establish the process for determining the respective obligations of the parties to identify, select, fund, develop, operate, maintain and repair habitat enhancement measures.
- To administer the Yuba Watershed Structural Science Fund and the Science Program.
- To establish a stakeholder advisory committee to assist in the administration of the Science Program.

Guiding Principles for Implementing the YWA VSA

Exhibit 9 sets forth guiding principles for development and interpretation of the YWA VSA.

Conclusion

YWA's VSA Project is a collaborative, interest-based, science-driven proposed project that can achieve and implement the SWRCB's coequal goals of water-supply reliability and ecosystem restoration. The YWA VSA Project is a preferred alternative project for contributing to the implementation of the Bay-Delta Plan's water quality objectives because it includes not only water for additional Delta outflows, but also habitat measures, a science program, funding and collaboration, in a manner that would achieve key objectives for increases in Bay-Delta outflows and enhancement of Chinook salmon and steelhead juvenile rearing habitat in the lower Yuba River.

LIST OF EXHIBITS

- Exhibit 1 – Yuba Accord
- Exhibit 2 – Flow Project
- Exhibit 3 – Habitat Enhancement Measures
- Exhibit 4 – Fisheries Background
- Exhibit 5 – Methodology for Evaluating Fisheries Benefits
- Exhibit 6 – Doubling Goal for the Yuba River
- Exhibit 7 – Monitoring and Adaptive Management Program
- Exhibit 8 – Other Provisions of the YWA VSA
- Exhibit 9 – Guiding Principles for Implementing the YWA VSA

GLOSSARY

ac-ft	acre-feet
AFLA	Amended Final License Application
AFRP	Anadromous Fish Restoration Program
Bay-Delta Plan	Bay-Delta Plan Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary
CDFW	California Department of Fish and Wildlife
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
cfs	cubic feet per second
m^3/s	cubic meters per second
DWR	California Department of Water Resources
D-1641	Water Right Decision 1641
DEM	digital evaluation model
ESA	Endangered Species Act
ELJ	engineered log jam
ESU	evolutionarily-significant unit
FR/EA	Feasibility Report and Environmental Assessment
FERC	Federal Energy Regulatory Commission
HSI	habitat suitability index
LWM	large woody material
NMFS	National Marine Fisheries Service
NGO	Non-Governmental Organization
Reclamation	Bureau of Reclamation
RMT	Yuba Accord River Management Team
SAM	Science and Adaptive Management
Science Program	Measurement, Monitoring, Adaptive Management and Reporting Program
SRA	shaded riverine aquatic

SWP	State Water Project
SWRCB	State Water Resources Control Board
SWRCB Staff Framework	SWRCB Staff Framework for the Bay-Delta Plan Update (July 2018)
UC Davis	University of California, Davis
USACE	U.S. Army Corps of Engineers
USACE Study	Yuba River Ecosystem Restoration Feasibility Study
USFWS	U.S. Fish and Wildlife Service
VSA	Voluntary Settlement Agreement
WPA	Water Purchase Agreement
WUA	weighted usable area
YRDP	Yuba River Development Project
Yuba Accord	Lower Yuba River Accord
YWA	Yuba Water Agency

1.3.7 Yuba River Appendices

Settlement Negotiations

YUBA WATER AGENCY
VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

EXHIBIT 1

Lower Yuba River Accord

During 2002 through 2005, YWA, CDFW, NMFS, USFWS, and NGO representatives participated in a rigorous and collaborative scientific process during which they examined all of the stressors to lower Yuba River salmonids by species, life stages and locations, and then developed new minimum flow requirements for the lower Yuba River to best protect and enhance these species, and their habitat, within the limits of available water supplies.

After these new requirements were developed, YWA, CDFW, and four NGOs (South Yuba River Citizens League (SYRCL), Friends of the River (FOR), Trout Unlimited (TU), and the Bay Institute) executed the Yuba Accord Fisheries Agreement in October 2007. NMFS and USFWS submitted formal written statements of support for the Yuba Accord Fisheries Agreement. Other parties also supported the development of the Yuba River Accord, including the Fisheries Agreement. YWA implemented the Yuba Accord Fisheries Agreement in 2006 and 2007 pursuant to interim orders issued by the SWRCB, pending final approval of the agreement.

The Yuba Accord Fisheries Agreement is one of four agreements that comprise the award-winning Yuba River Accord.

The Yuba Accord Fisheries Agreement's lower Yuba River minimum flow requirements were developed to achieve the following objectives:

- Maximize "optimal" flows and minimize the occurrence of sub-optimal flows, within the bounds of hydrologic variation and available water storage capacity.
- Maximize the occurrence of appropriate flows for Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) immigration, spawning, rearing, and emigration.
- Provide month-to-month flow sequencing in consideration of Chinook salmon and steelhead life history periodicities.
- Provide appropriate water temperatures for Chinook salmon and steelhead immigration and holding, spawning, embryo incubation, rearing and emigration.

- Promote a dynamic, resilient, and diverse fish assemblage.
- Minimize potential stressors to fish species and lifestages.
- Develop flow regimes that consider all freshwater lifestages of salmonids and allocate flows accordingly.

YWA and Reclamation then prepared a Draft Environmental Impact Report/Environmental Impact Statement ("EIR/EIS") for the Yuba Accord and circulated it for public review and comments in June 2007. YWA certified the Final EIR/EIS (as an EIR under the California Environmental Quality Act) on October 23, 2007. The Yuba Accord EIR/EIS evaluated each species and lifestage over the relevant months during the full range of Yuba River hydrologic conditions.

On May 20, 2008, the SWRCB adopted its Corrected Order WR 2008-0014, which added these requirements to YWA's water right permits. Since then, YWA has operated the YRDP to meet these requirements. The minimum instream flows for the 24 miles of the lower Yuba River under the Yuba Accord are substantially higher than the minimum streamflows for the lower Yuba River in the existing YRDP FERC license.

YWA's Amended Final License Application

YWA's AFLA proposes:

- The same Yuba Accord minimum instream flow requirements for the lower Yuba River for flow Schedules 1 through 6.
- Some changes to the requirements for Conference Years (the driest WYs, expected to occur approximately 1% of the time) from the corresponding Yuba Accord requirements, to provide some additional benefits to fish in those years.

The AFLA proposals are based on the best-available scientific information, and provide a contemporary "functional flow" program for anadromous salmonids in the lower Yuba River. The Delta Independent Science Board in its February 23, 2017 review of the SWRCB's "Working Draft Scientific Basis Report for New and Revised Flow Requirements on the Sacramento River and Tributaries, Eastside Tributaries to the Delta, Delta Outflow, and Interior Delta Operations" described functional flows as follows:

> *Functional flows are a mechanistic approach for estimating flow needs and trade-offs (Yarnell, et al. 2015; DISB 2015). Flows needed are based on field observations of life stages and computer and conceptual models of hydrodynamics, habitat, and ecological conditions for different flows. Environmental flows are then chosen to support different ecological functions and life stages of selected species.*

Figure 1 depicts the comparative annual quantities of water required to meet the minimum instream flows in typical Wet and Dry years under: (1) the existing YRDP FERC license; and (2) the Yuba Accord, as amended by the AFLA.

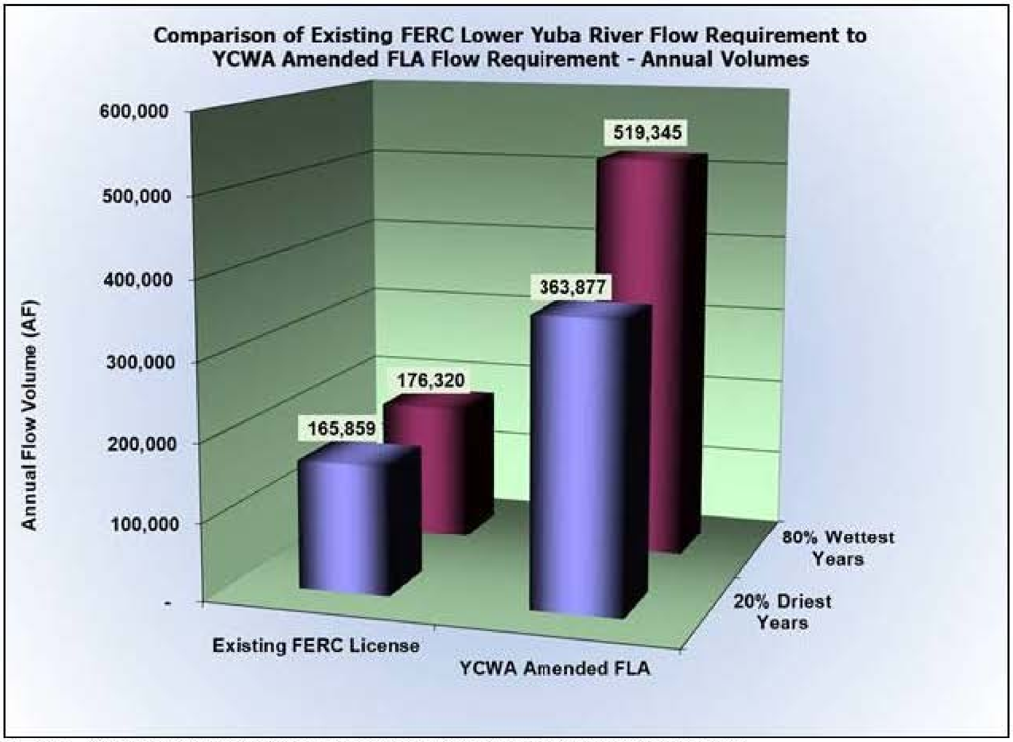


Figure 1. Comparative lower Yuba River annual required minimum flow volume.

The figure shows these annual quantities of water required to meet the minimum instream flows in typical Wet and Dry years:

(1) Existing Project license: Dry – 180,327 ac-ft annually; Wet – 175,208 ac-ft annually.

(2) Yuba Accord (as amended by the AFLA): Dry – 422,306 ac-ft annually; Wet – 546,952 ac-ft annually.

Therefore, the Yuba Accord flow requirements specify minimum flows that require a total annual flows of approximately 242,000 ac-ft more water in a typical Dry year (about 134% greater), and approximately 372,000 ac-ft more water in a typical Wet year (about 212%

greater), than is required under the existing Project FERC license. In other words, the Yuba Accord provides almost 300% of the required annual volume of the flows required in the FERC license in wetter years and over 220% of the required annual volume of flows required in the FERC license in drier years.

Before adoption of the Yuba Accord, YWA expended in excess of $10,000,000 costs for the technical work to support the development of the lower Yuba River flow requirements in the Yuba Accord Fisheries Agreement, environmental analysis of these flow proposals, and the SWRCB regulatory process under which these requirements were approved. Other parties to the Yuba Accord Fisheries Agreement also incurred significant costs in the development, analysis, approval and implementation of these flow requirements.

Yuba Accord River Management Team

As contemplated by the Yuba Accord Fisheries Agreement, YWA established the Yuba Accord River Management Team (RMT) in 2006. The RMT is a team of scientists who continue to refine science-based approaches to managing the lower Yuba River, for the benefit of fish and local stakeholders. The RMT's primary role has been to develop and implement a program of monitoring and evaluation studies to assess fisheries conditions in the lower Yuba River. The RMT includes representatives of YWA, CDFW, NMFS, USFWS, DWR, FOR, the Bay Institute, SYRCL, TU, and other parties. The RMT's science-based program evaluates the following:

- The effectiveness of the implementation of the updated flow schedules in protecting anadromous salmonids.
- The condition of fish resources in the lower Yuba River.
- The viability of lower Yuba River fall-run Chinook salmon, and any subpopulations of the Central Valley Steelhead Distinct Population Segment and the Spring-Run Chinook Salmon Evolutionarily Significant Unit that may exist in the lower Yuba River.

YWA has provided funding in excess of $6,000,000 since 2006 for the RMT's science program. The RMT science program has been augmented by scientific analyses conducted for the YRDP FERC relicensing process.

The RMT developed a Yuba Accord Monitoring and Evaluation (M&E) Program to evaluate the biological provisions of the Fisheries Agreement. The M&E Program embraces a monitoring-based adaptive management approach to increase the effectiveness of, and to address scientific uncertainties associated with, specific monitoring and study activities. The adaptive management component of the M&E Program allows the RMT to learn from past experiences through experimentation, or by altering specific studies or actions. Within the framework of the M&E Program, the RMT retains the flexibility to revise or develop and implement additional monitoring actions to address specific issues as they arise, or as additional information becomes available. This flexibility allows the M&E Program to obtain the appropriate types and amounts of data to evaluate the effectiveness of the implementation of the Yuba Accord and of potential habitat enhancement actions.

The RMT developed a first draft of the M&E Program framework with the intent of implementing a comprehensive M&E Program that would yield a variety of information on several species and lifestages that, in turn, would result in the ability to determine the efficacy of the Yuba Accord flow schedules. Additional goals of the M&E Program framework included requirements that the M&E Program be cost effective, and safely implemented.

Operating since 2006, the Yuba Accord science program has yielded many new, and sometimes surprising, results. These results help meet the Yuba Accord partners' goal of providing the right flows at the right time to protect the fisheries resources, and enhance their habitat in the lower Yuba River. Some of the science program's scientific accomplishments include:

- Published 15 journal articles, 11 technical reports, and 1 textbook, based on data collected as part of the Yuba Accord science program.
- Trained 2 post-doctoral researchers, 1 PhD student, 10 masters students, 11 undergraduate students, 4 technicians, and 3 international visiting scholars.
- Developed new information to help manage the lower Yuba River, such as information regarding what salmon and steelhead lifestages (adults, spawners, and juveniles) occur when and where in the river, and what they need to be successful.
- Developed statistical methods to differentiate between spring-run and fall-run Chinook salmon adults – never before accomplished in the Central Valley.
- Based on 3 years of tagging adult Chinook salmon with transmitters and tracking them in the river, determined their behavioral patterns, habitat use and distribution, including when they moved upriver to spawn.
- Using state-of-the-art infrared and videographic technology, documented that hatchery fish from the Feather River are drawn into the lower Yuba River because of differences between flows and water temperatures in the lower Yuba River and the lower Feather River.
- Created a more-detailed landform map and two dimensional (2-D) hydraulic model of the lower Yuba River compared with any other river in the Central Valley, using aerial remote sensing LiDAR surveys and boat-mounted multi-beam hydro-acoustic sampling.

Summary of Lower Yuba River Fisheries Habitat Conditions

Spawning habitat availability is not limiting, and represents a low stressor to anadromous salmonids, in the lower Yuba River (YWA 2017). According to the RMT (2013), spawning habitat does not appear to be limited by an inadequate supply of gravel in the lower Yuba River, because there are ample supplies of mining sediments in the banks, bars and dredger-spoil gravel berms. The USACE is augmenting spawning gravel supplies in one area of limited supply just downstream from Englebright Dam. It is estimated that the lower Yuba River will be supplied with good spawning materials to support resilient Chinook salmon and steelhead spawning habitat for the next 250+ years (see **Exhibit 4 – Methodology for Evaluating Fisheries Benefits** for additional details).

Overall, implementation of the Yuba Accord provides suitable flows and water temperatures for all lifestages of anadromous salmonids in the lower Yuba River.

- Benefits to spring-run Chinook salmon include:
    - More-suitable water temperatures during the entire adult immigration and holding period.
    - Higher spring-run Chinook salmon spawning habitat availability and more-suitable spawning water temperatures.
    - Improved embryo incubation conditions due to frequently and substantially lower, and therefore more-suitable, water temperatures.
    - Improved over-summer and early fall juvenile rearing conditions, due to more-suitable water temperature conditions.
    - Improved smolt emigration conditions due to higher flows, and generally-suitable water temperatures throughout most of the smolt emigration period.
- Benefits to fall-run Chinook salmon include:
    - More-suitable water temperatures during the adult immigration and staging period.
    - More-suitable water temperatures during the spawning period.
    - Improved embryo incubation conditions due to lower, and therefore more-suitable, water temperatures.
    - Improved juvenile rearing and outmigration conditions, due to higher flows and more-suitable water temperatures.
- Benefits to steelhead include:
    - More-suitable water temperatures during the adult immigration and holding period.
    - More-suitable water temperatures during the latter part of the spawning period.

- Improved embryo incubation conditions due to lower, and therefore more-suitable, water temperatures.
- Improved over-summer/early fall juvenile rearing conditions, due to more-suitable water temperature conditions.
- Improved smolt emigration conditions due to higher flows, and generally suitable water temperatures throughout the majority of the smolt emigration period.

NMFS (2014) Recovery Plan states that "*Implementation of the flow schedules specified in the Fisheries Agreement of the Yuba Accord is expected to address the flow-related major stressors including flow-dependent habitat availability, flow-related habitat complexity and diversity, and water temperatures. In fact, water temperature evaluations conducted for the Yuba Accord EIR/EIS indicate that Yuba River water temperatures generally would remain suitable for all life stages of spring-run Chinook salmon and steelhead.*"

Development and Implementation of the Yuba Accord-Based Flows and Related Provisions

The Yuba Accord-based flows and related provisions provide a contemporary "functional flow" program for anadromous salmonids in the lower Yuba River. As discussed in **Exhibit 4 – Methodology for Evaluating Fisheries Benefits**, overall, implementation of the Yuba Accord flows provides suitable flows and water temperatures for all lifestages of anadromous salmonids in the lower Yuba River. As discussed in the accompanying Project Description and several of the accompanying exhibits, the Yuba Accord flows are the foundation for the flow and habitat enhancement measures of the proposed YWA VSA Project.

Settlement Negotiations

YUBA WATER AGENCY
VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

EXHIBIT 2

YWA VSA Flow Proposal

YWA developed the flow proposal in the YWA VSA Project through: (a) an examination of CDFW's stated objectives for lower Yuba River flows and Bay-Delta inflows; (b) an examination of recommendations for voluntary agreements in the July 2018 SWRCB Staff Framework ; and (c) development of flow measures that would achieve these objectives and recommendations, but with significantly less adverse impacts to water-supply reliability and other important aspects of YWA's mission and with significantly less impacts to the fishery benefits being achieved with the Yuba Accord.

The following subsections describe: (1) the YWA VSA Project flow proposal; (2) how the flow proposal was developed; (3) how YRDP operations would be changed to provide these flows; and (4) the accounting principles associated with these flows.

1.1 Contributions to Delta Inflows

The YWA VSA Project flow proposal is founded on the Yuba Accord-based flows, including the requirements for instream flows specified in the Accord Fisheries Agreement and the SWRCB's Corrected Order WR 2008-0014, and the transfer operations and accounting provisions of the Yuba Accord WPA. YWA VSA Project operations would be supplemental to the Accord flows and YRDP operations.

The YWA VSA Project flow proposal includes two quantifiable water components that would provide up to 50,000 ac-ft of additional Bay-Delta inflow in Above-Normal, Below-Normal and Dry Years,[1] compared to existing conditions, through the following changes in YRDP operations: (a) all Yuba Accord transfer releases in April, May and June that cannot be backed up into Oroville Reservoir or exported by DWR would be repurposed from potential export to

[1] Unless otherwise specifically identified, all water year types are defined using the Sacramento Valley Index.

Bay-Delta outflow (Component A); and (b) additional storage releases from New Bullards Bar Reservoir would be made by operating to a new target September 30 storage level of 600,000 ac-ft, which is 50,000 ac-ft below the Yuba Accord target September 30 storage level of 650,000 ac-ft (Component B). The YWA VSA Project flow proposal also includes accounting for refills of storage releases for New Bullards Bar Reservoir from Component A and Component B that exceed 9,000 ac-ft annually in Above Normal, Below Normal and Dry Water Year types.

The resulting total volume of Component A and B water in some years would exceed 50,000 ac-ft. YWA's firm commitment for Above-Normal, Below-Normal and Dry years would be for up to 50,000 ac-ft, based on the existence of sufficient storage in New Bullards Bar Reservoir. Conditions under which more than 50,000 ac-ft would be produced would be dependent upon YWA's determination of its ability to produce the entire 50,000 ac-ft of Component B water when a significant volume of Component A water also is produced, and on the willingness of Parties to the YWA VSA Project to fund the additional amounts of water. The total quantity of water produced from these two components also could be less than 50,000 ac-ft, if September 30 storage in New Bullards Bar Reservoir under Yuba Accord operations (without-YWA VSA Project releases) would be lower than 650,000 ac-ft. In those cases, operations to a target storage of 600,000 ac-ft would produce less than 50,000 ac-ft of Component B water, and the available amount of Component A water may not bring the total to 50,000 ac-ft.

Under the YWA VSP Project, YWA would: (1) repurpose all Yuba Accord Released Transfer Water in April through June that cannot be accounted for as Delivered Transfer Water (as these terms are defined in the Yuba Accord WPA) to Delta outflows; and (2) re-operate New Bullards Bar Dam and Reservoir by releasing up to 50,000 ac-ft of additional water from storage, to provide: (a) Base Contribution Water of 9,000 ac-ft per year in Above Normal, Below Normal and Dry Years; and (b) Supplemental Flow Contribution Water of up to an additional 41,000 ac-ft per year in Above Normal, Below Normal and Dry Years, based on releases from storage with YWA's reoperation plan. The Base Contribution Water quantity reflects a proportionate Yuba River Watershed share of Sacramento Valley runoff, which is about 9% of total runoff. Based on YWA's estimates, YWA's share of a contribution to Bay-Delta inflow from the Sacramento River Basin would be 3% (one-third of 9%), resulting in 9,000 ac-ft of the total Sacramento Valley water user contribution to Delta inflow of 300,000 ac-ft.

1.1.1 The YWA VSA Flow Proposal Was Developed to Meet CDFW Delta Flow Objectives

YWA is in the process of relicensing the YRDP with FERC. During the relicensing process, relicensing participants (including CDFW, USFWS and NGO's) proposed new instream flow requirements for the Lower Yuba River. The most-significant changes to existing Yuba Accord flows under CDFW's flow proposals were: (a) higher flows in the spring, mostly in Schedules 1, 2 and 3 years (as defined in the Yuba Accord Fisheries Agreement), which are estimated to occur about 80% of the time; and (b) measures to mitigate for losses of lower Yuba River floodplain inundation that CDFW argues have occurred because of New Bullards Bar Reservoir operations.

CDFW provided YWA a summary of the general objectives that CDFW was seeking to achieve, relating to both lower Yuba River flows and Delta inflow contributions. YWA developed a set of science-based flow measures for the YWA VSA Project that would provide results that would be comparable to what would be achieved with CDFW's proposed flow measures, but with significantly reduced impacts to water supply reliability and other aspects of YWA's mission.

The following CDFW objectives (as defined in its proposal flow measures that were parts of its FERC relicensing section 10(j) recommendations) were considered in the preparation of the YWA VSA Project proposal for higher springtime flows:

- Provide science-based lower Yuba River flow-related habitat enhancements to increase fisheries productivity.
- Provide a spring flow recession.
- Provide higher spring flows in Schedule 1, 2 and 3 years (i.e., increased flows in late March and April).
- Repurpose certain Yuba Accord transfer flows from potential export to Delta outflow.
- Increase floodplain inundation.

Through extensive modeling studies, YWA developed its VSA Project flow proposal to be comparable to the results that would be achieved with CDFW's specific flow proposals:

- The YWA VSA Project proposal to release up to an additional 50,000 ac-ft of storage from New Bullards Bar Reservoir in the springtime addresses CDFW's objective for higher spring flows in Schedules 1, 2 and 3 years. These flows will result in average annual outflows and number of years of significantly increased outflow that will exceed what would have been achieved with the CDFW proposal.

- The YWA VSA Project proposal would increase salmonid rearing habitat, while the CDFW proposal would decrease such habitat. YWA's Flow Proposal would dovetail with YWA's Habitat Enhancement Measure proposal, resulting in greater duration of inundation of constructed rearing habitat.

- CDFW's spring flow recession was incorporated into YWA's AFLA submitted to FERC, and is now included in FERC's Final EIS for the new Federal Power Act license for the YRDP.

- The YWA VSA Project proposal would repurpose some springtime Yuba Accord transfer flows to Delta outflow, while not reducing the portions of these supplies that are critical to SWP and CVP contractors that rely on these supplies in dry conditions

In summary, YWA's VSA Flow Proposal would meet CDFW's objectives, but with significantly reduced impacts to water supply reliability and other aspects of YWA's mission.

1.1.2 The YWA VSA Flow Proposal Was Also Developed to Meet the SWRCB Staff Framework Delta Flow Objectives

The July 2018 SWRCB Staff Framework proposed a proposed numeric objective for maintenance of tributary outflows as percentages of unimpaired flows, with targets of 55%, and ranges of 45% to 65%. Previous SWRCB staff reports identified the January to June period as the focus of this flow, but the SWRCB Staff Framework proposed that this objective apply year-round flow.

YWA examined Yuba River outflow under existing conditions, and determined that: (1) Yuba River outflow in Wet years (Sacramento Valley Index basis) for the January to June period already equals or exceeds 55% of unimpaired flow for each month, most of the time. **Figure 1** shows the average monthly Yuba River outflow volumes for existing Wet Year conditions, compared to 45%, 55% and 65% of unimpaired flow.

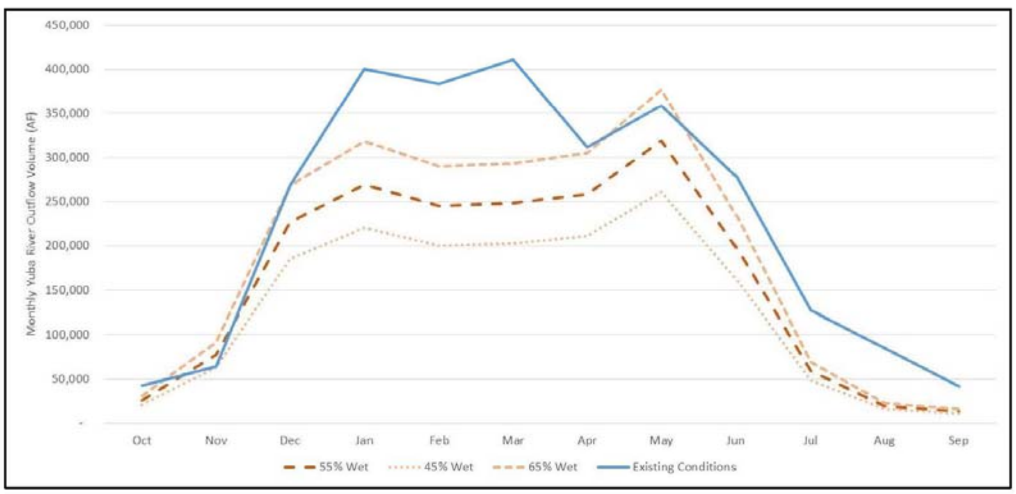


Figure 1. Modeled Yuba River outflow for the 1922 to 2016 period averaged for Wet years, compared to 45%, 55% and 65% unimpaired flow of the lower Yuba River.

YWA's examination of Yuba River outflows under existing conditions included an examination of flows during each month over the full range of hydrologic conditions. That examination showed that Yuba River outflows generally equaled or exceeded 55% of unimpaired outflows in all months except late March in some years, April, May, and sometimes June. Therefore, YWA focused its proposal on developing additional flows for the April through June period. **Figure 2** is a plot of monthly outflow volumes under existing conditions, averaged for Dry years under existing conditions compared with Dry year averages for 45%, 55% and 65% of unimpaired flow.

The YWA VSA Project flow proposal does not include a Critical Year flow component, because in Critical Years (when runoff is limited) YWA already releases large volumes of stored water from storage in New Bullards Bar Reservoir to meet the Yuba Accord flow requirements, which exceed natural flows and which were developed considering habitat stressors that occur during other times of the year (primarily summer and early fall water temperatures). Including a Critical Year flow component in the YWA VSA Project would significantly compromise YWA's ability to use stored water to meet Yuba Accord flow requirements.

In summary, the YWA VSA Project flow proposal would generally be consistent with the proposed numeric flow objectives in the July 2018 SWRCB Staff Framework, but with significantly reduced impacts to water supply reliability and other aspects of YWA's mission.

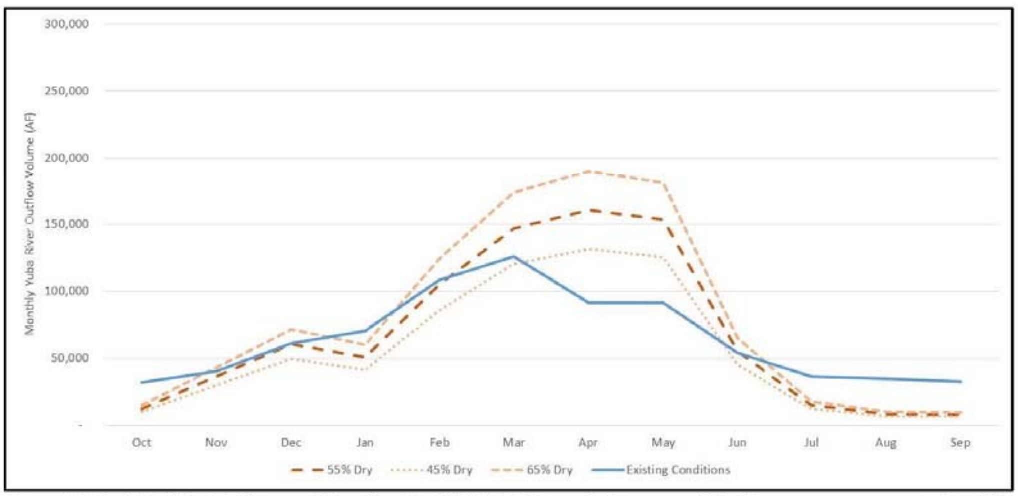


Figure 2. Modeled Yuba River outflow for the 1922 to 2016 period averaged for Dry years, compared to 45%, 55% and 65% unimpaired flow of the lower Yuba River.

1.1.3 Changes in YRDP Operations: Repurposing some Yuba Accord Transfer Flows from Potential Export to Bay-

Delta Outflow (YWA Project VSA Flow Proposal Component A Water)

The YWA-DWR WPA describes transfers to third parties. In amendment 5 of the WPA, third-party transfers of Yuba Accord water include Yuba Accord transfer releases that DWR cannot export from the Delta. Since 2014, YWA has been pursuing third-party transfers of springtime Yuba Accord water that DWR cannot back up into Oroville Reservoir for later transfer. In 2014 and subsequent years, YWA worked on long-term transfers to several third parties for some portions of this water, generally focusing on Yuba Accord water during times when the Delta is in excess conditions. This water is already covered as transfer water under the SWRCB Corrected Order WR 2008-0014, and for one of the potential third parties, EBMUD, the Freeport facility was added as an authorized point of diversion under YWA's water rights (YCWA Permit 15026) in 2014. Under the WPA, the SWRCB order and the Water Code, YWA may transfer Yuba Accord released transfer water that occurs in the springtime during excess conditions. Rather than continuing to transfer water or continuing to pursue long-term transfers of this water to third parties, YWA would forgo those transfers and instead use this water solely for Bay-Delta outflow under the YWA YSA Project. If the YWA VSA Project does not proceed or is not approved, YWA will continue to pursue these transfers to third parties.

VSA Component A is Released Transfer Water as defined in the **WPA Exhibit 1 – Scheduling and Accounting Principles**, and is further defined as water that occurs during April, May and June under excess Delta conditions and the other Bay-Delta conditions that DWR determines preclude DWR from exporting the water from the Delta for transfer under the WPA.

1.1.4 Changes in YRDP Operations: Reoperation of New Bullards Bar Reservoir for Release of Stored Water Dedicated to Delta Outflow (YWA VSA Project Flow Component B Water)

Transfer operations of the YRDP under the Yuba Accord are characterized into two categories: (a) operations that are required by the Yuba Accord instream flow requirements and that are above the flows that would occur under the baseline (without transfer) flows defined in the WPA, and (b) releases of water from storage in New Bullards Bar Reservoir that result in September 30 storage less than 705,000 ac-ft, and which are not releases of water to meet Yuba Accord instream flow requirements. The releases of water to meet the Yuba Accord target September 30 storage target always are scheduled to occur during July and August, when there is high confidence of balanced Delta conditions and accuracy in forecasted State Water Project operations. For YWA VSA Project storage releases, the planned primary months for releases would be April through June. There also may be some limited flexibility to release some of stored water during July and August, if such releases are recommended by CDFW and DWR, or if YRDP capacity or regulatory constraints limit releases during April through June.

Releases of water from storage in New Bullards Bar Reservoir for YWA VSA Project purposes would be scheduled to not interfere with current storage releases for the Yuba Accord operations to meet WPA commitments. Some flexibility in the shaping of YWA VSA Project releases would be available in some years, and YWA would coordinate with CDFW and DWR to set the release schedules. YWA would have the sole final authority to determine the release schedules. The springtime is very dynamic hydrologically and, in many years, it is difficult to predict runoff conditions, which create greater challenges for forecasted operations then during the summertime. Scheduling of, and accounting for, the volumes and timing of these releases would be based on the information available at the time of release planning, and might need to be adjusted through the springtime to address changing conditions. YWA would prepare forecasts of operations of the YRDP and resulting flows of VSA water. These forecasts would be compared to forecasts that are prepared for Yuba Accord operations (including baseline operations) to determine the amounts of the additional storage releases for YWA VSA Project purposes. Springtime Yuba Accord Released Transfer Water (as defined in the WPA accounting rules) also would be forecast (as required by the WPA), and would be accounted for as Component A water under the Yuba Accord accounting, with the added determination that the water would meet the criteria in the YWA VSA Project accounting provisions.

YWA would prepare preliminary operations plans for releases of water from New Bullards Bar Reservoir storage for YWA VSA Project water in coordination with DWR and CDFW as early as February, with the intent to have a planned operation developed in consultation with CDFW and DWR before April 1, which would be the earliest date on which a release of VSA water from New Bullards Bar Reservoir storage could occur. YWA would meet with CDFW and DWR to discuss and formulate the preliminary operations plan using information provided by the California-Nevada River Forecast Center and by DWR on Delta conditions and SWP and CVP forecasted operations. YWA might begin releases of water stored in New Bullards Bar Reservoir for YWA VSA Project purposes as early as April 1 based on this planning. YWA would revise the plan as new forecast information becomes available, and would finalize the plan in most years by May 15, with minor adjustments after that date as needed due to changing conditions. Due to the complexity of regulatory and operational criteria that apply to the YRDP, YWA would retain sole decision authority for final plans and scheduling water operations to implement YWA VSA Project water releases, although it is expected that DWR would need to approve any releases of VSA water that would be scheduled to occur after June 30.

VSA Component B is defined as Released Transfer Water in the WPA **Exhibit 1 – Scheduling and Accounting Principles** that would be made available through releases from New Bullards

Bar Reservoir to achieve September 30 storage below 650,000 ac-ft, and which would not be releases necessary for Yuba Accord instream flow requirements.

1.1.5 Accounting Principles for Determining YWA VSA Project Flow Measure Volumes

With the Yuba Accord operations under the WPA, YWA and DWR have more than ten years' experience accounting for long-term transfers that produce transfer flows throughout the year. The Yuba Accord WPA accounting principles (Exhibit 1 to the WPA) provide the basis for accounting for these contributions to Delta inflows.

For the YWA VSA Project, additional accounting principles would be developed, which would include a detailed accounting based on accounting principles agreed to by YWA and DWR that would tier off of the existing YWA-DWR Yuba Accord WPA accounting rules. The WPA accounting rules include a detailed description of the baseline for transfer flows. This description is the foundation for the Component A accounting. Because the existing condition includes the Yuba Accord flows that meet the definition of new water, and because this water is available for transfer under the WPA, the Water Code, and SWRCB Corrected Order WR 2008-0014, and because YWA would commit to allocate this water for Delta outflows and not for transfers during the term of the YWA VSA, the baseline for this water would be as defined in the Yuba Accord WPA.

Component B water would be accounted for as the amounts of actual flows that would be above the existing conditions under the Yuba Accord and which would be water that would be in addition to water for Yuba Accord releases. Generally, the baseline for YWA VSA Project releases would be existing conditions. For YWA VSA Project storage releases (Component B), the planned primary months for releases are April to June which would present a greater challenge for forecasting operations. Scheduling and accounting for the volumes and timing of these releases would be based on the information available at the time of the release planning and might need to be adjusted through the springtime to account for changing conditions. YWA would prepare forecasts of YRDP operations and resulting flows for YWA VSA Project water. These forecasts would be compared to the forecasts that would be prepared for Yuba Accord operations (including baseline operations) to determine the additional releases of water from New Bullards Bar storage that would be needed for YWA VSA Project purposes.

YWA is having discussions with DWR about these accounting principles, and the parties have not finalized the accounting rules. The following are principles that YWA has proposed:

1) WPA Accounting of transfer water for purchase by DWR would not change

2) Two sources of water would qualify as water provided under the YWA VSA Project as VSA Flow Measure Water: (a) YWA VSA Project Component A: April through June WPA Released Transfer Water that is not Delivered Transfer Water as those terms are defined in the WPA Accounting Exhibit; and (b) YWA VSA Project Component B: releases of water from storage in New Bullards Bar Reservoir that is not used to meet Accord instream flows and that results in storage levels on September 30 below 650,000 AF.

3) YWA VSA Project Component A would be Released Transfer Water, as defined in the WPA Exhibit 1 "Scheduling and Accounting Principles," and would be further defined as water that would occur during April, May and June under Delta Excess Conditions as determined by DWR.

4) YWA VSA Project Component B would be Released Transfer Water, as defined in the WPA Exhibit 1 "Scheduling and Accounting Principles," that would be made available through releases from storage in New Bullards Bar Reservoir to achieve September 30 storage below 650,000 AF, and which not be releases needed for Accord required instream flows.

5) For 2019 only, YWA VSA Project component A and B water that would be accounted for as being released during Delta excess conditions during April through June will be accounted as YWA VSA Project Flow Measure Water.

6) Flows from the Yuba River in April through June that would result from YRDP operations to the Yuba Accord, and that are accounted as negative values (negative flows in Accord accounting terms), would reduce the amounts of Accord flows credited to the YWA VSA Project (Component A), but would not reduce the amounts of water released from storage in New Bullards Bar Reservoir for YWA VSA Project purposes (Component B). Negative flows for Accord operations are already included in the Accord accounting provisions and the YWA VSA Project Component B releases would always be additive to releases under the "without VSA" condition. In other words, the YWA VSA Project Component B baseline flows would be the flows that would occur under the Yuba Accord and all other YRDP operations constraints.

7) Flow volumes to be credited for YWA VSA Project purposes would have to meet the WPA accounting rules for Released Transfer Water, as defined in Section 4 of Exhibit 1 of the WPA, except that the YWA VSA Project Component B storage release baseline would be the flows that would occur under the Yuba Accord without any releases of water from New Bullards Bar storage that would reduce storage below 650,000 AF (i.e. standard Yuba Accord releases).

8) YWA operations planning, forecasting and exchange of information would follow Section 11 of Exhibit 1 of the WPA with an added item that would be the forecasted flow at Marysville Gage with YWA VSA Project Component B releases (i.e. YWA would provide forecasts for Baseline Flow, Yuba Accord flows without any YWA VSA Project Component B flow and Accord flow with VSA Component B flow). Forecast updates would be provided each time a significant change in flows is anticipated due to changed conditions or updated forecast information that requires a change in planned flows.

9) The first 9,000 AF of water accounted as YWA VSA Project water would not be added to the volume of YWA VSA Project water to be accounted under the YWA VSA Project refill accounting rules (uncompensated water). If for any reason there would be any additional YWA VSA Project Flow Measure Water that would not be compensated, that additional water would not be included in the refill accounting volume.

10) If a volume of water would be accounted for refill in one refill accounting for impact (WPA or VSA) then that water would not be subject to any other refill accounting.

11) Accounting of YWA VSA Project Component A, the Released Transfer Water generated by Accord instream flows, and YWA VSA Project Component B water might occur simultaneously.

12) YWA VSA Project component water would be accounted at the Marysville Gage, as defined in the accounting of Release Transfer Water in the Accord WPA.

13) During the springtime, accounting of timing and volume of YWA VSA Project Component B releases would be based on actual flows which would determine the YWA VSA Project operation and the forecasted operations for the Accord and Baseline operations that would be in effect at the time of operation. Forecasted operations would use CNRFC ensemble based daily forecasts of runoff in the Yuba River watershed. YWA would describe the method for calculating a time series of runoff derived from the CNRFC ensembles.

14) Even with the proceeding method for scheduling and accounting for YWA VSA Project component releases, there might be times when changing conditions would require re-scheduling VSA Component B releases after the April to June period. Changes to the schedule resulting in releases of VSA water during July through September (and possibly October) would require prior agreement by DWR.

15) YWA would prepare the accounting for YWA VSA Project water and would submit the accounting to DWR for review and concurrence. Procedures for

accounting of YWA VSA Project Components A and B would generally follow those described in Section 6 of the WPA except where the accounting provisions listed here are in conflict with Section 6, these accounting principles would govern for YWA VSA Project water.

1.1.6 Modeling Analysis of the VSA Component Quantities

Exhibit 5 – Methodology for Evaluating the Benefits of the YWA VSA Project contains a proposed approach for evaluating the flow benefits of the YWA VSA Project as well as a comparison with alternative scenarios for levels of percentages of unimpaired flow, as outlined in the July 2018 SWRCB Staff Framework.

1.1.7 Early Implementation of YWA VSA Project Flow Measures

YWA is pursuing an early implementation pilot project in 2019 of the flow portion of the proposed YWA VSA Project. The pilot project would consist of YWA releasing up to 50,000 acre-ft of water from storage in New Bullards Bar Reservoir, as described in the YWA VSA Project, during April, May and June 2019. The intent of the flow proposal portion of the YWA VSA Project would be to release a volume of water that would result in an equivalent volume of Delta outflow. DWR and USBR would not be able to have regulatory approvals or environmental compliance in place for changed operations for this springtime pilot project and therefore could not ensure the YWA storage release would result in an equal amount of Delta outflow under the full range of Delta conditions. Because of these limitations, the 2019 pilot program would be only during excess Delta conditions. The YWA release of water from storage in New Bullards Bar Reservoir would be during excess conditions, the water would not be accounted as a transfer under the Accord Water Purchase Agreement, and the release would end up as Delta outflow.

YWA would ensure that the release of water from storage in New Bullards Bar Reservoir for the pilot project would not interfere with the Accord WPA. To demonstrate this, the plan of action would be for YWA to prepare a forecasted operation under three conditions: (1) a baseline condition, as described in the Accord WPA, (2) a planned operation under current conditions including current Yuba Accord flow requirements and operations to target September 30, 2019 New Bullards Bar Reservoir storage of 650,000 AF, and (3) a pilot project consisting of an additional release of up to 50,000 AF of water from storage in New Bullards Bar Reservoir during April through June by targeting September 30 New Bullards Bar Reservoir storage of 600,000 AF. If the Delta is in excess conditions on April 1, YWA would begin the additional release and would continue until the full amount of pilot project release was completed, but YWA would cease the additional releases when DWR notifies YWA that the Delta is no longer in excess conditions. YWA could begin the YWA VSA Project release after April 1 if the Delta was in balanced or restricted conditions on April 1, and subsequently transitioned to excess conditions later during the April to June period. As described in the YWA VSA Project Framework, water released as part of the Yuba Accord in the months of April through June and accounted as Released Transfer Water in the Accord WPA but not accounted as Delivered Transfer Water (i.e. water released from storage in New Bullards Bar Reservoir during excess conditions and not exported from the Delta or backed into storage in Lake Oroville) would also be accounted as a release for YWA VSA Project purposes, but this release would not change based on Delta conditions.

To implement the pilot project in 2019 the following actions must be completed:

- YWA must analyze the changes in operation and resulting flow and temperature changes in the lower Yuba River that would occur due to the pilot project implementation and make findings that: (a) lower Yuba River flows with the changes still would be within the normal ranges of flow and temperatures that occur under the Yuba Accord, and (b) that these changes in flow and temperatures would not have any significant negative impacts on fishery resources in the lower Yuba River.

- The YWA Board of Directors would make a finding that the pilot project would be a temporary one-year operation, would be within the range of effects analyzed under the Yuba Accord EIR, and would be within the normal operating range of the YRDP, and therefore is exempt from CEQA.

- YWA, DWR and CDFW would need to agree on a release plan for the pilot project VSA stored water releases. Due to the limitations described above, the flexibility of timing and release rates would be significantly more limited than for rates under a long term VSA after environmental compliance and all regulatory approvals.

- YWA would not seek any SWRCB approvals for the pilot project, because operations of the YRDP for this project would be authorized by the existing terms and conditions in YWA's water-right permits and within normal YRDP discretionary operations.

YUBA WATER AGENCY

VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

EXHIBIT 3

Habitat Enhancement Measures

The YWA YSA Project habitat enhancement measures are designed to improve juvenile Chinook salmon and steelhead rearing habitat in the lower Yuba River. The habitat enhancement measures are intended to produce larger juvenile anadromous salmonids in better condition with higher survivorship by providing: (1) physical habitat structure (i.e., complexity, sinuosity, diversity, instream object and over-hanging cover); (2) high food availability, quality and diversity; (3) refugia from predators; and (4) refugia from high flows.

The following subsections discuss: (1) the evaluation by the United States Army Corps of Engineers' (USACE) Yuba River Ecosystem Restoration Feasibility Study (YRERFS) of opportunities to improve juvenile Chinook salmon and steelhead rearing habitat in the lower Yuba River; (2) ongoing stressors and limiting factors for fisheries resources in the lower Yuba River; (3) habitat complexity and diversity considerations; and (4) the YWA VSA Project's proposed habitat enhancement measures.

1.1 Background

YWA has been involved in the development of habitat enhancement measures to improve fry and juvenile Chinook salmon and steelhead rearing habitat in the lower Yuba River since 2014.

The USACE Congressional authorization for the Reconnaissance Study that preceded USACE's Yuba River Ecosystem Restoration Feasibility Study was made through the Energy and Water Development Appropriations Act, 2014, Division D, P.L. 113-76. The initial evaluation completed by the USACE in September 2014 concluded that there would be significant National Ecosystem Restoration benefits associated with restoration of ecosystem structures, functions, and processes in the Yuba River. The USACE then asked YWA to be a non-federal sponsor, and a Feasibility Cost-Sharing Agreement between the USACE and YWA was signed in June 2015. The USACE released a Public Draft Interim Feasibility Report and Environmental Assessment for the Yuba River Ecosystem Restoration Feasibility Study ("FR/EA") in 2018. The USACE's

Tentatively Selected Plan includes floodplain lowering and grading, terraforming and riparian vegetation planting.

The USACE's assessment approach needed: (1) to provide an equitable evaluation that adequately distinguished between all habitat increments being considered; and (2) be based in the USACE's "SMART"[1] planning principles. The first consideration was satisfied by developing an assessment approach that produced a broadly-applicable output (i.e., habitat units) based on a multi-species/multi-habitat evaluation. This assessment approach provided an evaluation in terms of acre-based habitat units, which were calculated through the application of habitat suitability relationships of representative species (e.g., juvenile steelhead). Input data required for the juvenile steelhead habitat suitability index (HSI) included estimates of depth, velocity and cover. The Juvenile Steelhead HSI model proposed for the YRERFS was adopted from an HSI model developed by YWA for the YRDP (YWA 2013).

An integral part of the USACE's assessment approach included hydraulic modeling of increments to evaluate changes to key features of aquatic habitat (USACE 2018). The USACE developed a 2D hydraulic model based on an existing digital elevation model (DEM) developed by YWA in collaboration with the Yuba Accord River Management Team (RMT). Depth and velocity estimates were developed using the USACE's 2D hydraulic model, and the existing DEM was used to evaluate depth and velocity under "without YRDP" conditions. Depth and velocity for "with YRDP" conditions were evaluated by integrating a modified DEM reflecting physical habitat changes with various enhancement measures (e.g., creation of aquatic features including side channels, back waters, bank scalloping and floodplain lowering).

Since early 2019, the proposed Final FR/EA has been undergoing internal review by the USACE, and the USACE is nearing completion on the study. A "Chief's Report" is scheduled to be signed and submitted to Congress in December 2019. The project would then be eligible for consideration by Congress for a new authorization and appropriations. Some of the proposed habitat enhancement projects may be constructed with USACE and non-federal sponsor funding if the YRERFS is authorized by Congress, funds appropriated by Congress and the authorized study contains these projects. The earliest that a project could be authorized for appropriations and construction would likely occur in 2021 or later. The federal design and construction cost-share will be proportionally allocated as 65% federal and 35% non-federal. If the USACE projects go forward, this probably would not occur until after year 5, and the USACE would construct the project only if the 35% non-federal cost share is provided.

[1] "SMART" = specific, measurable, achievable, relevant, and time-bound.

1.1.1 Habitat Enhancement Sustainability and Resiliency Considerations

The Yuba River Watershed is a highly dynamic system, which has led to concerns regarding the sustainability and resiliency of potential habitat enhancement measures in the lower Yuba River.

Although the North Yuba River has greater flow peaks and more-pronounced spring runoff responses than the South Yuba and Middle Yuba rivers, hydrographs for all three major tributaries in the upper Yuba River Watershed indicate similar timing, duration and frequency of runoff. For return intervals of 2 to 10 years, the three sub-basins also have similar peak flow magnitudes on a per-acre drainage-area basis (Stillwater Sciences 2013). Flows from tributaries of the South, Middle and North Yuba rivers also influence flow conditions in the three major sub-basins. River habitat conditions in the North Yuba River downstream of New Bullards Bar Dam, the Middle Yuba River, the Yuba River, and the South Yuba River are defined in large part by flows released from the upstream dams. Stream flows in the upper Yuba River Watershed are characterized by low and constant summer flows (generally during mid-July through October), winter storm peaks, and spring snowmelt runoff.

Englebright Dam and Reservoir were constructed in 1941 to capture sediment produced by upstream hydraulic mining activities. The reservoir is located downstream of New Bullards Bar Dam, below the confluence of the Yuba River and the South Yuba River. The average annual inflow into Englebright Reservoir, excluding releases from New Bullards Bar Reservoir, is approximately 400,000 ac-ft. Englebright Reservoir has a total storage capacity of approximately 70,000 ac-ft. Englebright Reservoir does not have any dedicated flood storage space and only provides incidental flood control benefits. The USACE owns this facility.

Large floods on the lower Yuba River tend to be about 2,000 to 5,000 m^3/s (70,600 cfs to 177,000 cfs) (Pasternack and Wyrick 2016). The high flows that occurred during the winter of 2017 (peak flow of 80,938 cfs at the Marysville Gage on January 9, 2017) significantly altered the planform geometry in some areas, and changed the channel alignment and configuration throughout much of the lower Yuba River. A visual depiction of the Corps' proposed "Habitat Increment 1" site locations is shown in **Figure 1**. The Highway 20 Bridge is in the far left part of this figure.

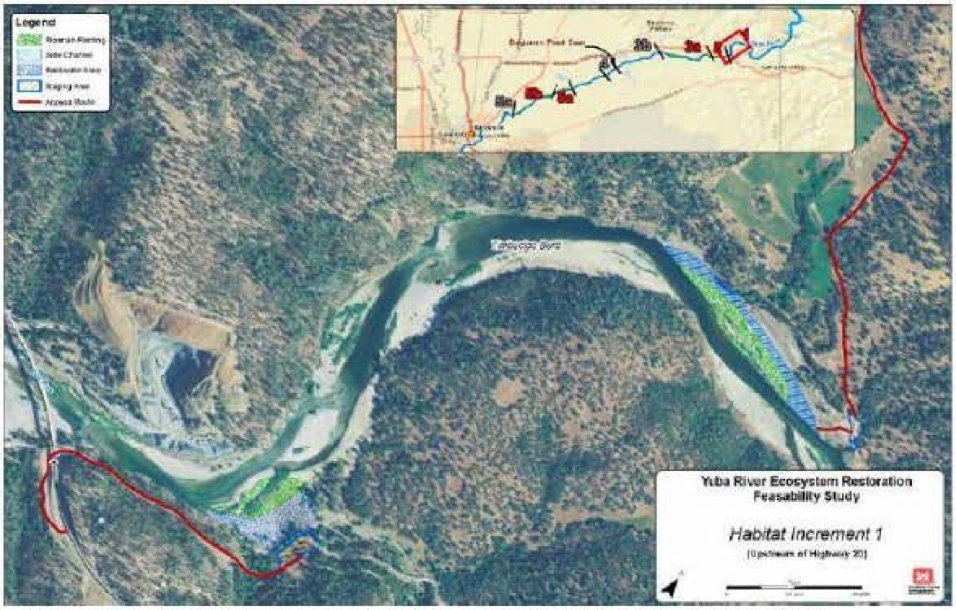


Figure 1. Habitat Increment 1 in the Corps' 2018 Draft Interim Feasibility Report and EA.

The left picture in **Figure 2** below shows the location of the westernmost component (just upstream of the Highway 20 Bridge) of "Habitat Increment 1" in April 2015, and the right picture in this figure shows the location identified for "Habitat Increment 1" in May 2017.

Figure 2. Lower Yuba River at and immediately upstream of the Highway 20 Bridge during April 2015 (left) and May 2017 (right). Mean daily flow at the Smartsville Gage was 697 cfs on April 14, 2015 (left) and 6,829 cfs on May 18, 2017 (right) (CDEC 2019).

As shown in the right picture in **Figure 2**, the high river flows that occurred during the winter of 2017 significantly altered the planform geometry (i.e., the "shape" of the lower Yuba River channel in this area). Consequently, if Habitat Increment 1 had been implemented before the winter of 2017, it would not have remained after the high flow conditions that occurred during that winter.

This example indicates that the USACE did not consider the lower Yuba River channel re-alignments and re-configurations that occurred during the winter of 2017 when the USACE developed and evaluated the habitat increments that are proposed in the Draft Interim FR/EA. A visual examination of remote sensing (see 2013 and 2017 Google Earth™ images in **Figure 3** below) of the lower Yuba River indicates that some of the habitat increment sites proposed in the Draft Interim FR/EA (Corps 2018) may no longer be suitable because of the considerable changes in river geomorphology that occurred during 2017.

As the non-federal sponsor for the USACE's YRERFS, YWA would need to periodically inspect the habitat enhancements to prevent encroachments or other damage caused by human activities, and to determine whether any repair, replacement or rehabilitation of project features would be needed. In consideration of the high flows that occurred during the winter of 2017, YWA has recognized that the sustainability of habitat enhancement measures would significantly affect the cost of operation, maintenance, repair, replacement and rehabilitation of enhancement measures. Therefore, in consideration of the dynamic nature of the lower Yuba River, and to evaluate the effects of the lower Yuba River channel re-alignments and re-configurations that occurred during 2017, YWA is collaborating with the University of California, Davis (U.C. Davis) to conduct a more-detailed analysis of sustainability, resiliency and persistence.

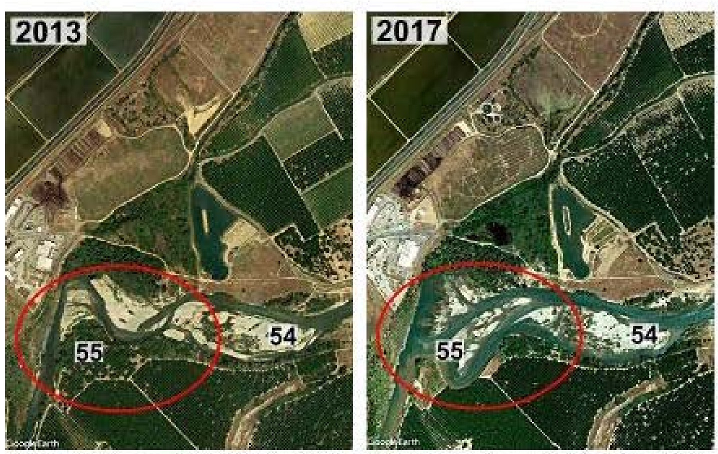


Figure 3. Comparison of lower Yuba River channel morphology near River Mile 4 during 2013 and 2017.

The habitat enhancement projects described in Section 1.3 and in **Attachment 1** (Yuba River Habitat Projects) are based upon the preliminary results of the geomorphic sustainability analysis that are available to date. These are preliminary projects that are going through additional screening for river geomorphology, land ownership and constructability, including access and greatest benefit per cost. Replacement projects will be developed if the listed projects are reduced in size or eliminated as a result of the study conclusions. The sustainability analysis and design development component of the study are anticipated to be completed during 2019.

1.2 Ongoing Stressors and Limiting Factors in the Lower Yuba River

The lower Yuba River anadromous salmonid populations are exposed and subject to a myriad of limiting factors, threats and stressors (YWA 2017). NMFS (2014) conducted a comprehensive assessment of stressors affecting both spring-run Chinook salmon and steelhead in the lower Yuba River, and lower Yuba River steelhead populations as members of these populations migrate downstream (as juveniles) and upstream (as adults) through the lower Feather River, the lower Sacramento River, and the Bay-Delta system. For the lower Yuba River populations of spring-run Chinook salmon and steelhead, the number of stressors in the categories of "Very High", "High", "Medium" and "Low" that occur in the lower Yuba River or occur out of basin are presented by lifestage in **Table 1**. Many of the most important stressors specific to spring-run Chinook salmon and steelhead in the lower Yuba River include limitations on fry and juvenile rearing physical habitat structure, loss of riparian habitat and instream cover (e.g., riparian vegetation, instream woody material), loss of natural river morphology and function[2], and loss of floodplain habitat[3] (YWA 2017).

---

[2] According to NMFS (2014), "Loss of Natural River Morphology and Function" is the result of river channelization and confinement, which leads to a decrease in riverine habitat complexity, and thus, a decrease in the quantity and quality of juvenile rearing habitat. Additionally, this primary stressor category includes the effect that dams have on the aquatic invertebrate species composition and distribution, which may have an effect on the quality and quantity of food resources available to juvenile salmonids (YWA 2017).

[3] NMFS (2014) listed the "Loss of Floodplain Habitat" in the lower Yuba River as one of the key stressors affecting anadromous salmonids (including spring-run Chinook salmon). NMFS (2009) stated …"*Historically, the Yuba River was connected to vast floodplains and included a complex network of channels, backwaters and woody material. The legacy of hydraulic and dredger mining is still evident on the lower Yuba River where, for much of the river, dredger piles confine the river to an unnaturally narrow channel. The consequences of this unusual and artificial geomorphic condition include reduced floodplain and riparian habitat and resultant limitations in fish habitat, particularly for rearing juvenile salmonids.*"

Table 1. The numbers of stressors in the categories of "Very High," "High," "Medium," and "Low" that occur in the lower Yuba River and out-of-basin, for the juvenile rearing and outmigration lifestages of lower Yuba River populations of spring-run Chinook salmon and steelhead.

Lifestage	Location	Stressor Categories			
		Very High	High	Medium	Low
Spring-run Chinook Salmon Juvenile Rearing and Outmigration	Lower Yuba River	5	1	1	5
	Out of Basin	12	16	6	9
Steelhead Juvenile Rearing and Outmigration	Lower Yuba River	5	1	1	5
	Out of Basin	12	16	6	9

Source: NMFS 2014

Although no recovery plan has been developed for the fall-run Chinook salmon because the ESU is not listed under the ESA, many of the key threats and stressors identified for spring-run Chinook salmon in the NMFS Recovery Plan (NMFS 2014) also are generally applicable to fall-run Chinook salmon in the lower Yuba River. In addition, Pacific Coast Chinook salmon juvenile rearing habitat concerns associated with Essential Fish Habitat (PFMC 1999) include the following.

- Diminished pool frequency, area, or depth
- Temperature/water quality problems
- Diminished prey/competition for prey
- Blockage of access to habitat (upstream or down)
- Loss of off-channel areas, wetlands
- Low water flows/high water flows
- Diminished nutrient availability
- Diminished channel complexity and cover
- Predation caused by habitat simplification or loss of cover

1.2.1 Physical Habitat Structure

Fry and juvenile salmonid rearing physical habitat structure pertains to habitat complexity and diversity. The concepts of habitat complexity and diversity pertinent to the lower Yuba River were described by CALFED and YWA (2005), as discussed below.

Habitat complexity and diversity refer to the quality of instream physical habitat including, but not necessarily limited to, the following physical habitat characteristics:

- Escape cover
- Feeding cover
- Allochthonous material contribution
- Alternating point-bar sequences
- Pool-to-riffle ratios

- Sinuosity
- Instream object cover
- Overhanging riparian vegetation

The physical structure of a river plays a significant role in determining the suitability of aquatic habitats for juvenile salmonids, as well as for other organisms upon which salmonids depend for food. These structural elements are created through complex interactions among natural geomorphic features, the power of flowing water, sediment delivery and movement, and riparian vegetation, which provides bank stability and inputs of large woody debris (Spence et al. 1996). The geomorphic conditions caused by hydraulic and dredge mining since the mid-1800s, and the construction of Englebright Dam, which affects the transport of nutrients, fine and coarse sediments and, to a lesser degree, woody material from upstream sources to the lower river, continue to limit habitat complexity and diversity in the lower Yuba River.

LWM creates both micro- and macro-habitat heterogeneity by forming pools, back eddies and side channels and by creating channel sinuosity and hydraulic complexity. This habitat complexity provides juvenile salmonids numerous refugia from predators and water velocity, and provides efficient locations from which to feed. LWM also functions to retain coarse sediments and organic matter in addition to providing substrate for numerous aquatic invertebrates (Spence et al. 1996).

In the lower Yuba River, mature riparian vegetation is scattered intermittently, leaving much of the banks devoid of LWM and unshaded – affecting components that are essential to the health and survival of the freshwater lifestages of salmonids (NMFS 2002). Although the ability of the lower Yuba River to support riparian vegetation has been substantially reduced by the historic impacts from mining activities, the dynamic nature of the river channel results in periodic creation of high-value shaded riverine aquatic (SRA) cover for fish and wildlife (Beak 1989).

Other important components of habitat structure at the micro-scale include large boulders, coarse substrate, undercut banks and overhanging vegetation. These habitat elements offer juvenile salmonids concealment from predators, shelter from fast current, feeding stations and nutrient inputs. At the macro-scale, streams and rivers with high channel sinuosity, multiple channels and sloughs, beaver impoundments or backwaters typically provide high-quality rearing and refugia habitats (Spence et al. 1996). The lower Yuba River can be generally characterized as lacking an abundance of such features. Consequently, available information indicates that fry and juvenile rearing physical habitat structure (complexity, sinuosity, diversity, instream object and over-hanging cover, nutrients) is an ongoing stressor and limiting factor for an anadromous salmonids in the lower Yuba River.

1.3 YWA's VSA Project – Habitat Enhancement Measures

Spring-run Chinook salmon in the Yuba River demonstrate mixed life histories regarding juvenile rearing and outmigration. "Ocean-type" spring-run Chinook salmon migrate shortly after emergence (as fry) while "stream-type" juveniles rear over the summer and migrate downstream the following year. YWA's habitat enhancement measures are designed to emulate the types of juvenile rearing habitats and fish feeding stations that would have been available to the stream-type life history that spring-run Chinook salmon and steelhead experienced in the upper watershed historically. Larger juvenile fish (i.e., summer holdover fish) emigrate downstream with the first freshets during the fall. Because larger fish have been shown to have greater survival rates during outmigration, the YWA VSA Project focuses on improving in-river habitat conditions to allow juvenile fish to remain in the river longer to rear and grow over the summer, and to outmigrate during the subsequent fall and winter as yearling+ smolts.

The primary objective of the YWA VSA Project is to improve the complexity and diversity of anadromous salmonid juvenile rearing habitat in the lower Yuba River by implementing various habitat enhancement measures. The biological objectives associated with the YWA VSA Project's habitat enhancement measures are to increase the growth and survivability of juvenile anadromous salmonids in the lower Yuba River. As discussed above, the provision of habitat enhancement measures is intended to produce larger juvenile anadromous salmonids in better condition with higher survivorship by providing: (1) physical habitat structure (i.e., complexity, sinuosity, diversity, instream object and over-hanging cover); (2) high food availability, quality and diversity; (3) refugia from predators; and (4) refugia from high flows. The habitat enhancement measures that include constructed off-channel and backwater areas will provide conditions favorable for growth (e.g., lower water velocity, moderated water temperature, overhanging vegetation for increased escape cover from piscivorous and avian predators, and enhanced food availability) and slow-water refuge for juvenile anadromous salmonids.

1.3.1 Design Approach

The ecological function and corresponding value of riverine and adjacent habitat types vary depending on seasonal fluctuations in flow. The YWA VSA Project approach is intended to improve juvenile rearing habitat, designed to be functional over a range of flows resulting from continued implementation of the Yuba Accord flow schedules. The Yuba Accord-based fisheries flows (as augmented by the recently issued FERC FEIS for the Yuba River Development Project relicensing) are "functional flows", which are defined as "*…a mechanistic approach for estimating flow needs and trade-offs. Flows needed are based on field observations of lifestages and computer and conceptual models of hydrodynamics, habitat, and ecological conditions for different flows. Environmental flows are then chosen to support different ecological functions* *and lifestages of selected species*". This approach was exactly the process that was undertaken to develop the Yuba Accord flow schedules.

The YWA VSA Project habitat enhancement measures are designed to be functional during the spring (i.e., February 1 through June 15). Because floodplain areas typically are not inundated during the important June through September over-summer rearing period for spring-run Chinook salmon and steelhead, in-channel habitat enhancements would provide greater opportunity for juvenile fish throughout the summer. Therefore, the YWA VSA Project's proposed approach focuses on improving physical habitat structure in areas of the lower Yuba River that are inundated within the bankfull flows (i.e., up to 5,000 cfs). The YWA VSA Project's proposed approach for improving in-channel physical habitat structure is designed to be functional at typical summer flow levels, as well as at February 1 through June 15 flow targets. This is in addition to the present floodplain inundation recurrence intervals that occur under current conditions.

In general, new habitat enhancement areas would be designed to be inundated at river flows between 1,500 cfs and 3,000 cfs. A majority of the habitat enhancement lowering is designed to create areas that will be inundated at river flows below 2,000 cfs. Specifically, 60% of the habitat enhancement areas created by the YWA VSA Project would be inundated at river flows less than 2,000 cfs, and the 40% would be inundated at river flows between 2,000 and 3,000 cfs. New backwater areas would be designed to have a desired duration inundation elevation and an inundation recurrence interval (e.g., 2,000 cfs, 3,000 cfs) that is agreed upon by both YWA and CDFW.

1.3.2 Floodplain vs. Bank Ecotone

In the lower Yuba River, the floodplain is identified as the area within the floodway that is inundated at river flows greater than 5,000 cfs. The floodway is the area between the upland slopes, levees, training walls and valley floor that is inundated at a river flow of 21,100 cfs (Wyrick and Pasternak 2012). Floodplain areas (i.e., areas along the lower Yuba River that are inundated at river flows between 5,000 cfs and 21,000 cfs) along the lower Yuba River generally do not provide high quality juvenile rearing habitat for anadromous salmonids due to the extensive amount of hydraulic mining debris. Inundating these areas would not provide biologically meaningful benefits to riparian vegetation or juvenile rearing habitat.

Bank ecotone is defined as the transitional area from the top of the base flow channel to the lower edge of the floodplain[4]. The bank ecotone zone in the lower Yuba River generally is the area that is inundated at river flows between base flows (880 cfs upstream of Daguerre Point Dam, and 530 cfs below Daguerre Point Dam) and bankfull flows (5,000 cfs). In the lower Yuba River, flows that inundate the bank ecotone zone are mostly within the controllable ranges of YRDP operations. Consequently, YWA's habitat enhancement measures are designed to improve aquatic habitat conditions within the bank ecotone of the lower Yuba River. Terraforming and terrain lowering would be used to improve existing areas of the bank ecotone and to create new bank ecotone areas by lowering high elevation terraces and floodplain areas so that these terraces and areas could start being inundated at river flows of 5,000 cfs or less.

With respect to the ongoing interests in enhancing juvenile salmonid rearing habitat on the lower Yuba River, consideration has been given to habitat that is either along the periphery of the channel per the research of Beechie et al. (2013)[5] or outside the channel per the research of Sommers et al. (2001, 2005).[6] The term "floodplain habitat" is often referred to in this context, but it is unclear if the ecological functions that are envisioned actually occur on the floodplain or within the bankfull channel (Pasternack 2017), and this is not just semantics, as channels and floodplains exhibit widely different geomorphological, hydrological, temperature, biochemical, and ecological regimes (Brown 1997). This concern has a nexus with the functionality of riparian vegetation, which is highly sensitive to inundation zones and undergoes significant changes through the riverbank ecotone (Pasternack 2017). It would be erroneous to simply assume that any inundated floodplain or ecotone constitutes salmonid juvenile rearing habitat. When considering the requirements for high quality juvenile rearing habitat, other physical habitat characteristics, such as substrate, velocity, depth, cover, food sources and water temperatures, also must be considered. Consequently, the concepts like increasing riparian vegetation and providing conditions favorable for growth (e.g., lower water velocity, moderated water temperature, and enhanced food availability) and slow-water refuge for juvenile anadromous salmonids are applicable to the bank ecotone (e.g., in-channel and off-channel areas that are inundated at river flows less than 5,000 cfs) of the lower Yuba River.

---

[4] Burman, S. G. and G. B. Pasternack. 2017. Riparian Canopy Abundance, Distribution and Height on the Lower Yuba River in 2008. Prepared for the Yuba Accord River Management Team. University of California, Davis, CA, *available at* www.yubaaccordrmt.com/Studies%20%20Reports/Riparian/UCDR36_LYR_UCDriparianreport_20170423.pdf.

[5] Beechie et al. (2013) reported that juvenile salmonids were present in different densities in different zones using a simple inundation zone classification (e.g., midchannel, edge, backwater, bank, and bar). They also reported that different species and age cohorts exhibit different timing and abundance among the inundation zones.

[6] Extensive research in California has been conducted that shows rearing juvenile salmonids exhibit significantly different growth rates in different inundation zones, especially when comparing the channel zone to the seasonally inundated floodplain zone (Sommer et al. 2001, 2005; Feyrer et al. 2006).

1.3.3 Preliminary Identification of Lower Yuba River Habitat Enhancement Measures

The YWA VSA Project would enhance 100 acres of habitat along the lower Yuba River, subject to the availability of and access to appropriate land, legal constraints and other external factors. To improve both habitat complexity and diversity in the lower Yuba River, the YWA VSA Project has proposed measures to enhance habitats within the bank ecotone (see **Table 2** and **Attachment 1**).

Table 2. YWA preliminarily identified lower Yuba River habitat enhancement measures.

Site Name	RM	Acres	Enhancement Features
Barton's Bar	20.0	2	Create a new side channel by terraforming, and add riparian plantings stabilized with bioengineering features (e.g., boulders, ELJs, LWM) to improve channel complexity and habitat diversity.
Big Ravine	18.2	4	Create a permanent off-channel backwater area by terraforming/lowering. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.
Upper Gilt Edge Bar	17.6	5	Use terraforming/lowering to increase side channel inundation frequency and duration, enhance stability of existing side channel inlet to protect against high flows, and add riparian plantings stabilized with bioengineering features.
First Island	15.8	14	Preserve two high value areas that provide very good spawning and rearing habitat by stabilizing the existing channel configuration to protect against high flow channel modifications.
Long Bar Pond	15.6	11	Use terraforming/lowering to re-connect areas of suitable off-channel rearing habitat (pond) with the lower Yuba River, and lower areas of high terrace to create additional shallow, slow velocity off-channel rearing habitat. Add riparian plantings stabilized with bioengineering features to improve channel complexity and diversity.
Bar B Pond	12.9	4	Use terraforming/lowering to improve the inlet connection between suitable off-channel rearing habitat and the lower Yuba River, and lower areas to create additional shallow, slow-velocity rearing habitat. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.
BVID Diversion	12.0	8	Add riparian plantings stabilized with bioengineering features to improve habitat productivity, complexity and diversity.
Pond Upstream of Daguerre Point Dam	11.8	3	Use terraforming to stabilize the inlet connections between off-channel slackwater areas and the lower Yuba River to create more permanent shallow, slow-velocity rearing habitat. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.
YWA Diversion	11.6	1	Add riparian plantings stabilized with bioengineering features to improve habitat productivity, complexity and diversity.
Island Stabilization Upstream of Daguerre Point Dam	11.6	2	Use terraforming to create anabranching channels to provide shallow, slow-water juvenile rearing habitat. Add riparian plantings stabilized with bioengineering features to improve channel complexity and diversity.
Walnut Pond	6.2	5	Use terraforming/lowering to create a permanent off-channel backwater habitat with suitable water depths and flow velocities for juvenile Chinook salmon and steelhead rearing. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.

Recology Pond	4.1	31	Use terraforming/lowering to create: (1) a permanent off-channel backwater habitat with suitable water depths and flow velocities for juvenile Chinook salmon and steelhead rearing; and (2) a side channel from the lower Yuba River to the newly constructed floodplain area. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.
Pilot Studies (e.g., Waterway 13, flooded agricultural fields to increase fish growth)	TBD	10	Study potential design options to permanently eliminate an existing stranding/isolation hazard at Waterway 13; test use of flooded farm fields to produce larger anadromous salmonids
Total	**13**	**100**	

Under the YWA VSA Project, YWA, on behalf of YWA and its Member Units, would contribute $10 million for habitat enhancement measures during the term of the YWA VSA Project. The habitat enhancement measures would be implemented on behalf of YWA and YWA Member Units, and not on behalf other water users or water diverters in the Yuba River Watershed or elsewhere in the Delta watershed. YWA would work with CDFW and DWR to develop a schedule for funding and habitat enhancement measures. The YWA VSA would include provisions regarding the process for, and respective obligations of, the parties to select, fund, develop, operate, maintain and repair habitat enhancement measures, without requiring an amendment to the YWA VSA.

YWA has conducted analyses that have demonstrated that, by far the greatest amount of salmonid juvenile rearing habitat occurs within the main channel and the bank ecotone and is inundated at river flows equal to or less than bankfull flows (that is, at flows equal to or less than 5,000 cfs). Many of the habitat enhancement measures would be located within the riverbank ecotone region, which includes perennially inundated swamps and ponds as well as seasonally inundated swales, secondary channels and alluvial bars. Other measures would involve lowering parts of the bank ecotone to create off-channel and backwater areas. Lowering these areas would increase inundation frequency and duration, support the establishment of riparian vegetation and increased production of benthic macroinvertebrates, and increase the availability of off-channel rearing habitat. Lower Yuba River in-channel habitat enhancement measures generally would involve: (1) riparian planting; (2) incorporation of bioengineering features (e.g., boulders, LWM, engineered log jams [ELJs]) to increase site stability and reinforce planting areas; and (3) grading or lowering the channel to facilitate planting and survival of vegetation in shallow water habitat to support juvenile salmonid growth and survival by providing diverse physical habitat conditions.

The YWA VSA Project envisions pilot studies to: (1) investigate the potential for enhancing Waterway 13[7]; and (2) to test the potential for using flooded agricultural fields to improve aquatic food web productivity and enhance fish growth to produce larger juvenile anadromous salmonids.

Refinements to Improve Sustainability and Resiliency

The YWA VSA Project's proposed habitat enhancement measures are undergoing additional hydrologic and hydraulic evaluations regarding site-specific persistence and sustainability (see discussion above in Section 1.1.2.3, Development of Lower Yuba River Habitat Enhancement Measures). These evaluations are comprised of qualitative and quantitative analyses of the enhancement measures based on satellite images from 2017, geomorphic change rates between 2008, 2014 and 2017, and 2D hydrodynamic modelling.

As the practice of fisheries habitat enhancement has expanded from an individual action at a single site to sequences of actions at many sites in the lower Yuba River, a primary question has arisen regarding the lifespan of such a sequence. YWA and U.C. Davis have developed a framework to identify relevant parameters, design criteria and survival thresholds for ten multidisciplinary habitat restoration techniques that are adequate for site-scale to segment-scale application, in a comprehensive review: (1) bar and floodplain grading; (2) berm setback; (3) vegetation plantings; (4) riprap placement; (5) sediment replenishment; (6) side cavities; (7) side channels and anabranches; (8) streambed reshaping; (9) structure removal; and (10) placement of wood in the shape of ELJs and rootwads. Survival thresholds were applied to a sequence of proposed habitat enhancement features for the lower Yuba River. Spatially explicit hydraulic and sediment data, together with numerical model predictions of the measures, were vetted against the survival thresholds to produce discharge-dependent lifespan maps (**Figure 4**).

---

[7] Due to the high permeability of the Yuba Goldfields, water from the Yuba River freely migrates into and through the Goldfields, forming interconnected ponds and canals throughout the undulating terrain (DWR 1999). Waterway 13 is an outlet canal of unknown origin that drains water from the Yuba Goldfields into the lower Yuba River. Past observations by USFWS and CDFW have indicated that the potential exists for adult Chinook salmon to be attracted into Waterway 13 and migrate into the interconnected ponds and canals of the Yuba Goldfields to spawn. Fish habitat within the ponds and canals is not conducive to anadromous fish survival because food supply is limited, predator habitat is extensive and water quality conditions (especially water temperature), are poor (DWR 1999). Waterway 13 would be expected to receive flow augmentation from Yuba Goldfields return flow, and potentially could be enhanced to create a side-channel within an existing stand of riparian vegetation that would extend from the main channel into a current off-channel backwater area.

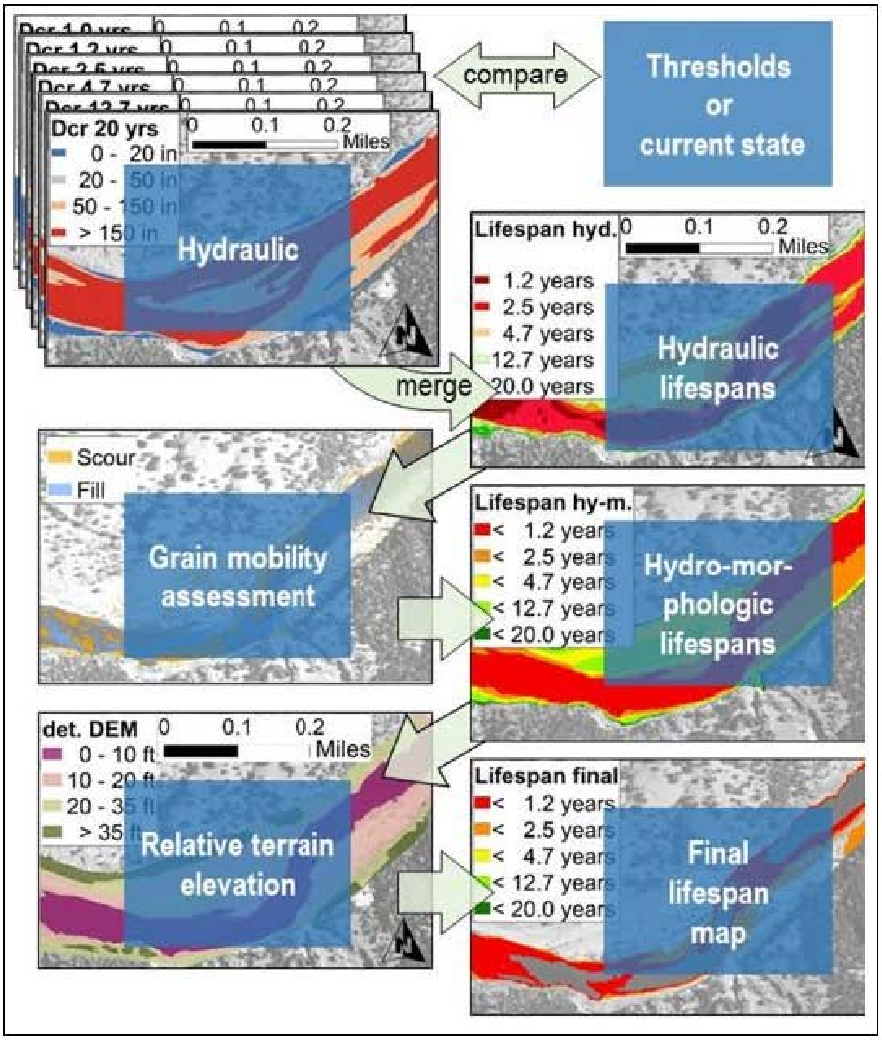


Figure 4. Flowchart of the lifespan map development process, beginning with the comparison of hydraulic threshold values and discharge-dependent hydraulic rasters, followed by the grain mobility (morphological stability) and relative terrain elevation assessments (Schwindt et al. in progress).

Estimates of river flows for specific flood-return periods enabled probabilistic estimates of the longevity of particular design features. The lifespan maps indicate the temporal stability of particular stream restoration and habitat enhancement features and techniques. Areas with particularly low or high lifespans are being used to optimize the design and positioning of habitat enhancement measures in the lower Yuba River. An example of a lifespan map is provided below in **Figure 5**.

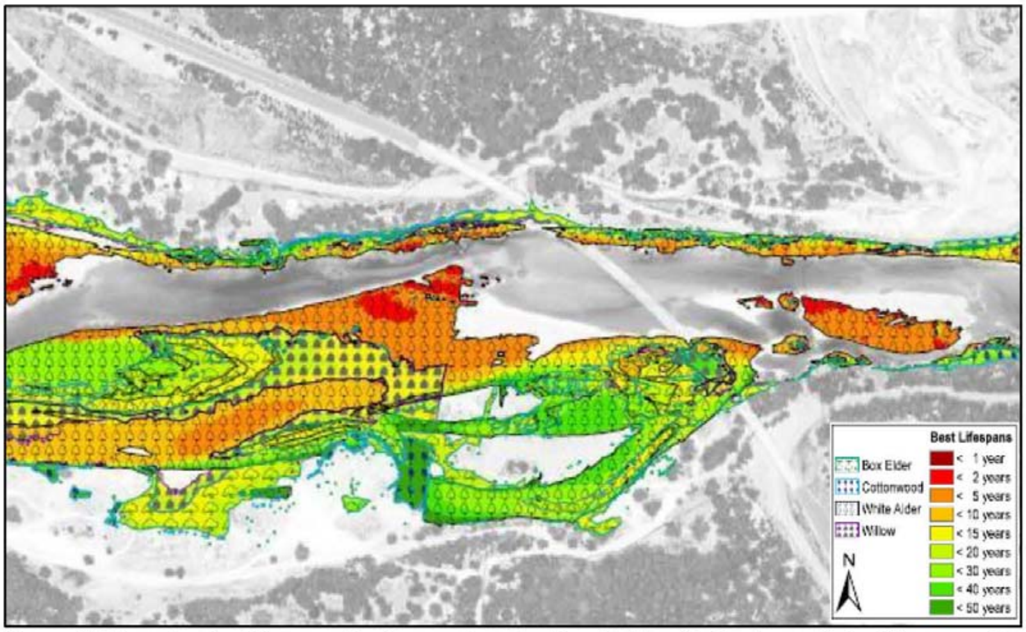


Figure 5. Example of a lifespan estimate map for riparian plantings in the lower Yuba River near the Highway 20 Bridge.

A complete description of the methodology and scientific basis for this approach is presented in the recently published paper titled "*Hydro-Morphological Parameters Generate Lifespan Maps for Stream Restoration Management*" by Schwindt et al. (2019)[8].

Preliminary results of the ongoing sustainability analysis have identified several priority sites for habitat enhancement actions in the lower Yuba River, including 10 sites upstream of Daguerre Point Dam (in close proximity to where the majority of Chinook salmon and steelhead spawning occurs in the lower Yuba River) and 2 sites downstream of Daguerre Point Dam. Next steps in the refinement process include the following.

- Finalizing the delineation process for selecting priority enhancement sites.

[8] S. Schwindt, G.B. Pasternack, P.M. Bratovich, G. Rabone, D. Simodynes. 2019. Hydro-Morphological Parameters Generate Lifespan Maps for Stream Restoration Management. Journal of Environmental Management, Volume 232, February 15, 2019, pp. 475-489. https://doi.org/10.1016/j.jenvman.2018.11.010

- Apply terraforming (if applicable to specific measures) based on assessments described above, including the lifespan maps.
- Automate terrain modification and "toolbox feature" placement (i.e., plantings, LWM, boulders, etc.) with Python code.
- Verify terraforming stability and effects on flow patterns (requires 2D modeling).
- Apply vegetation plantings and integrate bioengineering features, where necessary, to stabilize plantings.
- Add toolbox features (e.g., LWM, ELJs and angular boulders) to create cover habitat.

- Re-computing estimated construction costs.
- Evaluate design "benefits" of newly proposed technical features and habitat enhancement measures for spring-run Chinook salmon and steelhead, by lifestage.
    - Evaluate net gain in weighted usable habitat area (WUA) for fry and juvenile spring-run Chinook salmon and steelhead.
- Prioritize habitat enhancement measures based upon cost/benefit ratios.

The above approach is ongoing, and expected to provide the full suite of project design information for habitat enhancement (e.g., terrain lowering, plantings, boulders, ELJs, etc.) in the lower Yuba River, because it will incorporate a state-of-the-art geomorphic stability analyses with the best available information regarding lower Yuba River ecological functionality and projected costs.

The YWA VSA Project would enhance 100 acres of habitat along the lower Yuba River. Adjustments to the proposed total acreage of habitat enhancement measures would be dependent upon the availability of and access to appropriate land, legal constraints and other external factors. The habitat enhancement measures described above are not yet at the stage of final project designs. Although work is in progress, the habitat enhancement measures have not yet undergone requisite evaluations including, but not limited to, hydrologic sustainability analyses, land ownership and purchase or lease potential, site access, mineral rights, hazardous materials remediation, state lands commission lease requirements, future liability, and replacement requirements. The need for negotiations for access involving willing landowners, which took nearly a decade for one Anadromous Fish Restoration Program (AFRP) project on the lower Yuba River, will need to be carefully considered before conclusions are made about cost efficiency, ability to address real estate issues, or timeliness of implementation for habitat enhancement initiatives.

YUBA WATER AGENCY
VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

Attachment 1

Yuba River Habitat Projects

Project[1]	Identified In...	Description	Targeted Habitat (acres)	Benefits	Years	Timeline without VSA	Life Stage	Possible Funding Source(s)	Implementation Lead	Contingency	Planning/CEQA Status	Construction/Action Started?	Regulatory Requirement?
Barton's Bar	New	Create a new side channel by terraforming, and add riparian plantings stabilized with bioengineering features (e.g., boulders, engineered log jams [ELJs] and large woody material [LWM]) to improve channel complexity and habitat diversity.	2	Increase juvenile rearing habitat availability, increase channel complexity and habitat diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increasing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Big Ravine	New	Create a permanent off-channel backwater area by terraforming/lowering. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.	4	Increase juvenile rearing habitat availability, increase habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increasing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Upper Gilt Edge Bar	New	Use terraforming/lowering to increase side channel inundation frequency and duration, enhance stability of existing side channel inlet to protect against high flows, and add riparian plantings stabilized with bioengineering features.	5	Increase juvenile rearing habitat availability, improve habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increasing riparian habitat	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Long Bar Pond	New	Use terraforming/lowering to re-connect areas of suitable off-channel rearing habitat (pond) with the lower Yuba River, and lower areas of high terrace to create additional shallow, slow velocity off-channel rearing habitat. Add riparian plantings stabilized with bioengineering features to improve channel complexity and diversity	11	Increase juvenile rearing habitat availability, increase habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increasing riparian habitat	10-15 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Bar B Pond	New	Use terraforming/lowering to improve the inlet connection between suitable off-channel rearing habitat and the lower Yuba River, and lower areas to create additional shallow, slow-velocity rearing habitat. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity	4	Increase juvenile rearing habitat availability, improve habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increasing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
BVID Diversion	New	Add riparian plantings stabilized with bioengineering features to improve habitat productivity, complexity and diversity.	8	Increase juvenile rearing habitat availability, enhance productivity by increasing riparian habitat, and provide instream object cover and overhanging escape cover.	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Pond Upstream of Daguerre Point Dam	New	Use terraforming to stabilize the inlet connections between off-channel slackwater areas and the lower Yuba River to create more permanent shallow, slow-velocity rearing habitat. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.	3	Increase juvenile rearing habitat availability, improve habitat complexity and diversity, provide instream object cover and overhanging escape cover; enhance productivity by increasing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
YWA Diversion	New	Add riparian plantings stabilized with bioengineering features to improve habitat productivity, complexity and diversity.	1	Increase juvenile rearing habitat availability, enhance productivity by increasing riparian habitat, and provide instream object cover and overhanging escape cover.	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Walnut Pond	New	Use terraforming/lowering to create a permanent off-channel backwater habitat with suitable water depths and flow velocities for juvenile Chinook salmon and steelhead rearing. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.	5	Increase juvenile rearing habitat availability, improve habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increasing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Recology Pond	New	Use terraforming/lowering to create: (1) a permanent off-channel backwater habitat with suitable water depths and flow velocities for juvenile Chinook salmon and steelhead rearing; and (2) a side channel from the lower Yuba River to the newly constructed floodplain area. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.	31	Increase juvenile rearing habitat availability, increase habitat complexity and diversity, provide instream object cover and overhanging escape cover; enhance productivity by increasing riparian habitat	10-15 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Island Stabilization Upstream of Daguerre Point Dam	New	Use terraforming to create anabranching channels to provide shallow, slow-water juvenile rearing habitat. Add riparian plantings stabilized with bioengineering features to improve channel complexity and diversity.	2	Increase juvenile rearing habitat availability, increase habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increasing riparian habitat	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
First Island	New	Preserve two high value areas that provide very good spawning and rearing habitat by stabilizing the existing channel configuration to protect against high flow channel modifications.	14	Protection of spawning and rearing habitat from high flow modifications	0-5 years	Unknown	R, S	YWA, bond, science fund[2]	YCWA	None	None	No	No
Pilot Studies (e.g., Waterway 13, flooded farm fields to increase fish growth)	New	Study potential design options to permanently eliminate an existing stranding/isolation hazard at Waterway 13; test use of flooded farm fields to produce larger anadromous salmonids	10	Protection of fish species from stranding, improvement of juvenile rearing habitat and food production	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No

Notes

[1] These are preliminary projects that are going through additional screening for river geomorphology, land ownership, constructability including access and greatest benefit cost. Replacement projects will be identified if the listed projects are reduced in size or eliminated.

[2] Some of these projects may be constructed by USACE funding if the Yuba River Ecosystem Study is authorized by Congress, funds appropriated by Congress and the authorized study contains these projects. If the USACE projects go forward it would not likely be until after year 5 and the USACE would construct the project with a 35% local cost share.

YUBA WATER AGENCY
VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

EXHIBIT 4

Fisheries Background

1.1 Fisheries Resources in the Lower Yuba River

Provided below is an overview of the fisheries resources in the lower Yuba River that the YWA VSA Project habitat enhancement measures have been designed to benefit, based upon known stressors and limiting factors. Because limitations on fry and juvenile rearing physical habitat structure are ongoing stressors and limiting factors for an anadromous salmonids in the lower Yuba River, the life history information provided in this section focuses on the fry and juvenile rearing lifestages. The spawning lifestage is discussed briefly to provide context regarding where the majority of anadromous salmonid spawning occurs in the lower Yuba River, and its proximity to rearing habitat locations. However, because spawning is not considered to be a limiting factor for anadromous salmonids in the lower Yuba River (see Section 1.2.1), spawning enhancement measures are not being proposed under YWA's VSA Project.

Both spring-run and fall-run Chinook salmon occur in the lower Yuba River. CDFW does not distinguish between the two runs as part of its reporting and compilation process to estimate the annual population of Chinook salmon in the lower Yuba River. CDFW treats both spring-run and fall-run Chinook salmon as fall-run Chinook salmon for reporting annual escapement on the lower Yuba River. Therefore, the YWA VSA Project is designed to benefit both runs of Chinook salmon, and considers them together when considering doubling goals.

1.1.1 Spring-run Chinook Salmon

In 2013, the Yuba River Accord Fisheries Agreement River Management Team (RMT) developed representative temporal distributions for specific spring-run Chinook salmon lifestages in the lower Yuba River through review of previously conducted studies and recent and currently ongoing data collection activities of the M&E Program (e.g., VAKI Riverwatcher monitoring, carcass surveys, redd surveys, rotary screw trapping, etc.). The resultant lifestage periodicities encompass the majority of activity for a particular lifestage, and are not intended to be inclusive of every individual in the population (RMT 2010; RMT 2013). These periodicities represent the RMT's synthesis of the best available data regarding utilization of the lower Yuba River by phenotypic spring-run Chinook salmon. The lifestage-specific periodicities for lower Yuba River spring-run Chinook salmon are summarized in **Table 1**.

Table 1. Lifestage-specific periodicities for spring-run Chinook salmon in the lower Yuba River.

Lifestage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
SPRING-RUN CHINOOK SALMON																								
Adult Immigration & Holding							■	■	■	■	■	■	■	■	■	■	■	■						
Spawning																	■	■	■					
Embryo Incubation																	■	■	■	■	■	■	■	■
Fry Rearing	■	■	■																			■	■	■
Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Juvenile Downstream Movement	■	■	■	■	■	■	■	■	■	■	■	■										■	■	■
Smolt (Yearling+) Emigration	■	■	■	■	■	■	■	■	■										■	■	■	■	■	■

Source: RMT 2013.

Spring-run Chinook Salmon Spawning

The earliest spawning (presumed to be by spring-run Chinook salmon) generally occurs in the upper reaches of the highest quality spawning habitat in the lower Yuba River (i.e., below the Narrows pool). Chinook salmon spawning progressively moves downstream throughout the Chinook salmon spawning season (NMFS 2007). Almost all spring-run Chinook salmon spawning in the lower Yuba River is believed to occur upstream of Daguerre Point Dam (RMT 2013). During the pilot redd survey conducted from the fall of 2008 through spring of 2009, the RMT (2010c) reported that the vast majority (96%) of fresh Chinook salmon redds constructed by the first week of October 2008, potentially representing spring-run Chinook salmon, were observed upstream of Daguerre Point Dam. Similar distributions were observed during the 2010 and 2011 redd surveys, when weekly redd surveys were conducted. About 97% and 96% of the fresh Chinook salmon redds constructed by the first week of October were observed upstream of Daguerre Point Dam during 2009 and 2010, respectively (RMT 2013).

Spring-run Chinook Salmon Fry and Juvenile Rearing

Upon emergence from the gravel, juvenile spring-run Chinook salmon may reside in freshwater for 12 to 16 months, but some migrate to the ocean as YOY fish in the winter or spring months within 8 months of hatching (CALFED 2000a). The average size of fry migrants (approximately 40 millimeters (mm) between December and April in Mill, Butte and Deer creeks) reflects a prolonged emergence of fry from the gravel (Lindley et al. 2004).

During juvenile rearing and outmigration, salmonids prefer stream margin habitats with sufficient depths and velocities to provide suitable cover and foraging opportunities. Juvenile Chinook salmon reportedly utilize river channel depths ranging from 0.9 feet (ft) to 2.0 ft, and most frequently are in water with velocities ranging from 0 feet per second (ft/s) to 1.3 ft/s (Raleigh et al. 1986). For the spring-run Chinook salmon juvenile rearing and downstream movement lifestage, RMT (2013) identified 61°F as the upper optimum water temperature index (WTI) value and 65°F as the upper tolerable WTI value.

In general, juvenile Chinook salmon have been collected by electrofishing and observed by snorkeling throughout the lower Yuba River, but with higher abundances above Daguerre Point Dam (Beak 1989; CDFG 1991; Kozlowski 2004). This may be due to larger numbers of spawners, greater amounts of more complex, high-quality cover, and lower densities of predators such as striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*), which reportedly are restricted to areas below the dam (YWA et al. 2007).

The RMT (2013) conducted a series of juvenile habitat use surveys employing snorkel methods during January, February, March, June, and September of 2012 in seven reaches along the lower Yuba River (**Figure 1**). Juvenile Chinook salmon occurred primarily in lateral bar, slackwater, slow glide, and riffle transition morphological units (MUs) (RMT 2013).

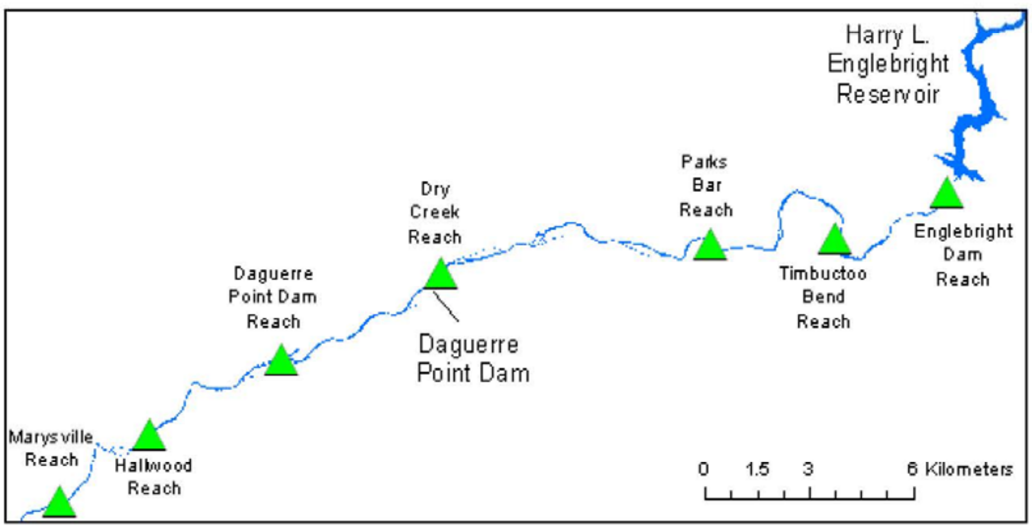


Figure 1. RMT juvenile snorkeling survey site locations on the lower Yuba River.
Source: RMT 2013

The density of juvenile Chinook salmon was highly variable throughout the lower Yuba River. Observations indicated that, with the exception of the upstream-most survey reach (i.e., Englebright Dam Reach) the density of juvenile Chinook salmon generally was higher in the survey reaches located upstream rather than downstream of Daguerre Point Dam. However, there was no statistically significant difference in the mean density of observed juvenile Chinook salmon among reaches (ANOVA, $F_{6, 25} = 1.09$, $P = 0.398$, **Figure 2**). Lower densities were observed in the Englebright Dam and Daguerre Point Dam reaches, and higher densities were observed in the Timbuctoo Bend and Dry Creek reaches (RMT 2013). Both of these dams are owned by the USACE.

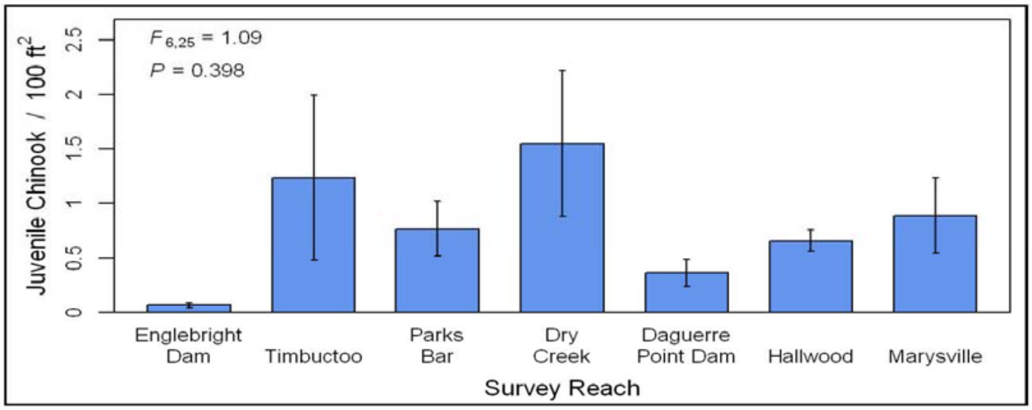


Figure 2. Observed densities of juvenile Chinook salmon across all survey reaches.
Source: RMT 2013

The densities of Chinook salmon observations by survey month were significantly higher during March than during January, June, and September (ANOVA, $F_{4,30} = 7.87$, $P < 0.001$) (RMT 2013). A peak in juvenile Chinook salmon abundance also was observed during March of 2012. This observation is supported in part from rotary screw trap (RST) surveys in the lower Yuba River from 1999-2009, which identified peak emigration timing for juvenile Chinook salmon to occur from January through March. Therefore, emigration from the lower Yuba River may account for the decline in observed abundance of juvenile Chinook salmon as the survey months progressed (RMT 2013).

Juvenile Chinook salmon appeared to occupy areas in close proximity to the shore during most survey months and in most survey reaches. When compared across sample months, juvenile Chinook salmon were generally located further from shore as the year progressed (ANOVA $F_{4,4866} = 24.39$, $P < 0.001$). Specifically, juvenile Chinook salmon remained within 10 ft of shore until June, and stayed relatively close to shore until September. Chinook salmon juveniles exhibited a similar pattern of observations farther from shore as they grew in size, although individuals in the 50-70 mm size class were observed closer to shore than smaller or larger size classes (ANOVA $F_{3,4867} = 60.69$, $P < 0.001$) (RMT 2013).

To evaluate potential relationships between juvenile Chinook salmon observations and mesohabitat characteristics, mean column water velocity at 60% depth (or at an average of the 80% and 20% depth) and the total measured stream depth at each Chinook salmon observation were overlaid with the mesohabitat characterization plot by Wyrick and Pasternack (2012). In addition, potential relationships were evaluated separately between juvenile Chinook salmon observations by 20 mm size class and for: (1) measured total stream depth; (2) the vertical position of the fish in the water column relative to total depth (depth of fish/total depth); and (3) the mean water velocity at Chinook salmon observation locations (RMT 2013).

The general trends in mesohabitat occupation (as contrasted with morphological units) occupied by juvenile Chinook salmon throughout the survey are shown in **Figure 3**. As shown in the figure, juvenile Chinook salmon occupied primarily slackwater and slow glide mesohabitats, and were rarely encountered in water depths greater than 4.5 ft or velocities greater than 2 ft/s (RMT 2013).

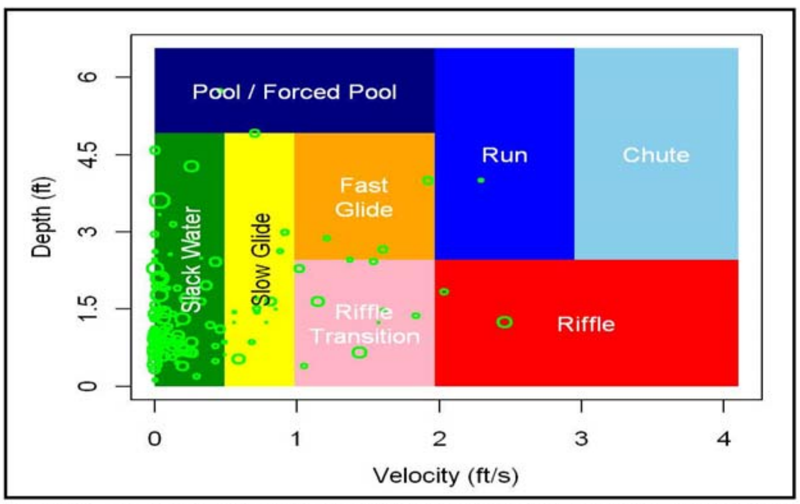


Figure 3. Overlay of the total measured stream depths and mean column water velocities at which juvenile Chinook salmon were encountered with mesohabitat characterizations. The size of the circle indicates the log10 transformed number of juveniles occurring at the total measured stream depth and mean column water velocity.
Source: RMT 2013

The proportional depth (i.e., vertical position in the water column) where juvenile salmon were observed indicates a trend of increasingly deeper water utilization as the individuals grow, until a size larger than 90 mm is reached, at which time the larger juveniles were observed again closest to the shore (ANOVA, $F_{3,5538} = 62.35$, $P < 0.001$). Chinook salmon generally occurred in the lower half of the water column, regardless of actual water depth, and occurred in progressively faster water as they grew (ANOVA, $F_{3,5538} = 99.18$, $P < 0.001$) (RMT 2013).

In summary, the vast majority of observations of juvenile Chinook salmon in the lower Yuba River occurred in water velocities and depths indicative of slackwater and slow glide mesohabitats, and smaller juveniles tended to occupy shallower habitats than larger juveniles (RMT 2013). These trends are consistent with data available for multiple other rivers (e.g., Bjornn and Reiser). Juvenile Chinook salmon are known to prefer slower water habitats than many other members of *Oncorhynchus* (Quinn 2005), and have been previously reported to actively seek out slow backwaters, pools, or floodplain habitat for rearing (Sommer et al. 2001; Jeffres et al. 2008). Similarly, juvenile Chinook salmon showed a clear preference for faster water (up to an average of about 1.8 ft/s) as they grew, consistent with trends found with salmonids in other rivers (Bjornn and Reiser 1991). The overall findings from this survey indicate that juvenile Chinook salmon in the lower Yuba River initially prefer slower, shallower habitat, and move into faster and deeper water as they grow (RMT 2013). For additional detail regarding the RMT juvenile fish snorkeling studies, refer to RMT (2013).

The spring-run Chinook salmon fry rearing period is estimated to extend from mid-November through mid-February (RMT 2013; 2013b). Updated characterization of the juvenile YOY emigration (i.e., downstream movement) period extends from mid-November through June (RMT 2013).

In the lower Yuba River, CDFW conducted juvenile salmonid outmigration monitoring by operating RSTs near Hallwood Boulevard, at a location approximately 6 RM upstream from the City of Marysville from 1999 to 2006. The RMT took over operation of the year-round RST effort in the fall of 2006, and continued operations through August 2009 (RMT 2013).

Analyses of CDFW RST data indicate that most Chinook salmon juveniles move downstream past the Hallwood Boulevard location before May of each year. Analysis of the fitted distribution of weekly juvenile Chinook salmon catch at the Hallwood Boulevard RST site from survey year 1999 through 2008 revealed that most emigration occurred from late-December through late-April in each survey year (RMT 2013). Approximately 95% of the observed catch across all years based on the fitted distribution occurred by April 30 (RMT 2013).

Overall, most (about 84%) of the juvenile Chinook salmon were captured at the Hallwood Boulevard RSTs soon after emergence from November through February, with relatively small numbers continuing to be captured through June. Although not numerous, captures of (oversummer) holdover juvenile Chinook salmon ranging from about 70 to 140 mm FL, primarily occurred from October through January with a few individuals captured into March (Massa 2005; Massa and McKibbin 2005). These fish likely reared in the river over the previous summer, representing an extended juvenile rearing strategy characteristic of spring-run Chinook salmon (Campos and Massa 2010a).

For the sampling periods extending from 2001 to 2005, CDFW identified specific runs based on sub-samples of lengths of all juvenile Chinook salmon captured in the RSTs by using the length-at-time tables developed by Fisher (1992, as cited in DWR 2003a), as modified by S. Greene (DWR 2003a). Although the veracity of utilization of the length-at-time tables for determining the run type of Chinook salmon in the Yuba River has not been ascertained based on the examination of run-specific determinations, in the lower Yuba River the vast majority (approximately 94%) of spring-run Chinook salmon were captured as post-emergent fry during November and December, with a relatively small percentage (nearly 6%) of individuals remaining in the lower Yuba River and captured as YOY from January through March. Only 0.6% of the juvenile Chinook salmon identified as spring-run was captured during April, only 0.1% during May, and none during June (YWA et al. 2007). The above summary of juvenile Chinook salmon emigration monitoring studies in the Yuba River is most consistent with the temporal trends of spring-run Chinook salmon outmigration reported for Butte and Big Chico creeks (YWA et al. 2007).

1.1.2 Fall-run Chinook Salmon

The RMT (2013) developed representative temporal distributions for specific fall-run Chinook salmon lifestages through review of previously conducted studies. As stated for spring-run Chinook salmon, the resultant lifestage periodicities encompass the majority of activity for a particular lifestage, and are not intended to be inclusive of every individual in the population. The lifestage-specific periodicities for fall-run Chinook salmon in the lower Yuba River are summarized in **Table 2**, and are discussed below.

Table 2. Lifestage-specific periodicities for fall-run Chinook salmon in the lower Yuba River.

Lifestage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Fall-run Chinook Salmon																								
Adult Immigration & Staging													■	■	■	■	■	■	■	■	■	■	■	■
Spawning																			■	■	■	■	■	■
Embryo Incubation	■	■	■	■	■	■													■	■	■	■	■	■
Fry Rearing	■	■	■	■	■	■	■	■																■
Juvenile Rearing		■	■	■	■	■	■	■	■	■	■	■												
Juvenile Downstream Movement	■	■	■	■	■	■	■	■	■	■	■	■												■

Source: RMT 2013

FALL-RUN CHINOOK SALMON SPAWNING

The lower Yuba River fall-run Chinook salmon spawning period has been reported to extend from October through December (CALFED and YWA 2005). According to RMT (2010b), fall-run Chinook salmon are primarily observed spawning during October in the upper reaches of the lower Yuba River upstream of Daguerre Point Dam. Spawning fall-run Chinook salmon begin expanding their spatial distribution further downstream in later fall months as suitable water temperatures become available near or downstream of Daguerre Point Dam (RMT 2010b). Analyses of available redd survey data, water temperature data and back-calculations from previous and carcass surveys generally confirm these characterizations (RMT 2013).

According to RMT (2013), for the periods analyzed from October through December (the fall-run Chinook salmon spawning period), the measure of central tendency of redd distribution continues to move downstream as the spawning season progresses from October through December. Also, redds were distributed farther downstream as water temperatures became cooler in late October, compared to early October (RMT 2013). Fall-run Chinook salmon spawning activity appeared to be associated with water temperature. RMT (2013) identified an upper tolerable water temperature index (UT WTI) value of 58°F for fall-run Chinook salmon spawning. For all Chinook salmon redds newly-constructed in the lower Yuba River during October through December of 2009 and 2010, about 97% were observed at locations where concurrent water temperature measurements were at or below the upper tolerable WTI value of 58°F (RMT 2013).

FALL-RUN CHINOOK SALMON FRY REARING

Fall-run Chinook salmon fry rearing in the lower Yuba River is reported to extend from mid-December through April (RMT 2013). Chinook salmon fry are typically 33-36 mm in length when they emerge, though there is considerable variation among populations, and size at emergence is determined in part by egg size (PFMC 2014). Upon emergence from spawning beds, juvenile salmonid fry begin foraging for food and seek cover in areas of reduced flow or move downstream (Healy 1991). A large downstream movement of Chinook salmon fry shortly after emergence is typical of most fall-run Chinook salmon populations in the Central Valley (Moyle 2000). Larger fry tend to be the most likely to disperse from redds earliest. Movement occurs mostly at night and tends to cease after a few weeks, when fry settle into rearing habitat in streams (DWR 2003). Water temperatures reported to be optimal for rearing of Chinook salmon fry and juveniles are reported to be between 45°F and 65°F (NMFS 2002a; Rich 1987; Seymour 1956).

In the lower Yuba River, most fall-run Chinook salmon reportedly exhibit downstream movement as fry shortly after emergence from gravels, although some individuals rear in the river for a period of up to several months and move downstream as juveniles (RMT 2010b). According to RMT (2010b), in past years CDFW employed the run identification methodology to identify fall-run Chinook salmon juveniles captured in the RSTs. Based on CDFW's examination of run-specific determinations, the majority (81.1%) of fall-run Chinook salmon in the lower Yuba River move past the Hallwood Boulevard RST from December through March, with decreasing numbers captured during April (8.9%), May (6.6%), June (3.2%), and July (0.2%) (RMT 2010b, as cited in RMT 2013a). Most of the fish captured from December through March were post-emergent fry (< 50 mm FL), while nearly all juvenile fall-run Chinook salmon captured from May through July were larger (≥ 50 mm FL) (YWA et al. 2007). Based upon estimation of initial emergence in consideration of the accumulated thermal units (ATUs) required for embryo incubation to hatching, and upon size-at-time of juvenile Chinook salmon in the RSTs as previously discussed, the phenotypic fall-run Chinook salmon fry rearing period generally extends from mid-December through April (RMT 2013).

FALL-RUN CHINOOK SALMON JUVENILE REARING AND DOWNSTREAM MOVEMENT

Fall-run Chinook salmon juvenile rearing in the lower Yuba River has been reported to primarily occur from December through June (CALFED and YWA 2005). The RMT has reviewed available data to further refine juvenile fall-run Chinook salmon lifestage periodicities. Based on size-at-time of juvenile Chinook salmon in the RSTs, the phenotypic fall-run Chinook salmon juvenile rearing lifestage extends from mid-January through June (RMT 2013a). Juvenile downstream movement, which includes both fry and larger juveniles as indicated by captures in the Hallwood Boulevard RSTs, generally occurs from mid-December through June (RMT 2013). RMT (2013) identified an upper tolerable WTI value of 68°F for the fall-run Chinook salmon juvenile rearing and downstream movement lifestage.

1.1.3 Steelhead

The RMT (2013) developed representative temporal distributions for specific steelhead lifestages through review of previously conducted studies, as well as recent and currently ongoing data collection activities of the M&E Program. The lifestage-specific periodicities for steelhead in the lower Yuba River are summarized in **Table 3**. As with spring-run and fall-run Chinook salmon, the resultant lifestage periodicities are intended to encompass the majority of activity for a particular lifestage, and are not intended to be inclusive of every individual in the population.

Table 3. Lifestage-specific periodicities for steelhead in the lower Yuba River.

Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Immigration & Holding												
Spawning												
Embryo Incubation												
Fry Rearing												
Juvenile Rearing												

Lifestage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Juvenile Downstream Movement							■	■	■	■	■	■	■	■	■	■	■	■						
Smolt (Yearling+) Emigration	■	■	■	■	■	■	■												■	■	■	■	■	■

Source: RMT 2013

STEELHEAD SPAWNING

RMT (2013) demonstrated that based upon cumulative temporal distribution curves, the steelhead spawning period in the lower Yuba River is generally characterized to extend from January through April. Steelhead spawning has been reported to primarily occur in the lower Yuba River upstream of Daguerre Point Dam (SWRI et al. 2000; YWA et al. 2007). Kozlowski (2004) states that field observations during winter and spring 2000 (YWA unpublished data) indicated that the majority of steelhead spawning in the lower Yuba River occurred from Long Bar upstream to the Narrows, with the highest concentration of redds observed upstream of the Highway 20 Bridge. USFWS (2007) data were collected on *O. mykiss* redds in the lower Yuba River during 2002, 2003, and 2004, with approximately 98% of redds located upstream of Daguerre Point Dam. Near-census redd surveys were conducted on the lower Yuba River during the 2009 and 2010 survey periods, although a substantial proportion of the weekly strata in the January through April time periods were not sampled due to elevated flows and associated turbidity levels. The numbers of redds counted each year were drastically different, although the proportions of redds in each of the survey reaches was quite similar between years (YWA 2017). The most consistent and reliable steelhead survey year was 2010, when over 94% of all steelhead redds were observed upstream of Daguerre Point Dam. Female steelhead construct redds within a range of depths and velocities in suitable gravels, oftentimes in pool tailouts and heads of riffles. In the lower Yuba River, steelhead have also been observed to spawn in side channel areas (YWA unpublished data).

STEELHEAD JUVENILE REARING AND OUTMIGRATION

As reported in NMFS (2014a), juvenile Central Valley steelhead may migrate to the ocean after spending 1 to 3 years in freshwater (McEwan and Jackson 1996). In general, it has been reported that after emergence steelhead fry move to shallow-water, low velocity habitats, such as stream margins and low gradient riffles, and will forage in open areas lacking instream cover (Hartman 1965; Everest et al. 1986). As fry increase in size and their swimming abilities improve in late summer and fall, juvenile steelhead have been reported to increasingly use areas with cover and show a preference for higher velocity, deeper mid-channel areas near the thalweg, rapids and deep pools (Hartman 1965; Everest and Chapman 1972; Bisson et al. 1982; 1988). Juvenile *O. mykiss* in the lower Yuba River apparently demonstrate a proclivity for near-bank areas, rather than open-channel habitats (USFWS 2008).

During the winter, steelhead prefer low velocity pool habitats with large rocky substrate or woody debris for cover (Hartman 1965; Swales et al. 1986; Raleigh et al. 1984), while smaller juveniles may seek refuge from high flows in interstitial spaces in unembedded cobble and boulder substrates (Bustard and Narver 1975; Everest et al. 1986).

Central Valley steelhead can suffer from mortality at constant temperatures of 77°F although they can tolerate 85°F for short periods, depending on acclimation temperature (Myrick and Cech 2001). Juvenile steelhead in northern California rivers reportedly exhibited increased physiological stress, increased agonistic activity, and a decrease in forage activity after ambient stream temperatures exceeded 71.6°F (Nielsen et al. 1994). An upper optimal water temperature limit of 65°F is preferred for growth and development of Sacramento River and American River juvenile steelhead (NMFS 2002).

In the lower Yuba River, juvenile steelhead exhibit variable durations of rearing. RMT (2010b) distinguished fry, juvenile, and yearling+ lifestages through evaluation of bi-weekly length-frequency distributions of *O. mykiss* captured in RSTs in the lower Yuba River, and other studies that report length-frequency estimates (Mitchell 2010; CDFG 1984). Some juvenile *O. mykiss* may rear in the lower Yuba River for short periods (up to a few months) and others may spend from one to three years rearing in the river. Scale analysis conducted by Mitchell (2010) indicates the presence of at least four age categories for *O. mykiss* in the lower Yuba River that spent 1, 2, or 3 years in freshwater and 1 year at sea before returning to the lower Yuba River to spawn.

The steelhead fry (individuals less than about 45 mm) lifestage generally extends from the time of initial emergence until about 3 months following the end of the spawning period. YWA (2010) identified the fry rearing lifestage as generally extending from mid-March through July, and identified the juvenile rearing lifestage as extending year-round. Based on all information collected to date, the RMT (2013) identified the steelhead fry rearing period as extending from April through July.

Based on the combined results from electrofishing and snorkeling surveys conducted during the late 1980s, CDFG (1991a) reported that juvenile steelhead were observed in all river reaches downstream of the Englebright Dam, but that most juvenile steelhead rearing occurred above Daguerre Point Dam. Similarly, annual snorkel surveys conducted from 1992 through 2000 (summarized by SWRI et al. 2000) showed that the primary rearing habitat for juvenile *O. mykiss* was upstream of Daguerre Point Dam. Kozlowski (2004) also found higher abundances of juvenile *O. mykiss* above Daguerre Point Dam, with approximately 82% of juvenile *O. mykiss* observations occurring upstream of Daguerre Point Dam. Kozlowski (2004) suggested that the distribution of age-0 *O. mykiss* appeared to be related to the distribution of spawning adults. SWRI et al. (2000) suggested that higher abundances of juvenile *O. mykiss* above Daguerre Point Dam may have been due to larger numbers of spawners, greater amounts of more complex, high quality cover, and lower densities of predators such as striped bass and American shad, which reportedly were restricted to areas below Daguerre Point Dam.

In the lower Yuba River, Kozlowski (2004) reports that juvenile *O. mykiss* were observed in greater numbers in pool habitats than in run habitats. He suggests that results of his study indicated a relatively higher degree of habitat complexity, suitable for various lifestages, in the reaches just below the Narrows compared to farther downstream. The Narrows reach includes greater occurrence of pool-type microhabitat suitable for juvenile *O. mykiss* rearing, as well as small boulders and cobbles preferred by the age-0 emerging lifestage (Kozlowski 2004).

A broad range of *O. mykiss* size classes has been observed in the lower Yuba River during spring and summer snorkeling, electrofishing, and angling surveys (SWRI et al. 2000). Juvenile *O. mykiss* ranging in size from 40-150 mm were commonly observed upstream of Daguerre Point Dam. Numerous larger juveniles and resident trout up to 18 in long were also commonly observed in the mainstem upstream and downstream of Daguerre Point Dam (SWRI et al. 2000). Age 0 YOY *O. mykiss* were clearly shown by the distinct mode in lengths of fish caught by electrofishing (40-100 mm FL). A preliminary examination of scales indicated that most yearling (age 1+) and older *O. mykiss* were represented by fish greater than 110 mm long. The sizes of age 0 and 1+ *O. mykiss* indicated substantial annual growth of *O. mykiss* in the lower Yuba River. Seasonal growth of age 0 *O. mykiss* was evident from repeated sampling in 1992 and 1999, but actual growth rates could not be estimated because of continued recruitment of fry (newly emerged juveniles) or insufficient sample sizes (SWRI et al. 2000).

Mitchell (2010) reports that analysis of scale growth patterns of juvenile *O. mykiss* in the lower Yuba River indicates a period of accelerated growth during the spring peaking during the summer months, followed by decelerated growth during the fall and winter. Following the second winter, juvenile *O. mykiss* in the lower Yuba River exhibit reduced annual growth in length with continued growth in mass until reaching reproductive age. Additionally, more rapid juvenile and adult *O. mykiss* growth occurred in the lower Yuba River compared to the lower Sacramento River and Klamath River *O. mykiss*, with comparable growth rates to *O. mykiss* in the upper Sacramento River (Mitchell 2010).

The RMT (2013) identified the steelhead juvenile rearing period as extending year-round, and the steelhead juvenile downstream movement period as extending from April through September.

CDFG (1991) reports that juvenile steelhead in the lower Yuba River emigrate primarily from March to June. In the lower Yuba River, some YOY *O. mykiss* are captured in RSTs located downstream of Daguerre Point Dam during late-spring and summer, indicating movement downstream. However, at least some of this downstream movement may be associated with the pattern of flows in the river. RST monitoring during water transfers in 2001, 2002, and 2004 (YWA and SWRCB 2001; YWA 2003a; YWA 2005), generally from about mid-June through September, indicated that the character of the initiation of the water transfers could potentially affect juvenile *O. mykiss* downstream movement. Based upon the substantial differences in juvenile *O. mykiss* downstream movements (based on RST catch data) noted between the 2001 study, and the 2002 and 2004 studies, it was apparent that the increases in juvenile *O. mykiss* downstream movement associated with the initiation of the 2001 water transfers were avoided due to a more gradual ramping-up of flows that occurred in 2002 and 2004 (YWA et al. 2007).

As previously discussed, some steelhead may move downstream as juveniles without exhibiting the ontogenetic characteristics of smolts. Presumably, these individuals continue to rear and grow in downstream areas (e.g., lower Feather River, Sacramento River, and the Delta) and undergo the smoltification process prior to entry into saline environments.

1.2 Existing Fisheries Habitat Conditions in the Lower Yuba River

The Yuba River downstream of Englebright Dam is one of the more thoroughly studied rivers in the Central Valley. Studies have shown that the flow- and water-temperature-related stressors to anadromous salmonids have been alleviated by implementation of the Yuba Accord, and other stressors in the lower Yuba River related to the migration, holding, and spawning lifestages are low (YWA 2017). Provided below is a brief summary of the existing fisheries habitat conditions in the lower Yuba River.

1.2.1 Anadromous Salmonid Spawning Habitat Availability

As described in Wyrick and Pasternack (2012), even though USACE' Englebright Dam blocks all downstream bedload transport, the lower Yuba River remains a wandering gravel-bed river with a valley-wide active zone due to the gravel-rich hydraulic-mining deposits (James et al. 2009; White et al. 2010). Almost 90% of the hydraulic mining tailings deposited in the Yuba River downstream of Englebright Dam remains today as deposits in the floodplains (FERC 2019). The tailings that remain from the hydraulic mining are the source for much of the present alluvium, and were used to create gravel berms in some sections of the river corridor.

In the lower Yuba River, anadromous salmonids spawn in mean substrate sizes ranging from about 50 to 150 mm, and most of the lower Yuba River from Englebright Dam to the confluence with the Feather River is characterized by average substrate particle sizes within this size range (RMT 2013). Overall, gravel for spawning anadromous salmonids does not appear to be limiting in the lower Yuba River. According to the RMT (2013), spawning habitat does not appear to be limited by an inadequate supply of gravel in the lower Yuba River due to ample storage of mining sediments in the banks, bars, and dredger-spoil gravel berms. Beak Consultants, Inc. (1989) stated

> *The spawning gravel resources in the river are considered to be excellent based on the abundance of suitable gravels, particularly in the Garcia Gravel Pit and*

> *Daguerre Point Dam reaches. The tremendous volumes of gravel remaining in the river as a result of hydraulic mining make it unlikely that spawning gravel will be in short supply in the foreseeable future. Armoring of the channel bed is possible, but has not developed to date, probably due to periodic flushing by floods comparable to the 1986 event.*

Similarly, Pasternack (2008) reported that…In Timbuctoo Bend "*…there is adequate physical habitat to support spawning of Chinook salmon and steelhead trout in their present population size. Furthermore, all of the preferred morphological units in the* [Timbuctoo Bend Reach] *TBR have a lot of unutilized area and adequate substrates to serve larger populations.*"

Studies (RMT 2013; Pasternack et al. 2014) have demonstrated that extensive amounts of substrate suitable for spawning, in combination with suitable flow conditions during the September through mid-October spring-run Chinook salmon spawning period, provide ample amounts of spawning habitat for spring-run Chinook salmon in the lower Yuba River. Weighted Usable Area (WUA) discharge relationships at multiple river scales characterize flow-dependent changes in habitat quality and can be used as an aid for determining appropriate flows that are beneficial for salmonids. Overall, WUA discharge relationships show that, at all spatial scales, a discharge of about 600 cfs yields the highest WUA value and those < 400 cfs or > ~880 cfs would noticeably decrease Chinook salmon spawning habitat availability in the lower Yuba River (Pasternack et al. 2014). As described in Pasternack et al. (2014), at 600 cfs, 6.6 million ft^2 of preferred Chinook salmon adult spawning microhabitat exists in the lower Yuba River, which is far beyond the requirement to sustain the highest recorded population size of spawners using the lower Yuba River annually. The only exception is the uppermost reach (Englebright Dam Reach) where there is a relative paucity of appropriate spawning substrate. However, since 2007, the USACE has been injecting a mixture of coarse sediment in the gravel (2-64 mm) and cobble (64-256 mm) size ranges into the Englebright Dam Reach, as part of their voluntary conservation measures associated with ESA consultations regarding Daguerre Point Dam.

To determine the length of time that remains before valley-wide downcutting will cease to dominate erosion in the lower Yuba River, and when remnant peripheral terraces in the Timbuctoo Bend reach will be the primary source of sediment, Pasternack and Wyrick (2016) considered the total supply of stored hydraulic mining sediment in the Timbuctoo Bend reach above the pre-mining sediment base level. Pasternack (2008) calculated some simple estimates of the volume of remnant mining sediment in Timbuctoo Bend above the base level at the end of the reach and concluded that there was about 6.1–16 million m^3, with a best intermediate estimate of 11.9 million m^3. Based on the export rate within Timbuctoo Bend reach alone, the remnant mining sediment would be removed in about 266 years (Pasternack and Wyrick 2016). Consequently, it is estimated that the lower Yuba River will be supplied with good spawning material to support resilient Chinook salmon and steelhead spawning habitat for at least that amount of time (i.e., 266 years), if all other factors remain unchanged.

Overall, spawning habitat availability is not limiting, and is considered to be a low stressor to anadromous salmonids in the lower Yuba River (YWA 2017).

1.2.2 Effects of Yuba Accord Implementation in the Lower Yuba River

After two one-year pilot programs in 2006 and 2007, in 2008 the SWRCB adopted its Corrected Order WR 2008-0014, which amended YWA's water-right permits to specify the Lower Yuba River Accord minimum instream-flow requirements, which protect and enhance the 24 miles of aquatic habitat in the lower Yuba River from Englebright Dam downstream to the river's confluence with the Feather River near Marysville.

FLOW CONSIDERATIONS

The Yuba Accord flow schedules were developed to meet specific objectives, including maximizing the occurrence of "optimal" flows and minimizing the occurrence of suboptimal flows, within the bounds of hydrologic variation and available upstream reservoir capacity. The flow schedules also were designed to provide month-to-month flow sequencing to address Chinook salmon and steelhead life history periodicities (RMT 2013).

For wet hydrologic conditions, the Yuba Accord flow schedules do not limit the flows that occur in the river during substantial portions of the year. Instead, flood control operations and high, controlled releases to move water through the system determine the actual flow rates (in wetter years, in-river flows may be substantially greater than the Yuba Accord required minimum flows). During drier hydrologic conditions, the Yuba Accord flow schedules often do govern YWA's operations, and the Yuba Accord flow schedules allocate all of the available water that can be controlled by the YRDP facilities and require mandatory consumptive limitations and conjunctive use to maximize flows in the river when hydrologic conditions put stress on the surface water supply (RMT 2013).

WATER TEMPERATURE

The RMT (2013) used previously available data and information, updated with recent biologic and abiotic monitoring, to review the appropriateness of the water temperature regime in the lower Yuba River associated with implementation of the Yuba Accord. The RMT updated the lifestage periodicities of target species based on data obtained in the lower Yuba River, identified suitable thermal regimes for target fish species taking into account individual species and lifestage-specific water temperature requirements, identified species and lifestage-specific water temperature index values, assessed the probability of occurrence that those water temperature index values would be achieved with implementation of the Yuba Accord, and evaluated whether alternative water temperature regimes are warranted. The RMT (2013) also addressed the issue regarding the potential that cold water conditions could affect adult spring-run Chinook salmon immigration and holding, and the issue of *O. mykiss* anadromy versus residency.

Daily water temperature monitoring data from October 2006 through late October 2015 at the Smartsville, Daguerre Point Dam, and Marysville water temperature gages were compared with anadromous salmonid lifestage-specific upper tolerable WTI values. These comparisons were conducted for the lifestage periodicity and geographic location pertinent for each lifestage of the species/run evaluated.

For spring-run Chinook salmon, water temperatures at all three gages during the period evaluated were always below the upper tolerable WTI value for yearling+ smolt outmigration. Water temperatures at all three gages were generally below the upper tolerable WTI value for adult immigration, with the exception of during the summer of 2015 (after a multi-year drought period) at the Marysville Gage. The upper tolerable WTI values for adult holding and juvenile rearing and outmigration also have rarely been exceeded, with the exception of two days during 2013, 23 days during 2014, and during approximately June through September of 2015 at the Marysville Gage. However, it is not expected that holding adults or juveniles spend extended periods of time at downstream locations (e.g., Marysville). For example, adult spring-run Chinook salmon were found to primarily exhibit holding behavior just downstream of Daguerre Point Dam or above Daguerre Point Dam during their adult holding period (RMT 2013), and juvenile Chinook salmon primarily rear where water temperatures are suitable in more upstream reaches of the lower Yuba River (RMT 2013). The upper tolerable spawning and embryo incubation WTI value was never exceeded at Smartsville (which is the only location evaluated for spring-run Chinook salmon spawning and embryo incubation), with the exception of during 11 days in September of 2015.

For steelhead, water temperatures at all three gages were almost always below the upper tolerable WTI values for juvenile rearing and downstream movement, and adult immigration and holding, with the exception of 38 days between June and September 2015 when the juvenile rearing upper tolerable WTI value of 68°F was exceeded at the Marysville Gage, during 16 days in September 2014, and during approximately August through September 2015, when the adult immigration and holding upper tolerable WTI value of 65°F was exceeded. The upper tolerable spawning and embryo incubation WTI value was never exceeded at Smartsville, and was generally not exceeded at Daguerre Point Dam with the exceptions of the end of May of some years, and during approximately mid-April through May of 2014 and 2015. The smolt (yearling+) emigration upper tolerable WTI value generally was not exceeded at the Smartsville Gage, with the exception of during some days in October of 2010 and 2011 and during most of October of 2014 and 2015, and was not exceeded at the Daguerre Point Dam and Marysville gages with the exception of during October into mid-November, and during portions of March or April.

As illustrated in **Figure 4** below, comparison of average daily monitored water temperatures in the Yuba River (Daguerre Point Dam), the American River (Watt Avenue), and the Feather

River (Gridley) from 2011-2017 demonstrates that water temperatures in the Yuba River were consistently much colder than river temperatures in adjacent watersheds during the recent multi-year drought. YWA's transfer releases during 2013 and 2014, which occurred mostly in the summer months of July and August, led to these lower water temperatures in the lower Yuba River.

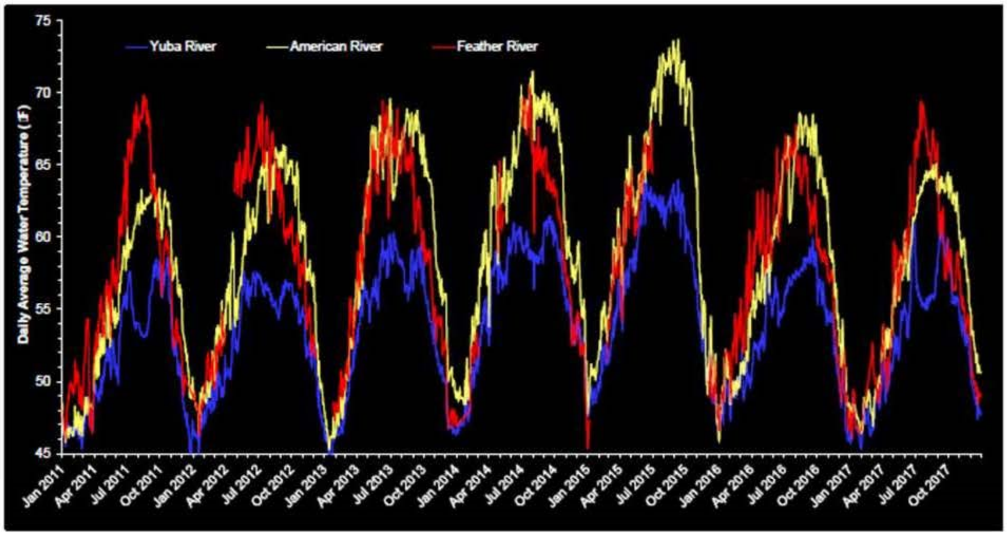


Figure 4. Comparison of average daily monitoring water temperatures in the Yuba River (Daguerre Point Dam), American River (Watt Avenue) and Feather River (Gridley) during 2011-2017.

Overall, implementation of the Yuba Accord provides suitable flows and water temperatures for all lifestages of anadromous salmonids in the lower Yuba River.

- Benefits to spring-run Chinook salmon include:
  - More-suitable water temperatures during the entire adult immigration and holding period.
  - Higher spring-run Chinook salmon spawning habitat availability and more-suitable spawning water temperatures.
  - Improved embryo incubation conditions due to frequently and substantially lower, and therefore more-suitable, water temperatures.
  - Improved over-summer/early fall juvenile rearing conditions, due to more-suitable water temperatures under relatively warm water temperature conditions.

- Improved smolt emigration conditions due to higher flows during low flow conditions, and generally suitable water temperatures throughout the majority of the smolt emigration period.

- Benefits to fall-run Chinook salmon include:
  - More-suitable water temperatures during the adult immigration and staging period.
  - More-suitable water temperatures during the spawning period.
  - Improved embryo incubation conditions due to lower, and therefore more-suitable, water temperatures.
  - Improved juvenile rearing and outmigration conditions, due to higher flows and more-suitable water temperatures.
- Benefits to steelhead include:
  - More-suitable water temperatures during the adult immigration and holding period.
  - More-suitable water temperatures during the latter part of the spawning period.
  - Improved embryo incubation conditions due to lower, and therefore more-suitable, water temperatures.
  - Improved over-summer/early fall juvenile rearing conditions, due to more-suitable water temperatures under relatively warm water temperature conditions.
  - Improved smolt emigration conditions due to higher flows during low flow conditions, and generally suitable water temperatures throughout the majority of the smolt emigration period.

NMFS (2014) Recovery Plan states that "*Implementation of the flow schedules specified in the Fisheries Agreement of the Yuba Accord is expected to address the flow-related major stressors including flow-dependent habitat availability, flow-related habitat complexity and diversity, and water temperatures. In fact, water temperature evaluations conducted for the Yuba Accord EIR/EIS indicate that Yuba River water temperatures generally would remain suitable for all life stages of spring-run Chinook salmon and steelhead.*"

1.2.3 Characterization of Existing Juvenile Rearing Habitat Conditions

In general, freshwater rearing sites for anadromous salmonids are areas with: (1) connectivity to the main river channel and water quantities that form and maintain physical habitat conditions and support juvenile growth and mobility; (2) water quality and forage that support juvenile development; and (3) habitat complexity characterized by natural cover such as shade, submerged and overhanging large woody material (LWM), log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids (YWA 2017). Juvenile lifestages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

The characteristics of the floodplain of the lower Yuba River are very different from other rivers in the Central Valley. During the period of hydraulic gold mining, vast quantities of sand, gravel, and cobble entered the Yuba River (Gilbert 1917) and deposited throughout the system. This human impact completely transformed the river. Presently, the lower Yuba River downstream of Englebright Dam continues to change in response to the complex assemblage of natural processes and past human impacts. The legacy of hydraulic mining remains as a substantial impact to the system. Englebright Dam prevents additional impacts from upstream mining debris, and is putting the river on a trajectory toward restoration of the pre-existing landform (Pasternack 2010). Daguerre Point Dam is a stabilizer to the river channel, limiting the extent of channel incision between Daguerre Point and Englebright dams. Mechanized re-working of alluvium and associated channelization have determined the lateral bounds of the river, and also have affected the diversity and distribution of river-corridor landforms. The fluvial geomorphology of the Yuba River is so unique that it is crucial to evaluate it on its own terms and not to apply simple generalizations and concepts from other rivers with dams (Pasternack 2010).

The existing juvenile rearing habitat conditions in the lower Yuba River primarily are due to several factors beyond the control of YWA, including the hydraulic mining legacy, channelization and reduction in river meander, limited habitat diversity and complexity, channel relocation and reconfiguration. Flows that would affect channelization and floodplain inundation would need to be 30,000 cubic feet per second ("cfs") or higher, and are beyond the capacity of YWA's operational control.[1]

The lower Yuba River floodplain is comprised of inorganic unconsolidated alluvium, and does not include the organic materials that make other systems highly productive. Consequently, floodplain habitats in the lower Yuba River have low habitat complexity, relatively low production of food organisms, and offer little protection from either fish or avian predators, as described below.

Riparian Habitat and Instream Cover

Riparian Vegetation

[1] Pasternack, G.B., Gravel/Cobble Augmentation Implementation Plan (GAIP) for the Englebright Dam Reach of the Lower Yuba River, CA at 43 (Sept. 30, 2010), available at http://pasternack.ucdavis.edu/files/3413/7581/8399/USACE_GAIP_FINAL_20100930.pdf.

As stated in CALFED and YWA (2005), riparian vegetation, an important habitat component for anadromous fish, is known to provide: (1) bank stabilization and sediment load reduction; (2) shade that results in lower instream water temperatures; (3) overhead cover; (4) streamside habitat for aquatic and terrestrial insects, which are important food sources for rearing juvenile fishes; (5) a source of instream cover in the form of woody material; and (6) allochthonous nutrient input.

Shaded riverine aquatic (SRA) cover generally occurs in the lower Yuba River as scattered, short strips of low-growing woody species (e.g., *Salix sp.*) adjacent to the shoreline. Beak (1989) reported that the most extensive and continuous segments of SRA cover occur along bars where [then] recent channel migrations or avulsions had cut new channels through relatively large, dense stands of riparian vegetation. SRA cover consists of instream object cover and overhanging cover. Instream object cover provides structure, which promotes hydraulic complexity, diversity and microhabitats for juvenile salmonids, as well as escape cover from predators. The extent and quality of suitable rearing habitat and cover, including SRA, generally has a strong effect on juvenile salmonid production in rivers (Healey 1991 as cited in CALFED and YWA 2005).

Since completion of New Bullards Bar Reservoir, the riparian community (in the lower Yuba River) has expanded under summer and fall streamflow conditions that have generally been higher than those that previously occurred (SWRCB 2003). However, the riparian habitat is not pristine. As discussed by NMFS (2005a), historical hydraulic mining operations and mining debris have eliminated much of the historical riparian vegetation along the lower Yuba River and have created poor conditions for re-establishment and growth of riparian vegetation. In addition, construction of Englebright Dam reduced regeneration of riparian habitats by preventing the transport of fine sediment, woody debris and nutrients to the lower river (NMFS 2005a). According to CALFED and YCWA (2005), the lower Yuba River, especially in the vicinity of Daguerre Point Dam and the Yuba Goldfields, is largely devoid of sufficient riparian vegetation to derive the benefits (to anadromous salmonids) discussed above.

Where hydrologic conditions are supportive, riparian and wetland vegetative communities are found adjacent to the lower Yuba River and on the river sides of retaining levees. These communities are dynamic and have changed over the years as the river meanders. The plant communities along the river are a combination of remnant Central Valley riparian forests, foothill oak/pine woodlands, agricultural grasslands, and orchards (Beak 1989).

In 2012, YCWA conducted a riparian habitat study in the Yuba River from Englebright Dam to the confluence with the Feather River (see Technical Memorandum 6-2, Riparian Habitat Downstream of Englebright Dam (YWA 2013)). Field efforts included descriptive observations of woody and riparian vegetation, cottonwood inventory and coring, and an LWM survey. Based on field observations, YWA (2017) reported that all surveyed reaches supported woody species in various lifestages – mature trees, recruits, and seedlings were observed within all reaches. Where individuals or groups of trees were less vigorous, beaver activity was the main cause, although some trees in the Marysville Reach appeared to be damaged by human camping.

The structure and composition of riparian vegetation was largely associated with four landforms. Cobble-dominated banks primarily supported bands of willow shrubs with scattered hardwood trees. Areas with saturated soils or sands supported the most complex riparian areas and tended to be associated with backwater ponds. Scarps and levees supported lines of mature cottonwood and other hardwood species, typically with a simple understory of Himalayan blackberry or blue elderberry shrubs. Bedrock dominated reaches had limited riparian complexity and supported mostly willow shrubs and cottonwoods.

Based on analysis of the riparian mapping data, RMT (2013) reported that the majority of the woody species present in the river valley include, in order of most to least number of individuals: various willow species (Salix sp. and *Cephalanthus occidentalis*); Fremont cottonwood (*Populus fremontii*) (i.e., cottonwoods); blue elderberry (*Sambucus nigra ssp. caerulea*); black walnut (*Juglans hindsii*); Western sycamore (*Platanus racemosa*); Oregon ash (*Fraxinus latifolia*); white alder (*Alnus rhombifolia*); tree of heaven (*Ailanthus altissima*); and grey pine (*Pinus sabiniana*). Willow on the lower Yuba River are dominated by dusky sandbar willow (*Salix melanopsis*) and narrow leaf willow (*Salix exigua*), and relative dominance of the two species shifts respectively in the downstream direction (WSI 2010). Other species occurring are arundo willow (*Salix lasiolepsis*), Goodings willow (*Salix goodingii*) and red willow (*Salix laevigata*).

Based on the surveys conducted by YWA (2013), cottonwoods are one of the most abundant woody species in the lower Yuba River, and the most likely source of locally-derived LWM due to rapid growth rates and size of individual stems commonly exceeding 2 ft in diameter and 50 ft in length. Cottonwoods exist in all lifestages including as mature trees, recruits (or saplings) and as seedlings. Of the estimated 18,540 cottonwood individuals/stands, 12% are within the bankfull channel (flows of 5,000 cfs or less), and 39% are within the floodway inundation zone (flows between 5,000 and 21,100 cfs). However, recruitment patterns of cottonwood have not been analyzed with respect to time or with any more detail regarding channel location.

YWA conducted a historical aerial photograph analysis to describe changes over time to total vegetation delineated within the valley walls, riparian vegetation delineated within 50 ft of the active river channel, and channel alignment (YWA 2013). To determine the cumulative change over time in total vegetative cover and riparian vegetation cover for the Marysville, Timbuctoo Bend, Narrows, and Englebright Dam study sites, YWA compared the aerial photographs from 1937 and 2010. Narrows study sites showed an overall decrease in vegetative cover. For the remaining study sites, including Marysville, Hallwood, Daguerre Point Dam, Dry Creek, Parks Bar, and Timbuctoo Bend study sites, the cumulative change in vegetative cover increased. The least amount of vegetation change over time was observed in the Englebright Dam, Narrows and

Marysville sites. The Dry Creek, Daguerre Point Dam and Hallwood sites had the greatest vegetated area, and YWA identified those sites as the most dynamic (i.e., both decreased in vegetative cover through 1970 and then increased through 2010).

Cumulative changes in riparian vegetation cover in the Englebright Dam and Narrows study sites decreased with very little detectable change for the Narrows study site. For the remaining study sites, the cumulative change in riparian vegetation cover increased. The observed changes for the Englebright Dam, Narrows and Marysville study sites were very small. For the Dry Creek and Parks Bar study sites, the greatest changes were observed, with dramatic increases in riparian vegetation cover. The magnitude of change of riparian vegetation cover between photoset years (in a stepwise comparison) was greater than that seen in the cumulative total riparian vegetation cover change over the entire period examined.

LARGE WOODY MATERIAL

LWM provides escape cover and relief from high current velocities for juvenile salmonids and other fishes. LWM also contributes to the contribution of invertebrate food sources, and micro-habitat complexity for juvenile salmonids (NMFS 2007). Snorkeling observations in the lower Yuba River have indicated that juvenile Chinook salmon had a strong preference for near-shore habitats with LWM (Jones & Stokes 1992).

About 8.7 miles of the Yuba River downstream of Englebright Dam, distributed among study sites per reach, were surveyed and evaluated for pieces of wood (YWA 2013). The number of pieces of wood was relatively similar above and below Daguerre Point Dam (i.e., about 5,100 and 5,750 pieces, respectively). Woody material was generally found in bands of willow shrubs near the wetted edge, dispersed across open cobble bars, and stranded above normal high-flow indicators. Most of the woody material was diffuse and located on floodplains and high floodplains, with only about a quarter of the material in heavy concentrations (YWA 2013).

Most (77-96%) pieces of wood found in each reach were smaller than 25 ft in length and smaller than 24 in in diameter, which is the definition of LWM in Technical Memorandum 6-2. These pieces would be typically floated by flood flows and trapped within willows and alders above the 21,100 cfs line, which is defined as the flow delineating the floodway boundary (YWA 2013).

LWM was not evenly distributed throughout the reaches. For the smaller size classes (i.e., shorter than 50 ft, less than 24 in in diameter), the greatest abundance of pieces was found in the Hallwood or Daguerre Point Dam reaches, with lower abundances above and below these reaches (YWA 2013).

The largest size classes of LWM (i.e., longer than 50 ft and greater than 24 in in diameter) were rare or uncommon (i.e., fewer than 20 pieces total) with no discernible pattern of distribution. Pieces of this larger size class were counted as "key pieces", as were any pieces exceeding 25 in in diameter and 25 ft in length and showing any morphological influence (e.g., trapping sediment or altering flow patterns). A total of 15 key pieces of LWM were found in all study sites, including six in the Marysville study site. Few of the key pieces were found in the active channel or exhibiting channel forming processes (YWA 2013).

Overall, the relative abundance of riparian vegetation and LWM in the lower Yuba River is considered to be a moderate to high stressor in the lower Yuba River.

Natural River Morphology and Function

According to NMFS (2014), "*Loss of Natural River Morphology and Function*" is the result of river channelization and confinement, which leads to a decrease in riverine habitat complexity, and thus, a decrease in the quantity and quality of juvenile rearing habitat. Additionally, this primary stressor category includes the effect that dams have on the aquatic invertebrate species composition and distribution, which may have an effect on the quality and quantity of food resources available to juvenile salmonids.

According to NMFS (2014a), attenuated peak flows and controlled flow regimes have altered the lower Yuba River's geomorphology and have affected the natural meandering of the river downstream of Englebright Dam. However, alteration of river morphology and function has been very substantively affected by hydraulic mining legacy and confinement of the river channel from dredger tailings and gravel berm deposits.

James (2015) determined that restoration of lower Yuba River floodplains to pre-mining conditions is severely constrained by several factors including changes in water and sediment regimes, deep floodplain aggradation by toxic Hg-rich alluvium, floodplain morphogenesis, and hard engineering of the channel (James 2015). Due to the narrow floodplains and high terraces, James (2015) further stated that laterally reconnecting channels in the vicinity of the Yuba Goldfields to their former floodplains cannot be accomplished by simply increasing flows. Moreover, the history of floodplain evolution in the lower Yuba River suggests that removal of stabilization structures to promote lateral migration could result in rapid geomorphic responses such as channel avulsions that would be difficult to control (James 2015).

As reported by the RMT (2013), preliminary evaluation of available data collected to date related to Yuba River fluvial geomorphology indicates that the Yuba River downstream of Englebright Dam has complex river morphological characteristics. Evaluation of the morphological units (MUs) in the Yuba River as part of the spatial structure analyses indicates that, in general, the sequence and organization of MUs is non-random, indicating that the channel has been self-sustaining of sufficient duration to establish an ordered spatial structure (RMT 2013).

The Yuba River downstream of Englebright Dam exhibits lateral variability in its form-process associations (RMT 2013). In the Yuba River, MU organization highlights the complexity of the channel geomorphology, as well as the complex and diverse suite of MUs. The complexity in the landforms creates diversity in the flow hydraulics which, in turn, contributes to a diversity of habitat types available for all riverine lifestages of anadromous salmonids in the Yuba River downstream of Englebright Dam (RMT 2013).

In the lower Yuba River, anadromous salmonids spawn in mean substrate sizes ranging from about 50 to 150 mm, and most of the lower Yuba River from Englebright Dam to the confluence with the Feather River is characterized by average substrate particle sizes within this size range (RMT 2013). The exceptions are sand/silt areas near the confluence with the Feather River, and the boulder/bedrock regions in the upper sections of Timbuctoo Bend and most of the Englebright Dam Reach. However, gravel augmentation funded by USACE in the Englebright Dam Reach over the past several years has spurred spawning activity and Chinook salmon redd construction in this reach. The net result is an increase in the spatial distribution of spawning habitat availability in the river, particularly for early spawning (presumably spring-run) Chinook salmon (RMT 2013).

The loss of natural river morphology and function is considered to be a high stressor to spring-run Chinook salmon in the lower Yuba River (YWA 2017).

Benthic Macroinvertebrates

In 2012, YCWA conducted benthic macroinvertebrate surveys at six sample sites[2] on the lower Yuba River between Englebright Dam and the confluence with the Feather River. In general, the BMI communities at all sites were dominated by midges (Chironomidae), worms (Oligochaeta), mayflies (Baetidae), and caddisflies (Hydropsychidae). No clear upstream to downstream trend in total estimated abundance and taxa richness was observed (FERC 2019; YWA 2013).

With respect to physical habitat, the riparian zone was not a major determinant in stream reach function, because channel banks were contained by bedrock, cobble bars, or levees. Most riparian vegetation was limited to narrow fringes of understory vegetation (e.g., willows) and sparse deciduous trees. LWM and allochthonous material (i.e., leaf litter) were generally absent in all of the sites (YWA 2013). The Yuba Goldfield berms and constructed levees clearly affected the habitat distribution in the lower river, confining an otherwise anastomosing channel form (YWA 2013).

Overall, the composition of the BMI feeding groups at most sites was dominated by collector-filterers and collector-gatherers, indicating the dominance of detritus and suspended particulates as BMI food sources (YWA 2013). The relative abundance of predators was much lower than

---

[2] Lower Yuba River BMI sample sites included: (1) Hallwood Boulevard; (2) Daguerre Point Dam; (3) Hammon Bar; (4) Parks Bar to Long Bar; (5) Timbuctoo Bend; and (6) Downstream of the Narrows 2 Powerhouse.

collector-filterers and collector-gatherers at most sites, but still accounted for a substantial percentage of the site-specific samples. At all six sites, the percentage of scrapers and shredders ranged from relatively "low" to "very low", indicating the relatively small component of the community that process periphyton, allochthonous material and coarse particulate organic matter (YWA 2013).

Relative abundance of the "scraper" functional feeding group of BMI's was relatively low (1% to 8%). These BMIs feed off of periphyton and other organic matter attached to the benthic substrate. The "shredder" functional feeding group of BMIs process particulate organic matter (e.g., leaf litter) as a food source. The potential for inputs of coarse and fine particulate organic material is dependent on the vegetative structure of the riparian area. Organic inputs from riparian vegetation become food for stream organisms. A strong indicator of the potential for these riparian inputs is an estimation of canopy cover. Overall canopy cover across all the sites was low (6% to 35%). The relatively low abundance of canopy cover and expected lack of inputs of coarse particulate matter are concordant with the low relative density of shredder BMIs found across all sites (0% to 1%) (YWA 2013).

During YWA's FERC relicensing process, BMI metrics were examined for upstream to downstream trends, and for correlations with physical habitat features among the sites. Non-parametric (rank-order) Spearman correlation coefficients were calculated for pairwise combinations of BMI metrics and physical habitat variables. Correlation coefficients of 80% and higher were further examined for biological relevance. The intent of the correlation analysis was to screen and identify possible relationships for qualitative analysis. Interpretation of the correlation results was limited to a qualitative analysis because of the small sample size and because of the risk of erroneously interpreting spurious correlations. Hypothesis testing with statistical confirmation sampling was beyond the scope of the study (YWA 2013).

YUBA WATER AGENCY

VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

EXHIBIT 5

Analyzing the Benefits of the YWA VSA Project

1.1 Background

1.1.1 Lower Yuba River Flow and Habitat Enhancements Since 1999

The SWRCB has issued numerous orders and decisions regarding water quality and water right requirements for the San Francisco Bay/Sacramento-San Joaquin Bay-Delta Estuary (Bay-Delta). Water Right Order D-1641, which was adopted by the SWRCB on December 29, 1999 and revised on March 15, 2000, specifies many implementation actions for the 1995 Bay-Delta Plan. Specifically, D-1641 made numerous amendments to the terms and conditions in the water-right permits for the Central Valley Project and State Water Project to implement the water quality objectives in the 1995 Bay-Delta Plan.

Several of the regulatory conditions that pertain to the lower Yuba River have changed since D-1641 was issued in 1999. A discussion of some of the flow- and habitat-related changes that have occurred in the lower Yuba River since 1999 is provided below for illustrative purposes, but this discussion is not comprehensive.

1.1.1.1 Changes in Lower Yuba River Minimum Flow Requirements and Narrows 2 Powerhouse Bypass

YWA's operations of facilities in the Yuba River Watershed previously were subject to the 1965 agreement between YWA and CDFW[1], which was incorporated into YWA's water-right permits (Water Right Permits 15026, 15027, and 15030). YWA operated its facilities to meet the instream flow requirements specified in that agreement, although lower Yuba River flows normally substantially exceeded those requirements.

[1] The California Department of Fish and Wildlife (CDFW) previously operated under the name California Department of Fish and Game (CDFG). The Department changed its name to CDFW in 2013. For consistency, the Department is referred to as CDFW throughout this document.

Settlement Negotiations

In February 1988, a coalition of fishery groups filed a complaint with the SWRCB alleging that the instream flow requirements in YWA's permits did not provide adequate protection for fish. In March 1991, the CDFW released a "Lower Yuba River Fisheries Management Plan," which contained recommendations for restoration, maintenance, and protection of fishery resources in the lower Yuba River. The plan recommended higher minimum flow requirements, maximum water temperature requirements and improved fish screens. CDFW requested that the SWRCB modify YWA's water rights permits to implement the recommendations in the CDFW plan. In response to CDFW's request, and to address various allegations raised by the coalition of fishery groups concerning several other water agencies, the SWRCB initiated a proceeding to consider fishery protection and water rights issues on the lower Yuba River in 1991.

SWRCB 2001 Water Right Decision 1644

The SWRCB conducted hearings in 1992 and 2000, which ultimately led to the adoption of Water Right Decision 1644 (Decision-1644 or D-1644) on March 1, 2001. In D-1644, the SWRCB: (1) increased the minimum instream flow requirements in YWA's water right permits; (2) directed YWA and other water districts diverting water from the lower Yuba River at two major diversion facilities to consult with CDFW and federal fishery agencies, and to prepare a plan to reduce losses of fish at those diversions; (3) required YWA and other parties to take several other actions regarding their water rights; (4) required YWA to take actions to address potential concerns regarding water temperatures for Chinook salmon and steelhead; and (5) required studies and consultation on various other issues.

SWRCB 2003 Revised Water Right Decision 1644

YWA, several local water districts in Yuba County, and a coalition of conservation non-governmental organizations (NGOs) all filed legal actions challenging D-1644. After considering new evidence, the court directed the SWRCB to vacate D-1644 and to reconsider the decision in light of the new evidence. Following a two-day hearing, the SWRCB issued RD-1644 on July 16, 2003. RD-1644 contained interim requirements that were intended to remain in place until 2008, when the long-term requirements were scheduled to take effect. The RD-1644 interim instream flow requirements specified two compliance points, the United States Geological Survey (USGS) gages at Smartsville (~RM 22) and Marysville (RM 6.2). After the SWRCB issued RD-1644, the parties that had challenged D-1644 initiated new legal proceedings challenging RD-1644.

Lower Yuba River Accord

While the RD-1644 litigation was pending, representatives of YWA, CDFW, NMFS, USFWS, the South Yuba River Citizens League (SYRCL), Trout Unlimited (TU), The Bay Institute, and Friends of the River, formed a Technical Team, which then met for several years to develop the comprehensive set of instream-flow requirements and other measures that ultimately were specified in the Yuba Accord Fisheries Agreement.

Settlement Negotiations

When the Technical Team started to work on this matter, it decided that, to meet its goals, efforts would be focused on addressing "keystone" lower Yuba River species. The Technical Team agreed that a flow regime that supported Central Valley steelhead and Central Valley Chinook salmon also generally would benefit other native fish species, recreationally important non-native fish species such as American shad and striped bass, aquatic macroinvertebrates, and other aquatic and riparian resources. Several steps were taken by the Technical Team to develop to the Yuba Accord flow schedules, including:

- Developing a Stressor Matrix for key fisheries species in the lower Yuba River.
- Considering general aquatic habitat conditions and health in the lower Yuba River.
- Defining general fisheries goals (e.g., maintenance, recovery, enhancement, etc.).
- Defining specific fisheries-related goals for the new flow regime in terms of flow, water temperature, habitat, and other parameters.
- Developing a comprehensive understanding of the hydrology and range of variability in hydrology of the Yuba Basin.
- Developing a comprehensive understanding of the operational constraints (regulatory, contractual, and physical) on the Yuba River Development Project (YRDP) and affecting the lower Yuba River, and an understanding of the flexibilities and inflexibilities of those constraints.
- Developing flow regimes based on specific fisheries-related goals and water availability (as defined by operational constraints and hydrologic conditions).

The Technical Team identified the following biological objectives for flow schedule development:

- Maximize occurrence of appropriate Chinook salmon and steelhead spawning, rearing, and emigration flows.
- Provide month-to-month flow sequencing consistent with salmonid life history periodicities.
- Provide appropriate water temperatures.
- Adult salmonid immigration, holding, and spawning.
- Juvenile salmonid rearing and emigration.
- Promote a dynamic, resilient, and diverse fish assemblage.
- Minimize potential stressors to fish species and lifestages.

The freshwater lifecycle for each species was broken into six commonly acknowledged lifestages: (1) adult immigration and holding; (2) spawning and embryo incubation; (3) post-emergent fry outmigration (referred to as young-of-year (YOY) downstream movement/outmigration for steelhead); (4) fry rearing; (5) juvenile rearing; and (6) smolt outmigration (referred to as yearling (+) outmigration for steelhead). Sixteen potential stressors (also referred to as "limiting factors") then were identified. These stressors were not necessarily considered to be all stressors, but they were the major perceived stressors, based on current information. A stressor prioritization process provided context for and assistance in the development of the flow schedules. To do this, the potential effects of each of these 16 stressors on each particular species and lifestage were evaluated. However, only five to eight of the stressors ultimately were determined to be potential limiting factors for each particular species and lifestage.

The prioritization of stressors in the lower Yuba River consisted of a limiting factor analysis, by species and lifestage, which was based on the existing hydrological and biological conditions of the river. Particular emphasis was placed on the instream conditions during the past 10 to 15 years, because that recent historical information was likely to be reasonably representative of future hydrologic patterns, and most representative of current operational practices.

After the Stressor Matrix was developed, the Technical Team developed an initial set of flow schedules for the lower Yuba River. The lower Yuba River flow schedules balanced consideration of numerous elements, including specific biological objectives, annual variability in water availability, reservoir constraints for flood control and power generation, ramping and flow delivery constraints, water delivery obligations (contractual and by rights), and the complex interrelations among these elements. Development of flow schedules included the following steps:

- Identification of basic hydrologic conditions, physical parameters and operations objectives that influence flow.
- Development of an "optimal" flow schedule for years with virtually unlimited water availability.
- Development of a "survival" flow schedule for years with extremely low water availability.
- Development of additional flows schedules between the high and low range, corresponding to varying the water availabilities between very wet years and extremely dry years.

A comparison of the total annual volumes of water necessary to meet the 1965 CDFW Agreement requirements, the RD-1644 long-term requirements, the D-1644 interim requirements, and the Yuba Accord requirements in the 20% wettest years and 20% driest years is provided in **Figure 1**.

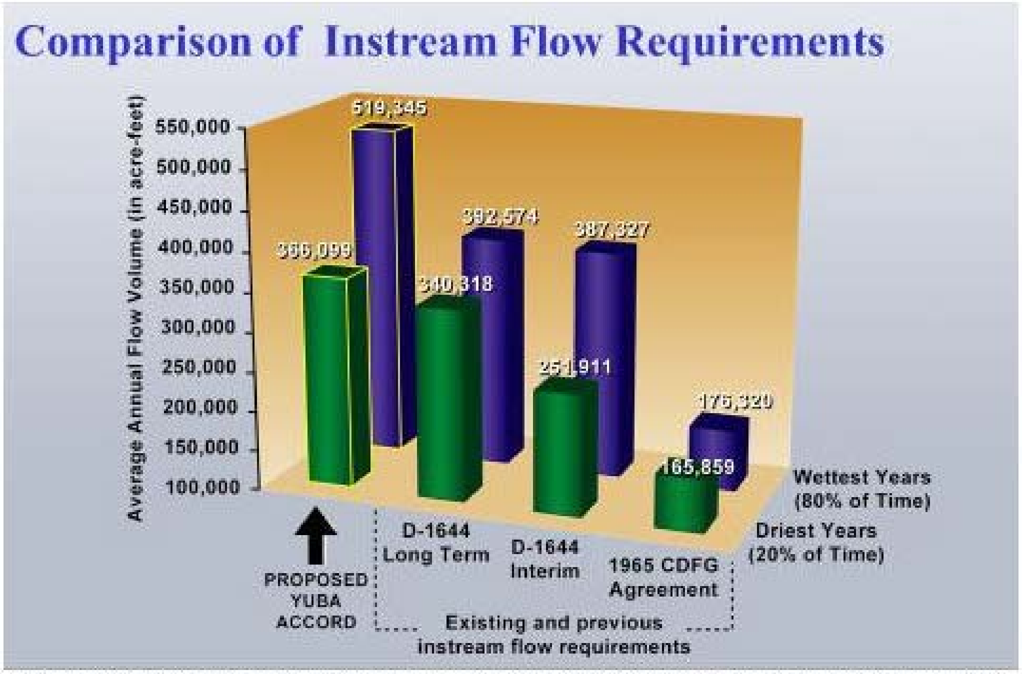


Figure 1. Comparison of lower Yuba River instream flow requirements under the 1965 CDFG Agreement, D-1644 Interim, D-1644 Long Term, and the Yuba Accord.

Relative to the RD-1644 long-term requirements, the Yuba Accord requirements provide: (1) higher total volumes of water during most years; (2) higher flows during the summer and fall; (3) higher flows during April of drier years; (4) lower flows during May of drier years; and (5) lower water temperatures during summer and fall. The benefits to the fisheries resources in the lower Yuba River from the Yuba Accord flow requirements include the following:

- **September through March** - For the September through March period, which generally encompasses the spring-run Chinook salmon, fall-run Chinook salmon, and steelhead spawning periods, the Yuba Accord flows generally provide maximum (or near maximum) spawning habitat (as measured by flow at the Smartville Gage).
- **April through June** – For the April through June period, the Yuba Accord flows generally minimize flow fluctuations and mimic the natural unimpaired hydrological patterns for juvenile rearing and emigration, which were particular concerns to the Technical Team.
- **July and August** – Lower Yuba River water temperatures, particularly downstream of Daguerre Point Dam, were the primary concern that led the Technical Team to develop

the July and August flow requirements. Important anadromous salmonids lifestages present in the lower Yuba River during July and August include steelhead juvenile rearing and adult immigration (August only), spring-run Chinook salmon juvenile rearing and adult immigration, and fall-run Chinook salmon adult immigration (August only).

NMFS's 2005 Biological Opinion on YWA's Narrows 2 Full-Flow Bypass

On November 4, 2005, NMFS issued a biological opinion (BO) for the YRDP (FERC License No. 2246) License Amendment, which authorized YWA: (1) to install a full-flow bypass structure on the Narrows 2 Powerhouse; and (2) to implement specific ramping and flow fluctuation criteria for flows downstream of the Narrows 2 Powerhouse. This NMFS BO analyzed effects on spring-run Chinook salmon and steelhead, designated critical habitat for spring-run Chinook salmon and steelhead and the Southern DPS of North American green sturgeon. This NMFS BO authorized the construction and operation of the 3,000 cfs bypass at the Narrows 2 Powerhouse, which increased the capacity for controlled releases from Englebright Reservoir (through the Narrows 1 and Narrows 2 Powerhouses) to about 3,540 cfs. This bypass minimizes the possibility that emergencies or other events requiring that Narrows 2 Powerhouse be taken offline will cause significant flow fluctuations in the lower Yuba River, and thereby minimizes the possibility that such fluctuations will strand juvenile spring-run Chinook salmon and steelhead or dewater redds of those species.

1.1.1.2 Habitat Enhancement Measures

In addition to the flow- and water-temperature enhancements that occurred as a result of implementing the Yuba Accord, several other habitat enhancement projects have been implemented in the lower Yuba River since 1999.

As part of its 2014 ESA consultation with NMFS, the U.S. Army Corps of Engineers (USACE) committed to incorporate several protective conservation measures into its activities associated with the operation and maintenance (O&M) of Daguerre Point Dam. These measures are intended to improve conditions for listed salmonids in the lower Yuba River (NMFS 2014). The USACE implements the following protective conservation measures under its obligations under ESA Section 7(a)(1) for the conservation of threatened species.

- **Implementation of the Daguerre Point Dam Fish Passage Sediment Management Plan.** The USACE continues to implement the 2009 Fish Passage Sediment Management Plan. The USACE considers the Fish Passage Sediment Management Plan to be a protective conservation measure because it includes activities beyond those specified in the Daguerre Point Dam O&M Manual (Corps 2013a).

- **Management of a Long-term Flashboard Program at Daguerre Point Dam.** The USACE continues to implement the Flashboard Management Plan through the administration of a license issued to Cordua Irrigation District.

- **Implementation of a Debris Monitoring and Maintenance Plan at Daguerre Point Dam.** Through coordination with CDFW and NMFS, the USACE is implementing the Debris Monitoring and Maintenance Plan for clearing accumulated debris and blockages in the fish ladders at Daguerre Point Dam. This plan specifies that CDFW is responsible for inspecting and clearing the portion of the ladders containing the VAKI Riverwatcher™ device, and that the USACE is responsible for all other parts of the ladders. The USACE conducts weekly inspections of the Daguerre Point Dam fish ladders for surface and subsurface debris. The USACE also routinely inspects the fish ladder gates to ensure that no third parties close them. This plan also specifies that routine inspection and clearing of debris from the two fish ladders at Daguerre Point Dam may be conducted by CDFW pursuant to agreement with the USACE, or by other parties (e.g., PSMFC) under CDFW direction. When river flows are 4,200 cfs or greater, the USACE or other designated parties are to conduct daily manual inspections of the Daguerre Point Dam fish ladders. Upon discovering debris in the ladders, the debris is to be removed within twelve hours, even if the USACE or CDFW determines that flow levels are adequate for fish passage. If conditions do not allow for safe immediate removal of the debris, the debris is to be removed within twelve hours after flows have returned to safe levels.

With respect to the conservation of federally-listed endangered and threatened species on existing USACE project lands, the USACE Environmental Stewardship and Maintenance Guidance and Procedures (Corps 2013b) states that identified conservation activities will be accomplished when funds are available. Therefore, conservation measures contained within the USACE's Voluntary Conservation Program are subject to the availability of funding. In the past, the USACE has been successful in obtaining the additional funding because it places a high priority on the measures described below.

- Gravel Injection in the Englebright Dam Reach of the Lower Yuba River
- Large Woody Material Management Program

The Anadromous Fish Restoration Program has contributed federal funding toward several non-flow habitat enhancement projects in the lower Yuba River, including the following:

- Hammon Bar Riparian Enhancement Project
- Teichert Hallwood Facility Salmonid Habitat Restoration Project

- Yuba River Canyon Salmon Habitat Restoration Project
- Long Bar Habitat Restoration Project
- Yuba River Upper Rose Bar Project
- Yuba River Downstream of Highway 20 Project

1.1.2 CEQA Existing Conditions

Under CEQA, the impacts of a proposed project must be evaluated by comparing expected environmental conditions after project implementation to conditions at a point in time referred to as the baseline (Stevens and Rivasplata 2016). The changes in environmental conditions between those two scenarios represent the environmental impacts of the proposed project.

The State CEQA Guidelines Section 15125(a) provides the following guidance for establishing the baseline:

> *An EIR must include a description of the physical environmental conditions in the vicinity of the project, as they exist at the time the notice of preparation is published, or if no notice of preparation is published, at the time environmental analysis is commenced, from both a local and regional perspective. This environmental setting will normally constitute the baseline physical conditions by which a lead agency determines whether an impact is significant.*

In 2012, the SWRCB issued its Supplemental Notice of Preparation (NOP) for Environmental Documentation for the Update and Implementation of the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. The SWRCB has not stated whether it will issue a new NOP for its Substitute Environmental Document ("SED") for the Sacramento/Delta updates to the Bay-Delta Plan. Because so many changes to the physical conditions in the Delta and its tributaries have occurred since 2012, YWA supports the SWRCB using existing, 2019 conditions, as the CEQA Existing Conditions for the new SED's analyses of the various VSA projects, including the YWA VSA Project.

1.1.2.1 Flows

Under this approach, the CEQA Existing Conditions include the conditions that have occurred in the lower Yuba River since 2006, when implementation of the Yuba Accord instream flow requirements began, with operations under YWA's existing FERC license (including the NMFS 2005 BO on YWA'S Narrows 2 Full-Flow Bypass), and with current diversion demands at Daguerre Point Dam.

1.1.2.2 Habitat Enhancement Measures

Under this approach, the lower Yuba River non-flow habitat enhancement projects and programs described above in Section 1.1.1.2 should be included in the CEQA Existing Conditions.

1.2 Methodology for Evaluating Flow-Related Benefits

The Yuba Accord provides extensive fishery habitat benefits to the lower Yuba River. The release of water stored in New Bullards Bar Reservoir under the Yuba Accord provides higher instream flows and colder water temperatures during the summer and fall, which provide significant benefits to spring-run Chinook salmon over-summer adult holding, spring-run and steelhead over-summer juvenile rearing, and spring-run and fall-run Chinook salmon fall spawning. These releases consume a significant portion of the water stored by the YRDP and provide flows that are higher than the natural flows during some portions of all years, and most of the time in the driest years.

1.2.1 Quantification and Assessment of the Changes in Yuba River Outflows

The SWRCB Bay Delta Water Quality Control Plan Update Phase 2 Scientific Basis Report has identified percentage of unimpaired flow as an indicator water quality parameter, and the July 2018 SWRCB Staff Framework for the Sacramento/Delta Bay-Delta Plan Update includes a new proposed numeric water quality objective with a range of percentages of unimpaired flows. Analyses of the changes in Yuba River outflows and Delta inflows that would occur with various alternatives can be made to compare the benefits and impacts of the alternatives. These analyses would not assess the changes in Bay-Delta outflows that would result from the various Yuba River alternatives because they would not determine the fate of the water associated with flow changes in river reaches downstream of the Yuba River. One specific element that is not included in these analyses is the Delta outflow benefits of the YWA VSA Project Component A flows. Without the YWA VSA Project, water from the YWA VSA Project Component A flows in some years would be diverted from the Feather River or the Sacramento River before the water would enter the Delta, or would be exported from the Delta. Preliminary analysis shows that these amounts would average more than 6,000 acre-ft per year.

YWA has developed a detailed water balance/operations model for the YRDP FERC relicensing that uses a daily time step, and includes the controlling regulatory and operations constraints on the YRDP and a detailed runoff hydrology input time series. When YWA was developing the YWA VSA Project flow proposal, YWA used this model (with modification to model VSA alternatives) to assess the changes in Yuba River flows that would occur with the YWA VSA Project, and to compare these results to model results to: (1) existing conditions; and (2) the model results of the percentage-of-unimpaired flow numeric objective stated in the July 2018 SWRCB Staff Framework.

1.2.1.1 Comparative Analysis Assumptions – Proportionate Share of Requirements

YWA has not made any assumptions about if or how the SWRCB might require upstream projects in the Yuba River Watershed to contribute to implementation of the proposed numeric percent-of-unimpaired flow objective. Therefore, YWA's analysis of its VSA Project flow proposal does not include any assumptions regarding the future operations of these upstream projects, and instead uses the existing operations conditions for these projects. To make a valid comparison of the YWA VSA Project to the proposed percentage-of-unimpaired flow numeric objective, YWA's analysis assumes a proportionate sharing of the responsibility among all diverters of water within the Yuba River Watershed for that alternative. Modeled implementation of this shared responsibility is accomplished by setting a YRDP requirement for Yuba River outflow as a percentage of all runoff that occurs within the watershed, including flows that occur directly below the upstream projects. If the SWRCB requires additional releases from the upstream projects, then flows from these additional releases would be in the modeling results for both alternatives, and therefore would increase the modeled Yuba River outflow percentages for both alternatives by equal amounts.

1.2.1.2 Yuba River Outflow Preliminary Results

The following presentation of results for the various scenarios is not intended to be a detailed examination of the differences of the YWA VSA Project and the percent–of-unimpaired-flow alternative (relative to existing conditions), but rather provide an overview of the major aspects of the modeled flow changes. Five plots (**Figures 1 through 5**) are provided to illustrate the monthly flow volumes provided under each scenario, summarized by water year type. These plots include the following:

- Dashed brown lines at 45%, 55% (dark) and 65% of unimpaired flow by monthly volumes summarized by the Sacramento Valley Index (SVI) water year type for each plot. These are calculated as percentages of the California Department of Water Resources' (DWR) published unimpaired flow volumes for the Yuba River at Smartsville plus Deer Creek.

Water Year Type	Occurrence (percent of time)
Wet	28 years (29%)
Above Normal	13 years (14%)
Below Normal	18 years (19%)

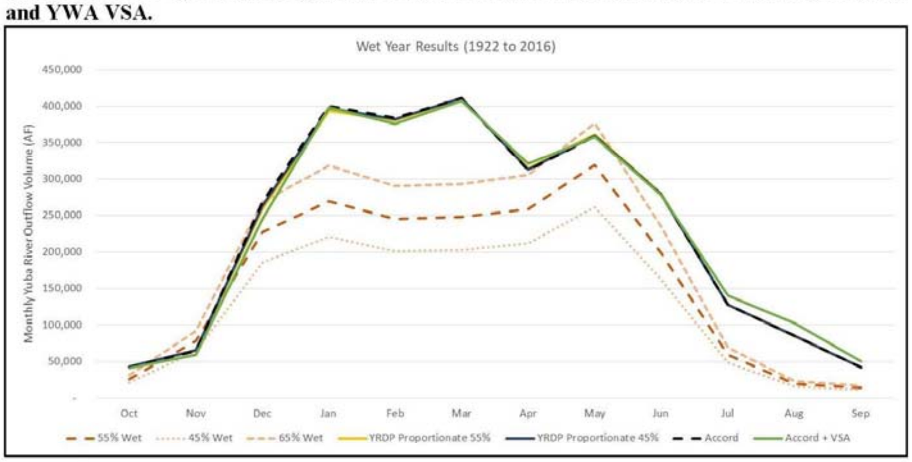
Settlement Negotiations

- The historical occurrence of the SVI water year types based on unimpaired flow volumes for water years 1922-2016 (i.e., the 95-year period of record) is as follows.

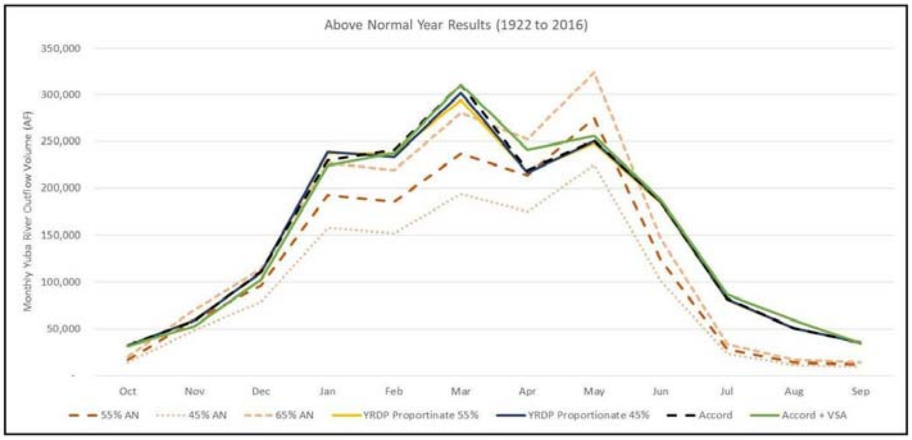
Dry	21 years (22%)
Critical	15 years (16%)

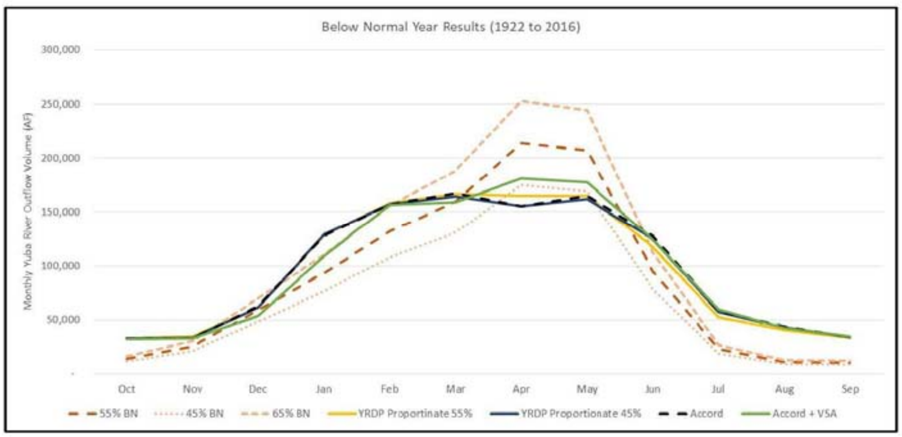
- Yellow line (55%) and blue line (45%) monthly Yuba River outflow volumes resulting from modeling of a proportionate sharing of the outflow requirement with only YWA operating to the proposed percent-of-unimpaired flow requirement (and historical operations for the upstream projects).
- Light blue line – Yuba Accord under Existing Conditions (and historical operations for upstream projects).
- Green line – Yuba Accord with YWA VSA Project flow measure operations (and historical operations for upstream projects).

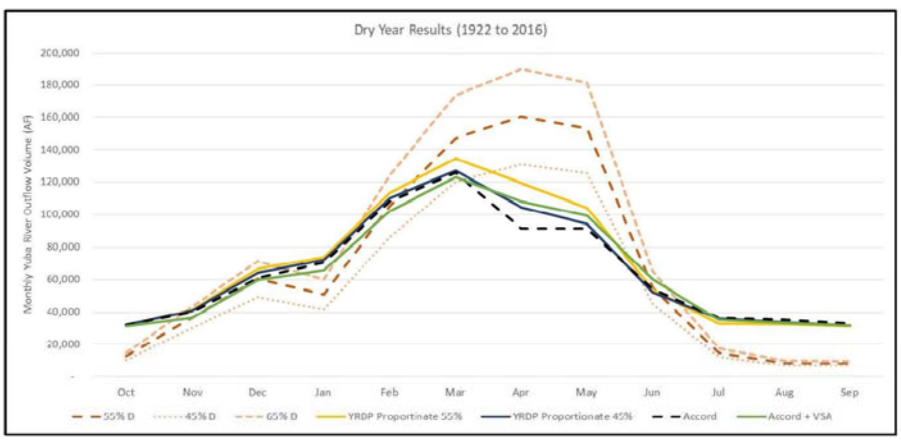
Figures 1 through 5. Monthly flow volumes summarized by water year type for 45%, 55% and 65% of unimpaired flow (calculated not modeled), Yuba Accord (Existing Condition), and simulated YRDP operations proportionate share of 45% and 55% unimpaired flow requirement and YWA VSA.

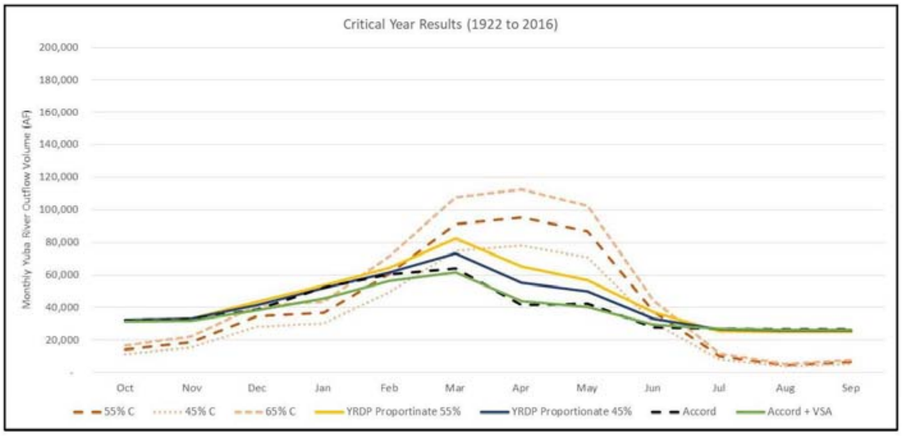


Settlement Negotiations









The brown dashed lines show the minimum amounts of flow that would occur with all diverters in the watershed providing their proportionate shares of unimpaired flows, although these flows would not be the actual flows resulting from a modeling analysis. Comparing the green line (Yuba Accord plus VSA) to the yellow line (55% unimpaired simulated for YRDP) and the blue line (45% unimpaired simulated for YRDP) shows the volume of water that YWA would be required to provide under the percent-of-unimpaired flow proposal relative to the volumes that YWA is proposing to provide with the YWA VSA Project.

The following are key observations regarding the flow volume plots (Figures 1 – 5):

- During all years, for January, February, and July through December (a total of 8 months), modeled Accord Yuba River outflow is within or above the range shown for the SWRCB Staff Framework percent-of-unimpaired flow proposal.

- During March and June, with the exception of Critical Years, modeled Accord Yuba River outflow also is within or above the range for the SWRCB Staff Framework percent-of-unimpaired flow proposal (for a total of 10 months in all but Critical Years).

- The previous two bullets points demonstrate that any focus for changes in Yuba River outflows should focus on April and May, and for a few years, on June and late March.

- During Wet and Above-Normal years (which constitute approximately 1/2 of all years), modeled Accord Yuba River outflow exceeds 55% of unimpaired flow during April and 50% during May.

- The YWA VSA Project would provide more water than YWA's comparable and proportionate share of a 55% of unimpaired flow requirement during April and May of Above-Normal and Below-Normal years (with no need to provide any supplemental water in Wet years due to sufficient existing flows), and more than YWA's proportionate share of a 55% of unimpaired flow requirement during June in Dry years. Additionally, the YWA VSA Project would provide more than YWA's proportionate share of a 45% of unimpaired flow requirement during April and May.

- During Critical years, there would be no additional YWA VSA releases, and YWA's operations would provide about 10,000 AF less than YWA's proportionate share of a 45% of unimpaired flow requirement for March, April and May. The total volume would, on average, be approximately 36,000 AF less than under the 45% of unimpaired flow requirement for YWA's proportionate share for March through June. However, during July through October, operations to the Yuba Accord flow schedules would result in releases of 46,000 AF more than the100% of unimpaired flow of the Yuba River.
- Most of the modeled deficit compared to the percent-of-unimpaired flow requirements (45% or 55%) during Critical years is due to upstream diversions during April and May.
- During all years, modeled lower Yuba River flows for the July through October period are more than 65% of unimpaired flow, and most of the time are more than 100% of the unimpaired flow, due to YWA operations to meet the Yuba Accord instream-flow requirements for anadromous salmonid spawning flows, juvenile rearing flows, and to maintain cool water temperatures.

1.2.2 Analysis of Inundation-Duration of Native Floodplain and VSA Proposed Constructed Floodplain Type and Constructed Rearing Habitat during the February 1 to June 15 period using USFWS Methodology

To assess potential benefits to juvenile anadromous salmonid rearing habitat in the lower Yuba River, an inundation-duration analysis similar to that developed by the USFWS for the YRDP relicensing can be used. An inundation-duration analysis helps determine the benefits associated with the longer residence time of water on the floodplain or inundation of constructed rearing habitat that would be developed under the YWA YSA Project. The inundation-duration analysis also identifies the flow alternatives that would impact the existing condition or floodplain inundation, and identifies pre-project inundation-duration quantities for comparison. This section is a brief overview of a preliminary inundation-duration analysis of the existing condition with the Yuba Accord, YWA operations to meet the proposed percent-of-unimpaired flow requirement, and YWA VSA Project operations.

1.2.2.1 Assumptions for the Analysis

Floodplains are identified as the areas within the floodway that are inundated when river flows are greater than 5,000 cfs. The floodway is the area between the upland slopes, levees, training walls and valley floor that is inundated at a flow of 21,100 cfs (Wyrick and Pasternak 2012).

- Methodology is from USFWS Report "Use of Cumulative Acre-days to Evaluate Changes in Floodplain Inundation on the Lower Yuba River under Different Hydrological Regimes and Quantification of Mitigation Measures", Stephanie Millsap, Ph.D. USFWS, Mark Gard, Ph.D. USFWS, August 2017, submitted to FERC as appendix to USFWS and CDFW 10(j) conditions.

- Simulation of flows and calculation of inundated areas done with the YRDP FERC Project 2246 relicensing model with some modifications to simulate the alternatives, which is a daily time step-based water balance/operations model, as updated to simulate a longer period of record than was used in the relicensing proceeding.

- Period of simulation is 1922 to 2016.

- Floodplain inundation area versus flow tables provided from a high-resolution 2-dimension hydrodynamic model of the lower Yuba River developed by Prof. Gregory Pasternack, U.C. Davis. Information is documented in the published technical report titled "*Landforms of the Lower Yuba River*" (Wyrick and Pasternack 2012). Floodplain definition also was taken from Wyrick and Pasternack (2012).

- Existing Condition (Yuba Accord) scenario uses current condition assumptions for YRDP operation and Yuba Accord flow requirements and all other regulatory requirements as modeled for the YRDP Relicensing "base case".

- 55% of Unimpaired Flow scenario uses current condition assumptions for YRDP operation and Yuba Accord flow requirements with an added flow requirement at the Marysville Gage for all days of the year, assuming YWA operates to provide its proportionate share of the 55% outflow requirement.

- A theoretical, conceptual representation of YWA VSA Project rearing habitat development is used to demonstrate potential inundation benefits of the YWA proposal of increased spring flows and constructed habitat. The theoretical YWA VSA habitat enhancement proposal is assumed as 50 acres constructed above Daguerre Point Dam and 50 acres constructed below Daguerre Point Dam that are contoured to lower existing floodplain to inundate at 2,000 cfs. Constructed habitat to have enhanced habitat values for rearing equal to or greater than high value floodplain habitat.

1.2.2.2 Discussion of Analysis Results

Figure 6 presents the averages of annual floodplain and constructed rearing habitat inundation area and duration in acre-days during February 1 to June 15 for: (1) the existing condition (Yuba Accord); (2) conditions with a 55% of unimpaired flow requirement; and (3) conditions with 100 acres of floodplain habitat enhancement. Averages are shown for the wettest, middle and driest one-third of years, using annual unimpaired flow for determination of the three categories and the years contained in each. **Table 1** presents the same information shown in the Figure 6 for annual inundation of floodplain and constructed rearing habitat in acre-days.

- Under current conditions (blue bars) the average of middle hydrology years inundation-duration of existing floodplain is 914 acre-days, representing an average of 7 days of floodplain inundation annually of 130 acres.

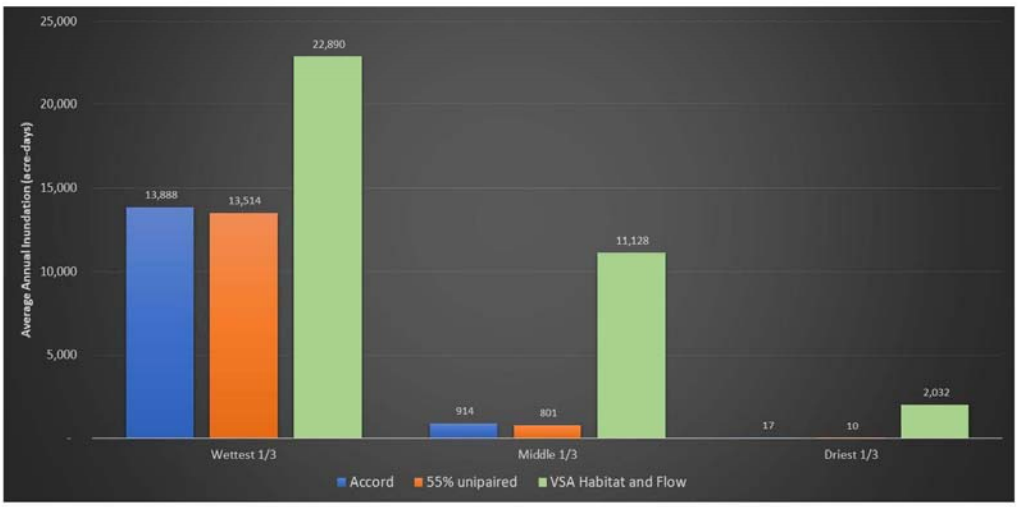


Figure 6. Averages of annual floodplain and constructed rearing habitat inundation area and duration in acre-days during February 1 to June 15 for the existing condition (Yuba Accord), conditions with a 55% unimpaired flow requirement and conditions with 100 acres of floodplain habitat enhancement.

- A 55% of unimpaired flow requirement (orange bars) would reduce floodplain inundation at the average of middle hydrology years inundation-duration by 12% or an inundation of 801 acre-days, representing average of 7 days of floodplain inundation annually of 113 acres.

- Alternative analysis was done to examine YRDP operation to a full 55% of unimpaired Yuba River outflow (not proportionately shared within the watershed), and does not significantly change the resulting inundation shown in the plotted scenario with YWA operating to its proportional share of the 55% unimpaired flow.

Table 1. Annual inundation of floodplain and constructed rearing habitat in acre-days.

	Existing Conditions (Yuba Accord)	55% Unimpaired	VSA Habitat and Flow
Wettest 1/3	13,888	13,514	22,890
Middle 1/3	914	801	11,128
Driest 1/3	17	10	2,032

- The theoretical VSA constructed rearing habitat, as described above, when modeled under YWA's VSA Project flow proposal, would result in a total (natural and constructed habitat) average of middle hydrology years inundation-duration of 11,128 acre-days, more than 12 times the existing floodplain inundation.

- The theoretical VSA constructed rearing habitat described above, when modeled under YWA's VSA Project flow proposal, would result in a total (natural and constructed habitat) average of the driest one-third of years inundation-duration of 2032 acre-days, where under existing conditions and with a 55% of unimpaired flow requirement there would be almost no floodplain inundation.

- In the driest one-third of years, floodplain inundation would occur under existing conditions or under the 55% of unimpaired scenario only during 1 day for each of 6 years of the 32 years in the driest one-third of years, while the theoretical VSA constructed habitat would be inundated an average of 15 days annually in the driest one-third of years, and there would be some inundation during 24 of the 32 one-third driest years.

- The reason the theoretical VSA constructed habitat would be such a large improvement is that the 100 acres of constructed habitat would be at elevations that would be inundated at river flows of 2,000 cfs, which occur annually on average 82 days out of the 136 days in February 1 through June 15.

- In the YWA FERC relicensing, USFWS estimated the amount of floodplain habitat inundation that would have occurred if the YRDP had not been constructed (the "without YRDP" condition), and determined that the estimated median amount would be 2,598 acre-days (USFWS FERC Project 2246 10(j) Conditions Appendix 3). In contrast, the YCWA VSA Project would provide 11,073 acre-days of inundation, which is over 4 times greater. The "without YRDP" analysis consisted of the natural flow conditions with only the upstream projects present in the Yuba River Watershed.

- The YWA VSA Project would provide inundated natural floodplain and constructed rearing habitat in 9 out of 10 years equal to or greater than the inundation that would occur under existing or 55% of unimpaired flow conditions during only one-half of all years (86% exceedance inundation for the YWA VSA is greater than the 50% exceedance existing condition and 55% unimpaired inundation).

In summary, the preceding information shows that there would be a very large increase in the amounts of anadromous salmonid rearing habitat in the lower Yuba River with implementation of the YWA VSA Project.

1.3 Suggested Methodology Framework for Evaluating Fisheries Benefits of the Lower Yuba River Habitat Enhancement Measures

YWA's VSA Project includes five major elements: (1) collaboration with CDFW, DWR and NGO representatives (and other stakeholders); (2) a Delta flow component (i.e., up to 50,000 acre-feet per year of additional water during Above-Normal, Below-Normal and Dry-years), as measured at the Marysville Gage; (3) 100 acres of habitat enhancement in the lower Yuba River for Chinook salmon and steelhead juvenile rearing habitat; (4) a Measurement, Monitoring, Adaptive Management and Reporting (MMAM&R) Program that would contribute to informing fisheries science in the California Central Valley; and (5) a dedicated funding commitment of $10 million from YWA for funding habitat measures, and $7.8 million from YWA for funding an MMAM&R Program.

The primary objectives for the enhancement of aquatic habitat are to restore the quantity, quality, complexity, and connectivity of these habitats. Juvenile salmonid rearing habitat, in general, encompasses a wide variety of microhabitats and physical disturbances of the lower Yuba River channel have reduced the quantity and diversity of those habitats. The proposed habitat enhancement measures include the creation of additional diverse aquatic habitat types such as secondary channels, backwaters, and floodplain lowering, and installation of complex riparian features. Implementation of these habitat features would be expected to benefit the lower Yuba River through the creation of additional microhabitat types that would support a more diverse range of anadromous salmonid life histories.

The successful establishment of aquatic habitat would be evaluated through the enhancement of physical habitat, including depth, velocity, and area. Performance standards used to determine success of the habitat enhancement measures will be developed as part of the MMAM&R Program.

1.3.1 Physical Indicators

Anticipated potential benefits of habitat enhancement measures in the lower Yuba River would be evaluated in terms of physical parameters. A monitoring strategy would be developed as part of the MMAM&R Program. The monitoring strategy should be focused on successful establishment of critical physical habitat attributes, such as those described below.

Physical changes to the river channel and surrounding landscape could be quantified in terms of: (1) the projected gain in acres of riparian vegetation plantings; (2) the projected gain in the amount of suitable wetted area (acres) resulting from terraforming and floodplain lowering; and (3) the frequency and duration of inundation of habitat enhancement areas.

Depth and velocity are critical components of aquatic habitat and support a variety of biological and abiotic functions. Depth and velocity are important indicators of shallow water refuges for juveniles, as well as food availability and resting areas. Using the Yuba Accord-based flows, the amount of additional wetted area (acres) identified as being suitable for juvenile Chinook salmon and steelhead rearing could be determined by evaluating the frequency that site-specific depths and velocities are within a defined range, and whether suitable rearing habitat is available during the most limiting period (i.e., summer and fall).

Area is another important physical indicator of successful site establishment because it provides a simple measure of quantitative performance. Area could be measured as the two-dimensional wetted area of a feature at base flow. No broadly applied minimum area would be established for determining successful establishment of habitat features because each habitat feature would be created on a site-specific basis and would vary in the initial design and construction of wetted area. Successful establishment of area could be based on maintaining a percentage of initial design area. Successful establishment of wetted area, coupled with depth and velocity, would ensure that a feature was providing suitable quantity and quality of habitat.

Lowering the floodplain would increase inundation frequency and duration and support establishment of riparian vegetation, increased production of benthic macroinvertebrates, and increase access to off channel rearing habitat. An inundation duration of 21 consecutive days during the February through June period has been identified to support these functions, as described below.

- A 21-day duration of inundation is considered to be necessary to establish trophic productivity, and to provide benefits to juvenile anadromous salmonid rearing habitat functionality through provision of increased food resources and increased off-channel rearing habitat (Reedy 2016).
- Studies on the lower American River - a river system in some ways analogous to the lower Yuba River, have shown that floodplain invertebrate densities approach main channel densities after 2 to 4 weeks of inundation (J. Merz, pers. comm., as cited in cbec 2013).

- In Central Valley lowland river floodplains, studies have shown increased juvenile salmonid growth rates as a result of at least 21 days on the floodplain (Jeffres et al. 2008; Sommer et al. 2001, 2002).
- During this time period, phytoplankton and zooplankton life cycles produce valuable food resources in relatively slow moving, shallow water with temperatures typically warmer than the main river channel (Sommer et al. 2004).

Therefore, the parameters of frequency and duration of inundation can be used as physical indicators of functionality, and as a surrogate for increased aquatic food web productivity.

After completion of construction, physical monitoring would be conducted to evaluate whether the habitat enhancement measures are functional over the range of flows and performing as they are intended (e.g., are suitable depths and velocities for juvenile salmonids being achieved). Monitoring for assessing physical habitat structure also should include a survey before construction to determine pre-project baseline conditions.

1.3.2 Biological Indicators

It will be challenging to quantify the biological benefits associated with habitat enhancements in the lower Yuba River due to the complex nature of Chinook salmon and steelhead life histories, the potential for exposure of these species to a multitude of abiotic and biotic factors across broad geographic areas (many of which are outside the Yuba River Watershed), and uncertainties regarding environmental variations from year to year. Although challenges exist regarding the quantification of biological benefits in terms of specific numbers of juvenile outmigrants or adult returns, the scientific literature has generally demonstrated that the enhancement of juvenile Chinook salmon and steelhead rearing habitat does lead to increased juvenile growth and improved species survival.

Riparian habitats support the greatest diversity of wildlife species of any habitat in California, including many species of fish within channel edge habitats (CALFED 2000a). Furthermore, more extensive and continuous riparian forest canopy on the banks of estuaries and rivers can stabilize channels, provide structure for submerged aquatic habitat, contribute shade, overhead canopy, and instream cover for fish, and reduce water temperatures (CALFED 2000). More extensive and continuous shoreline vegetation associated with large woody material (LWM) (e.g., root wads) in shallow aquatic habitats can increase instream productivity and provide for instream structure for juvenile fishes and other aquatic organisms (CALFED 2000). LWM is of particular importance to riverine ecosystems, and reportedly may be the most important structural component of instream fish habitat (National Research Council 1996).

Although fish species do not directly rely on riparian habitat, they are directly and indirectly supported by the habitat services and food sources provided by the highly productive riparian ecosystem. Riparian communities provide habitat and food for species fundamental to the aquatic and terrestrial food web, from insects to top predators. Riparian vegetation on floodplains can provide additional benefits to fish when the floodplain is inundated, by providing velocity and refugia from predators.

Habitat complexity would be accomplished by providing hydraulic roughness elements such as submerged large woody material, building engineered log jams, planting riparian vegetation and placing large rocks and boulders. Habitat diversity would be improved by lowering channels and providing features such as riparian vegetation plantings, side channels, anabranching systems, floodrunners (i.e., side channels activated at higher flows) and enhanced backwater areas. Hall et al. (2018) found that quantifiable measures of riverine habitat complexity is a strong correlate of sub-yearling Chinook salmon productivity in Puget Sound populations. Specifically, the density of side and braid channel connections and their lengths relative to the length of the main channel were positively related to measures of Chinook salmon productivity (e.g., sub-yearlings per spawner) across multiple rivers with variable size, hydrologic and geomorphologic characteristics. Hall et al. (2018) also found that quantitative changes in habitat complexity associated with restoration projects (e.g., side channel creation) could be detected with their analysis.

Increased growth and improved survival of juvenile anadromous salmonids would be accomplished through increased habitat complexity and diversity, in combination with enhanced food availability, increased cover, and reduced potential for predation-related mortality. Floodplain habitat (including riparian vegetation as cover) and inundation duration, in conjunction with warmer water temperatures associated with shallow, low velocity areas, can promote increased prey abundance and production. Greater prey densities in floodplain-related habitats, relative to the main-channel, have been shown to improve feeding rates and result in faster growth. Flow-related surrogates such as depth and velocity will be used as indicators of suitable rearing habitat conditions. The frequency and duration at which off-channel and backwater areas are inundated within a range of suitable flows also will be used as indicators of food availability (primary production, macroinvertebrate colonization, etc.).

Juvenile salmon and steelhead survival is directly influenced by growth, with larger individuals being less susceptible to stressors and predation during critical early lifestages. Increased cover is an indicator of structure and survival. Instream object cover (e.g., riparian plantings) provides structure, which promotes hydraulic complexity, diversity and creates microhabitats for juvenile salmonids, as well as escape cover from predators. Predation is often a major source of mortality for juvenile salmon and steelhead, and the amount and quality of cover and structure can reduce predation rates. Because riparian plantings in isolation tend to be unsustainable, it is important to include other elements of cover and structural complexity (e.g., boulders, engineered log jams, other bioengineering features) in order to provide long-term sustainability and to enable these features to successfully serve as predator reduction mechanisms. Provision of overhanging riparian vegetation and LWM would increase avian and terrestrial predator escape cover, thereby also contributing to improved survival.

1.3.2.1 Net Gain in Weighted Usable Area (WUA)

An evaluation also would be conducted to estimate the design "benefits" of newly proposed technical features and habitat enhancement measures for spring-run Chinook salmon and steelhead, by lifestage. Because inundation duration values are not necessarily an indicator of habitat suitability, additional considerations must be given to species and lifestage-specific biological preferences regarding depth, velocity and cover. YWA would analyze fry and juvenile Chinook salmon and steelhead rearing habitat availability using the commonly accepted Physical Habitat Simulation component of the Instream Flow Incremental Methodology to quantify habitat suitability and availability expressed as Weighted Usable Area ("WUA"). Fisheries benefits would be measured in terms of the net gain in fry and juvenile rearing WUA (yd^2 per year) that would occur from the YWA VSA Project, compared to pre-project conditions on an annual basis.

DETAILED EVALUATION APPROACH

- Fry and juvenile rearing analyses would be conducted for the following lifestage-specific periodicities identified in RMT (2013).
    - Spring-run Chinook salmon fry rearing – Mid-November through mid-February
    - Spring-run Chinook salmon juvenile rearing – Year-round
    - Steelhead fry rearing – April through July
    - Steelhead juvenile rearing – Year-round
- Spring-run Chinook salmon and steelhead fry and juvenile rearing Habitat Suitability Criteria (HSCs) would be used to determine whether technical features improved water depth and velocity suitability patterns over the expected range of flows during specified time periods (i.e., months of the year).
- Composite Habitat Suitability Index (CHSI) maps of the lower Yuba River would be developed to determine amounts of suitable habitat areas for spring-run Chinook salmon and steelhead fry and juvenile rearing at various river flows.
- Potential habitat enhancement success would be evaluated as a measure of net gain in WUA (yd^2) per species and lifestage-specific periodicity on an annual basis over the entire period of hydrologic assessment.

- Rather than estimating potential habitat enhancement benefits using "representative" modeled flows, the potential for improved fry and juvenile rearing habitat in the lower Yuba River would be evaluated using exceedance probabilities of WUA[2] with and without enhancement measures, using daily values over the 41-year period of hydrologic model simulation.

1.3.2.2 Survivorship of Riparian Vegetation Plantings

Monitoring of riparian vegetation plantings associated with YWA's habitat enhancement measures would be conducted to assess annual growth rates and survival percentages. Performance standards used to determine riparian planting success will be developed as part of the MMAM&R Program. Monitoring activities associated with the riparian plantings would be consistent with those described for riparian vegetation in YWA's 2016 Lower Yuba River Aquatic Monitoring Plan.

[2] Because the WUA-discharge relationships are static and do not represent how often a specific habitat-discharge relationship occurs, habitat duration analyses (or probability of exceedance distributions) will be conducted using the daily flow model. A habitat duration curve is constructed in exactly the same way as a flow duration curve, but uses habitat values instead of discharge as the ordered data. A habitat duration curve is computed simply by obtaining the WUA value (for each species/lifestage) that corresponds to the mean daily flow for each day in the hydrologic record. The product is the mean daily habitat for each day in the hydrologic record. These data are then ordered into what is referred to as a habitat duration (or probability of exceedance) curve showing the percent time a particular habitat value is equaled or exceeded.

YUBA WATER AGENCY
VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

EXHIBIT 6

Chinook Salmon Doubling Goal Applied to the Lower Yuba River

Contributing to the Central Valley Project Improvement Act ("CVPIA") Chinook Salmon Doubling Goal and the narrative Chinook salmon doubling objective in the 2006 Bay-Delta Plan is one of the purposes of the YWA VSA Project. CDFW has stated that one of its resource objectives for the Voluntary Settlement Agreement process is attainment of the AFRP doubling goal of 66,000 fall-run Chinook salmon for the Yuba River. Therefore, it is important to accurately describe and understand how the doubling goal was developed for the lower Yuba River. For the reasons explained in this exhibit, the spawning stock escapement (annual spawner abundance) for the lower Yuba River equates to 26,000 adult Chinook salmon associated with the CVPIA doubling goal for naturally-produced adult Chinook salmon.

Title 34 of Public Law No. 102-575 established the goal of doubling natural production of Chinook salmon in Central Valley rivers. The doubling goal is for "naturally produced adults." The CVPIA identified the doubling goal for naturally-produced adult fall-run Chinook salmon in the lower Yuba River as being for "Chinook salmon" in general, referred to all Chinook salmon in the river as "fall-run," and did not consider or distinguish between spring-run and fall-run Chinook salmon.

In 1995, the USFWS conducted technical work to define and calculate the natural production doubling goal. The USFWS (1995) Working Paper defined natural production to be that portion of production not produced in hatcheries, and defined total natural production to be the sum of harvest (in-river and ocean) and escapement (river spawning adults).

USFWS's (1995) AFRP Working Paper[1] from which the doubling goals were identified and presented, stated that calculations to estimate natural Chinook salmon production included up to four components:

(1) In-river spawner abundance (i.e., escapement)

(2) In-river sport harvest

(3) Ocean sport and commercial harvest

(4) Hatchery returns (not applied to the Yuba River)

The reference period upon which the doubling goal is based is 1967-1991.

The doubling goals were not based upon life-cycle fisheries models. They were based on the simple addition of average estimated numbers of Chinook salmon adults in three separate categories over this same time period for the lower Yuba River. While total natural production applicable to the Yuba River was estimated to be 33,000 adult Chinook salmon for this reference period (1967-1991)[2], that number included not only adult in-river spawners, but also in-river sport harvest estimates, as well as ocean harvest (sport and commercial). As shown in the following tabulation, average escapement (in-river spawners) in the Yuba River (1967-1991) was 13,000 adult Chinook salmon. Average in-river harvest during that time period was estimated to be 1,000 adults, and ocean harvest was estimated to be 19,000 adult Chinook salmon.

Lower Yuba River

1967 – 1991 Reference Period[1]				Doubling Goal
Escapement	**In-River Harvest**	**Ocean Harvest**	**Production**	
13,000	**1,000**	**19,000**	**33,000**	**66,000**

[1] All of the individual values presented in the table were rounded to the nearest 1,000, including the natural-production doubling goal.
Source: USFWS 1995

USFWS (1995) rounded the estimates of each of these components to the nearest 1,000, which resulted in the natural production estimate of 33,000 adults (all putatively assumed to be fall-run) for the lower Yuba River Chinook salmon population. The CVPIA identified an AFRP goal of natural production of anadromous fish at twice the average attained during 1967-1991 in Central Valley rivers and streams, including the lower Yuba River.

[1] U.S. Fish and Wildlife Service (USFWS) 1995 Working Paper on Restoration Needs. Habitat Restoration Actions to Double Natural Production of Anadromous Fish in the Central Valley of California. Vol. 1 – 3. Prepared for the U.S. Fish and Wildlife Service under the direction of the Anadromous Fish Restoration Program Core Group.

The doubling goal of 66,000 adult Chinook salmon for the lower Yuba River was determined by simply doubling the estimate for each of the variables included in the estimate of natural production.

Hence, the spawning stock escapement (annual spawner abundance) equates to 26,000 adult Chinook associated with the CVPIA doubling goal for naturally-produced adult Chinook salmon. The remaining 40,000 adult Chinook salmon are categorized as harvest - the total of an average annual in-river harvest of 2,000 adults and an average annual ocean harvest of 38,000 adults.

The only part of the "doubling goal" for the Yuba River Chinook salmon population that the YWA VSA Project can address is the escapement component, because that is the only component of the population that will return to, hold and spawn in the lower Yuba River. Because there is no hatchery on the lower Yuba River, and because YWA has no control over hatchery operations elsewhere, it is appropriate for certain calculations associated with the CVPIA doubling goal to be based on 26,000 in-river spawners, not 66,000 naturally produced adults – which includes in-river spawners, in-river harvest and ocean harvest. "Natural production" does not equate to the annual number of in-river spawning adults.

Using an in-river Chinook salmon adult spawning value of 66,000 would be incorrect, because it would improperly combine the three different variables used in the estimate of natural production for the lower Yuba River into one number, and then apply that number to one component of the population. If such an incorrect assumption was carried forward into subsequent estimates of Chinook salmon habitat requirements, then it would produce a gross over-estimate of the juvenile habitat requirements in the lower Yuba River for the AFRP goal of doubling natural Chinook salmon production.

Therefore, modeling assumptions regarding the number of spawning adults used to estimate the amount of juvenile rearing habitat that may be necessary in the lower Yuba River should be based on 26,000 in-river spawning adults. If habitat quantity objectives to achieve the CVPIA doubling goal are developed for the VSA process, then those habitat-related objectives also should be based on a spawning population of 26,000 adult Chinook salmon for the lower Yuba River.

In conclusion, assumptions pertaining to achievement of the CVPIA Chinook Salmon Doubling Goal for naturally-produced adult Chinook salmon, and any use of the CVPIA doubling goal in the VSA process, should be appropriately based on the spawning stock escapement (annual spawner abundance) of 26,000 adult Chinook salmon for the lower Yuba River.

YUBA WATER AGENCY

VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

EXHIBIT 7

Yuba River Measurement, Monitoring, Adaptive Management and Reporting Program

The proposed Monitoring and Adaptive Management Program (Science Program) would be developed and implemented after execution of the YWA VSA Project. Similar to the approach taken for the Yuba Accord River Management Team's (RMT) Monitoring and Evaluation (M&E) Program, the Science Program for YWA's VSA Project would embrace a monitoring-based adaptive management approach to increase the effectiveness of, and to address the scientific uncertainty associated with, specific monitoring actions and habitat enhancement measures. The Science Program would include: (a) identification of Yuba River habitat enhancement goals and objectives; (b) an outline of the management actions that could be undertaken to achieve those goals and objectives; (c) a clear statement of the metrics and indicators by which progress toward achieving goals can be assessed; (d) identification of quantitative (e.g., conceptual ecological model) and qualitative (e.g., Yuba River Operations Model) tools to be used to assess metrics and indicators; and (e) a description of monitoring and evaluation procedures to be used to assess progress. Adaptive management would rely on monitoring, and would involve the development of mechanisms to incorporate monitoring results into the decision-making processes that would be used to determine if the goals and objectives were being achieved.

The Lower Yuba River Aquatic Monitoring Plan included in YWA's AFLA (which was developed in coordination with NMFS, USFWS, CDFW and the SWRCB), would be used as a foundation for the Science Program for the YWA VSA Project. The Lower Yuba River Aquatic Monitoring Plan, which will be implemented when the FERC license for the YRDP is issued, identifies procedures to monitor the following: (a) passage of fish by species at Daguerre Point Dam year-round; (b) annual spawning population abundance for spring-run Chinook salmon, fall-run Chinook salmon and steelhead; (c) the temporal and spatial distributions and habitat use of spawning steelhead upstream and downstream of Daguerre Point Dam; (d) abundance, size and timing of emigrating juvenile salmonids; (e) channel substrate and LWM; and (f) riparian vegetation cover and community structure.

Settlement Negotiations

As agreed to in the FERC relicensing process, YWA, in consultation with the NMFS, USFWS, CDFW and the SWRCB, would review, update and/or revise, the Lower Yuba River Aquatic Monitoring Plan, as needed, when significant changes in the existing conditions occur, including, but not limited to, changes in the listing status of aquatic species and changes in recommended sampling technology.

If necessary, the following framework could be applied to further develop specific Science Program components for the YWA VSA Project that are not already addressed in the Lower Yuba River Aquatic Monitoring Plan, which could include:

- High-level statement (Goals) that provides overall context for what a project is trying to achieve or accomplish (based on "SMART" principles). Goals are typically: (a) generic, abstract statements of overarching principles that guide decision-making; and (b) descriptive, open-ended, and broad statements of desired future conditions that convey a purpose, but do not define measurable units.

- Lower-level statement (Objective) that describes the specific, tangible product and deliverable that a project will provide (based on "SMART" principles). Objectives are typically: (a) specific, measurable steps that can be taken to meet a Goal; and (b) provide the basis for determining strategies, and evaluating the success of strategies, based on Goals.

- Descriptions of the results and measures of the effectiveness of actions implemented to meet objectives (Performance Criteria). Performance indicators are qualitative or quantitative means (standard, rule, or test) of gaging the performance of an action or a suite of actions. A performance indicator specifies what is to be measured along a scale or dimension. Examples of Performance Criteria for the habitat enhancement measures could include the following:

    - Sufficient availability of suitable juvenile rearing habitat where rearing enhancements are implemented, in consideration of parameters such as the quantity, distribution, and quality of in-stream cover, shaded riverine aquatic habitat, canopy cover, hydraulics, and water temperatures.

    - Changes in channel morphology and changes in use and abundance of juvenile salmonids are observed within the intended timeframe.

    - Increased fitness and densities of juvenile salmonids in enhancement reaches relative to control reaches.

- Specific values, units of measurement or narrative expressions (Metrics) that would be used to describe the reference biological condition corresponding to performance indicators.

- Specific data (Data and Analyses) that would be collected, and data analyses that would be performed, to establish the spatial and temporal scale in which relevant data will be collected.

- An evaluation of the habitat enhancement feature or measure in the field to determine whether they were constructed according to design, and ascertain whether they were implemented according to schedule (Implementation Monitoring).

- An evaluation to determine how well the habitat enhancement feature or measure achieved its desired results, and whether the biological objectives were met (Effectiveness Monitoring).

- A special subset of effectiveness monitoring intended to increase the effectiveness of monitoring and management by improving knowledge about the ecological system and about management techniques (Targeted Studies). Targeted studies may be implemented as short-term studies rather than as long-term monitoring.

- Identify the parameters that would be monitored prior to (i.e., pre-project conditions), during, and following (i.e., post-project conditions) implementation of the habitat enhancement measures.

- Identify the physical parameters, including hydraulic parameters (e.g., water depth and velocity), geomorphic (e.g., substrate), riparian (e.g., streamside vegetation), and chemical (e.g., water quality) attributes of the system that would be expected to exhibit an observable and quantifiable response to the implemented habitat enhancement measures and the expected direction and/or magnitude of anticipated change.

- Identify the biological parameters that would be expected to exhibit an observable and quantifiable response and the expected direction and/or magnitude of change. Changes in biological parameters are often measured as secondary responses resulting from improved habitat conditions created by physical modifications or enhancements.

- Criteria for habitat enhancement measure success (e.g., specific measure to determine whether the habitat enhancement measures were designed and implemented according to specifications, whether objectives for each measure were met, whether target species' or lifestage response(s) were achieved, etc.).

- Develop a conceptual ecological model that would include: (a) types and number of enhancement activities; (b) physical actions to be undertaken; (c) functions and values that will result; and (d) monitoring activities to be carried out.
- Identification of comparative bases, such as the following: (a) characterize the quantity and quality of juvenile rearing habitat in habitat enhancement measure areas and control reaches over time; and (b) quantify densities of juvenile salmonids in habitat enhancement measure areas and control reaches over time.
- Estimated cost and duration of monitoring.
- Contingency plan for corrective actions if corrective actions do not achieve ecological success.
- A range of management options that would achieve or contribute to achieving the goals and objectives.
- Governance structure and roles (see Section 11 of the Project Description).

Specific procedures for the administration of the would be informed by the YWA VSA governance provisions.

Specific reporting requirements for presenting monitoring results, evaluating progress toward achieving success and determining adaptive management decisions would be identified during the development of the Science Program for the YWA VSA Project.

YUBA WATER AGENCY

VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

EXHIBIT 8

Other Provisions of the YWA VSA

1. Compensation for Supplemental Flow Contribution

YWA would not receive any compensation for Base Contribution Water (i.e., YWA VSA Component A Water: the first 9,000 ac-ft per year provided by YWA). Component A Water represents YWA's proportionate contribution.

CDFW and DWR would be responsible for paying YWA $290 per acre foot for all Supplemental Contribution Water (YWA VSA Component B Water). Component B Water exceeds YWA's proportionate contribution. YWA would be entitled to receive payment within 60 days of making Supplemental Contribution Water available under the YWA VSA Project. This payment may be funded through: (1) the Water Purchase Revolving Fund that is being established by CDFW and DWR; or (2) other funding sources that are approved by YWA.

CDFW and DWR would not seek contributions from, or support charges to, YWA or the YWA Member Units for the Water Purchase Revolving Fund or any comparable fund established for a similar purpose.

2. Support for YRDP FERC License AFLA

YWA cannot perform its commitments under the YWA VSA Project unless instream flow requirements of any new FERC license for the YRDP are substantially consistent with YWA's Amended Final License Application (AFLA), which was based on the flow requirements the SWRCB added to YWA's water right permits through Corrected Order WR 2008-0014, and which have been proposed in substantially the same form in the FERC's Final Environmental Impact Statement (FEIS). Comments previously made by the CDFW and SWRCB to FERC in the YRDP relicensing process were inconsistent with the Yuba Accord, YWA's AFLA and the FERC's FEIS. If new instream flow requirements based on these comments were adopted, then they would make the proposed YWA VSA approach to lower Yuba River flows infeasible.

Yuba Accord-based fishery flows were included in the AFLA, with only minor modifications. The AFLA specifies the proposed regulatory requirements that should be used in implementing the Bay-Delta Plan Update and the new FERC license for the YRDP. Under the YWA VSA Project, CDFW and DWR would support the AFLA in YRDP FERC license proceedings and other regulatory proceedings.

CDFW and DWR would not seek any additional requirements beyond those in the AFLA: (1) in their requests to the SWRCBs for its Clean Water Act section 401 certification for the FERC license for the YRDP; (2) in consultations under the ESA; (3) in any other proceedings regarding the FERC license for the YRDP; or (4) in any SWRCB proceeding regarding YWA's water rights.

Upon the effective date of the YWA VSA, CDFW and DWR would notify FERC of their support for the AFLA, and CDFW would withdraw its pending requests and proposals to FERC for additional requirements different from those in the AFLA.

YWA's requirement to perform its obligations under the YWA VSA Project would be subject to provisions of the new FERC license for the YRDP not being materially inconsistent with the AFLA. If YWA believes that the any provisions of the new FERC license is materially inconsistent with the YWA VSA Project, then the parties would meet and confer to attempt to resolve any such inconsistency. YWA's obligations to perform the VSA would terminate if the new FERC license has any requirements that are in addition to or inconsistent with the FEIS.

3. Consistency of YRDP License and Bay-Delta Plan Update Implementation

YWA's requirement to perform its obligations under the YWA VSA Project would be subject to implementation of the YWA VSA flow and habitat enhancement measures through amendments to the SWRCB's plan of implementation for the Bay-Delta Plan Update, and not through other regulatory proceedings.

During the term of the YWA VSA Project, YWA and the YWA Member Units would not be required to contribute additional water or funds beyond the quantities and amounts specified in the YWA VSA. If the SWRCB, through the Bay-Delta Plan Update or otherwise, or if any other regulatory agency, were to adopt any provisions that would be in addition to, inconsistent with or contrary to, the YWA VSA Project, then the VSA would subject to termination or withdrawal by YWA as a failure of a condition subsequent to the obligations of the Parties to perform their respective obligations under the YWA VSA, upon YWA providing 30 days' notice to the other VSA parties.

4. Amendment of Yuba Accord WPA

YWA's requirement to perform its obligations under the YWA VSA Project would be subject to DWR agreeing to amend the Yuba Accord Water Purchase Agreement: (1) to extend the term of the WPA to be the same as the term of the VSA; (2) to agree to repurpose from potential exports to Bay-Delta outflows all Yuba Accord Released Transfer Water in April, May and June that cannot be backed into Lake Oroville or exported by DWR (i.e., that cannot be accounted for as Delivered Transfer Water), as these terms are defined in the Yuba Accord Water Purchase Agreement; and (3) to support a request by YWA to the SWRCB to extend the period specified in the SWRCB's Corrected Order WR 2008-0014 for the authorized place of use, purpose of use and points of rediversion for Yuba Transfer Water to equal the terms of the amended Yuba Accord Water Purchase Agreement and the VSA.

YWA's requirement to perform its obligations under the YWA VSA Project would be subject to the SWRCB approving a request by YWA to extend the period specified in the SWRCB's Corrected Order WR 2008-0014 for the authorized place of use, purpose of use and points of rediversion for Yuba Transfer Water to equal the terms of the amended Yuba Accord Water Purchase Agreement and the VSA.

YWA would not be required to perform its obligations under the YWA VSA Project if the SWRCB or a court with jurisdiction determines that YWA must obtain approvals or authorizations under the Yuba Accord Fisheries Agreement to implement the Flow Measures.

The Yuba Accord Water Purchase Agreement furthers California law and policy by providing supplemental water supplies in times when they are needed in other parts of California. The ability of YWA to continue to provide water supplies under the Yuba Accord Water Purchase Agreement should be preserved during implementation of the Bay-Delta Plan Update and the new FERC license for the YRDP.

5. YWA Contributions for Science Program and Habitat Enhancement

YWA's contributions to the Yuba Watershed Structural Science Fund under the YWA VSA would be on behalf of YWA and YWA Member Units, and not on behalf of other water users in or diverters of water from the Yuba River Watershed.

CDFW and DWR would not seek any contributions from, or regulatory requirements applicable to, YWA Member Units for habitat enhancement measures for the purposes described in the YWA VSA.

CDFW and DWR would not seek contributions from, or support charges to, YWA or any of its

Member Units for the Yuba River Watershed Habitat Enhancement Fund or any comparable fund established for a similar purpose.

6. No Approval Required under the Yuba River Accord Fisheries Agreement

CDFW, DWR and YWA would agree that implementation of the YWA VSA Project would not require any approval under, or amendment of, the Yuba Accord Fisheries Agreement.

YWA's obligations to perform the YWA VSA would terminate if there were any determination that implementation of the YWA VSA Project would require an approval under, or amendment of, the Yuba Accord Fisheries Agreement.

Settlement Negotiations

YUBA WATER AGENCY

VOLUNTARY SETTLEMENT AGREEMENT PROJECT DESCRIPTION

EXHIBIT 9

Guiding Principles for Implementing the YWA VSA

The YWA VSA Project would be implemented and interpreted in accordance with these guiding principles:

1. The Yuba Accord Water Purchase Agreement furthers California law and policy in providing supplemental water supplies in times of need to other parts of California. The ability of YWA to continue to provide such water supplies under the Yuba Accord Water Purchase Agreement should be preserved during implementation of the Delta Plan Update and the new FERC license for the YRDP.

2. Contributions to Delta inflows for implementation of the Delta Plan Update from the Yuba River watershed should be comparable and proportionate to the contributions required of other tributaries in the Sacramento River Basin. YWA has provided information to CDFW and DWR that shows that the diversions of flow from the Yuba River watershed comprise about 9% of average annual Sacramento River Basin diversions. CDFW and DWR would review this and other relevant information to confirm that the percentage allocation for this purpose in the YWA VSA is appropriate.

3. Contributions to Delta inflow in implementing the Delta Plan Update by major diverters of water from the Yuba River watershed should be comparable and proportionate to the amounts of their respective diversions of unimpaired flows from the Yuba River watershed. YWA has provided information to DWR and CDFW that shows that, based on average diversions for the past 25 years: (a) YWA diversions are about one-third of the total Yuba River watershed diversions; and (b) the other two-thirds of average diversions are used outside of the Yuba River watershed. CDFW and DWR would review this and other

relevant information to confirm that the percentage allocation for this purpose in the YWA VSA is appropriate.

4. Based on YWA's estimates, YWA's share of a contribution to Delta inflow from the Sacramento River Basin should be 3% (one-third of 9%). CDFW and DWR will review this and other relevant information to confirm that the percentage allocation for this purpose in the YWA VSA is appropriate.

5. The Base Contribution Water (YWA VA Component A Water) that YWA would provide under the YWA VSA Project for Delta inflow would be comparable and proportionate to YWA's proportionate share of the Yuba River watershed's comparable and proportionate share of a 300,000 acre-foot per year flow contribution to Delta inflows from the Sacramento River Basin.

6. Supplemental Contribution Water (YWA VA Component B Water) that YWA would provide under the YWA VWA Project for Delta inflows exceeds YWA's comparable and proportionate share of contributions to Delta inflow (i.e., the Base Contribution Water).

7. YWA's willingness to provide Supplemental Contribution Water for Delta inflow that exceeds what would be YWA's comparable and proportionate share of contributions to Delta inflow would not be a precedent for any future regulatory proceedings.

8. YWA cannot perform its commitments under this Agreement without adequate assurances that the new FERC license for the YRDP and YWA's water right permits will be consistent with the Final EIS for the new FERC license for the YRDP, and that such new FERC license will not impose any additional or inconsistent requirements on the YRDP.

9. Floodplain enhancement and fisheries habitat enhancement measures on the Yuba River should be implemented through voluntary and collaborative actions, like those that would be provided for under the YWA VSA, rather than as regulatory requirements.

Appendix A4: American River

1.4 American River

1.4.1 Flow and Temperature Measures

Reclamation and the American River parties would manage and supplement environmental flows through several components. The project description set forth below reflects the American River agencies' proposal based on the December 12, 2018 presentation to the SWRCB and detailed follow-up discussions with Reclamation. Details concerning this proposal are subject to further refinement as the parties continue their discussions.

Minimum Lower American River Flows and Flow Augmentation. Reclamation would operate Folsom and Nimbus Dams to release minimum flows to the Lower American River as specified by the minimum release requirements (MRR) proposed by the Water Forum in 2017. The streamflows required by the MRR would range from 500 to 2,000 cfs, based on time of year and annual hydrology, would be adopted and implemented in all water years. The criteria defining the MRR are stated in detail in Appendix A-1. Reclamation's water-right permits for Folsom Dam and Reservoir (Permits Nos. 11315 and 11316) would be made subject to the MRR through the Voluntary Agreement for that agreement's term. As described in more detail below, the American River parties would augment the flows released from Folsom in certain water year types through groundwater substitution, reservoir reoperation and groundwater banking. These flows would contribute water for the purpose of testing Delta outflow and other hypotheses.

Folsom Reservoir Storage Management. In its CVP operational planning and forecasting for all water years, Reclamation would use an end-of-December Folsom Reservoir storage planning minimum of a single value, or a number of values that vary by hydrologic conditions, within a range between 250,000 and 300,000 acre-feet (Planning Minimum). Reclamation would plan to meet or exceed the Planning Minimum. When Reclamation forecasts that it will not be able to meet the Planning Minimum in a given year, it will inform an identified representative of the American River parties of that forecast within five days and transmit the supporting information and modeling. The American River parties and Reclamation will consult to identify and implement appropriate actions to improve forecasted storage, which may include, but not be limited to, the American River parties recommending to their respective governing boards that they initiate the first stage of their water shortage contingency plans. Those parties will work together to educate the public on the actions that have been agreed upon and implemented and the reasons and basis for them. Reclamation's water-right permits for Folsom Dam and Reservoir would be made subject to these storage management terms, including the Planning Minimum, through the Voluntary Agreement for that agreement's term.

Water Temperature Management. To seek to maintain water temperatures appropriate for salmonids in the Lower American River, Reclamation will continue to operate the Folsom/Nimbus Dam complex, in consultation with the American River Group (ARG), as follows:

- Operate the Folsom/Nimbus Dam complex, and the water control shutters at Folsom Dam, to maintain, to the maximum extent possible, a daily average water temperature of 65ºF or lower at Watt Avenue Bridge from May 15 through October 31 to provide suitable conditions for juvenile steelhead (Temperature Target);
- Adopt an annual water temperature management plan by May 15 of each year;
- Use the Coldwater Pool Management Model (CPMM) developed by the Water Forum, or a replacement that the parties agree is equivalent or better, in developing the plan;
- If the CPMM indicates that the Temperature Target cannot be met, then Reclamation will use the Automated Temperature Selection Procedure (ATSP) developed by the Water

Forum, or a tool that the parties have determined is equivalent or better than the ATSP, to select that year's temperature goal at Watt Avenue (Annual Temperature Goal), which may be as high as 68ºF; and

- If, during the May 15-October 31 period, Reclamation determines that the Annual Temperature Goal cannot be met because of limited cold water availability at Folsom Reservoir, then Reclamation may propose to adjust that Goal incrementally (no more than 1ºF every 12 hours) to as high as 68ºF at Watt Avenue.
- At times, releases from Folsom Reservoir, and lower American River streamflows, may be above the MRR due to CVP operations that address conditions or demands outside of the American River region. Reclamation will ramp down those releases and streamflows as soon as possible in the fall and maintain the resulting flows, where possible given the CVP's integrated operations and flood-control operations, through the winter in an effort to maximize spring Folsom Reservoir storage for the purpose of developing the largest possible annual cold-water pool.[4]

The ARG was established in 1996 and is comprised of Reclamation, CDFW, NMFS, the U.S. Fish & Wildlife Service and the Water Forum. The ARG meets at least monthly and more frequently as needed. The ARG's functions were described in NMFS's 2009 biological opinion.

Reservoir Reoperation in Above Normal and Below Normal Water Year Types (American Flow Contribution 1). Subject to the commitment of agreed funding, Placer County Water Agency (PCWA), El Dorado Irrigation District (EID), Georgetown Divide Public Utility District (GDPUD) and Foresthill Public Utility District (FPUD) would reoperate reservoirs that they own and operate upstream of Folsom Reservoir to contribute a total of 10,000 acre-feet per year to augment Lower American River and Delta flows in the April-June period, or a later period determined to be biologically preferable in a particular year through the science program, in Above Normal and Below Normal water years. Calls for this water may be made in up to six Above Normal or Below Normal water years during the 15-year term of the Voluntary Agreement. The upstream reservoirs' operations following the reoperations will be subject to reservoir refill criteria so that those reoperations do not affect CVP/SWP operations by, in general, requiring that refill occur during times that Folsom Reservoir is in flood operations or is passing inflow. Reclamation will augment Lower American River and Delta flows in the April-June of the applicable years and the reoperations will occur in the following months to replenish water that Reclamation releases from Folsom Reservoir on a schedule that the parties coordinate and that Reclamation approves.

Groundwater Substitution in Dry and Critical Water Year Types (American Flow Contribution 2). Subject to the commitment of agreed funding, the American River parties who can pump groundwater, or arrange such pumping, would support augmentation of April-June Lower American River flows, and Delta flows, through the use of 10,000 acre-feet of groundwater substitution water in Critical and Dry water years. Reclamation may release the water after the April-June period if such releases are determined to be biologically preferable through the science program. The groundwater would be pumped: (1) during the April-June period or, if necessary, within 12 months following the date on which the call for water is made, to replenish water released from Folsom Reservoir by Reclamation; (2) from the North American or the South American Subbasins; and (3) pursuant to the applicable groundwater management plan(s) or, no later than February 2022, groundwater sustainability plans. Calls for this water may be made in up to six Critical or Dry water years during the 15-year term of the Voluntary Agreement. The depletion rates would be determined by Reclamation and DWR, in consultation with the American River parties, based on

[4] The measures described above were originally imposed in Reasonable and Prudent Alternative Action II.2 stated in the National Marine Fisheries Service's (NMFS) 2009 biological opinion. The parties agree that these measures should be continued, even if the 2009 biological opinion is superseded during the term of the VA.

local conditions and data developed by the American River parties, or, absent a determination, based on technical conclusions. The current depletion rates are at eight percent. The flow contribution would be 10,000 acre-feet net of calculated depletion.

Groundwater Bank for Dry and Critical Water Year Types (American Flow Contribution 3). Subject to the commitment of agreed funding, the American River parties who can pump groundwater, or arrange such pumping, would support augmentation of April-June Lower American River flows, and Delta flows, up to an additional 20,000 acre-feet in Critical and Dry water years through groundwater substitution made possible by a groundwater bank. Reclamation may release the water after the April-June period if such releases are determined to be biologically preferable through the science program. The American River parties' commitment would be 500 acre-feet per each $1 million of funding for new groundwater facilities provided by state bond funding, other state funds or other federal funds. Each increment of 500 acre-feet would be implemented within 18 months of the American River parties receiving the commitment of associated $1 million of funding. The groundwater would be pumped: (1) during the April-June period or, if necessary, within 12 months following that period to replenish water released from Folsom Reservoir by Reclamation; (2) from the North American or South American Subbasins; and (3) pursuant to the applicable groundwater management plan(s) or, no later than February 2022, groundwater sustainability plans. Calls for this water may be made in up to six Critical or Dry water years during the 15-year term of the Voluntary Agreement. The depletion rates would be determined by Reclamation and DWR, in consultation with the American River parties, based on local conditions and data developed by the American River parties, or, absent a determination, based on technical conclusions. The current depletion rates are at eight percent. The flow contribution would be 20,000 acre-feet net of calculated depletion.

Additional Water in Dry Water Year Types (American Flow Contribution 4). Subject to the commitment of agreed funding, the American River parties would support augmentation of Lower American River and Delta flows in the April-June period of up to an additional 10,000 acre-feet from: (1) reservoir reoperation among PCWA, EID, GDPUD or FPUD; (2) groundwater substitution by American River parties who can pump groundwater, or arrange such pumping; or (3) a combination of those sources. Reclamation may release the water after the April-June period if such releases are determined to be biologically preferable through the science program. The sources of this contribution would depend on the hydrology and related operations in immediately preceding water years. Reservoir reoperations to support this flow contribution would be subject to the same terms as for the base reservoir reoperations described above. Groundwater substitution to support this flow contribution would be subject to the same terms as for the base groundwater substitution described above.

1.4.2 Non-Flow Measures

Lower American River Habitat Contributions. Subject to sufficient funding and the issuance of necessary permits, Reclamation, CDFW and the American River parties will ensure that an additional 50 acres of anadromous fish spawning habitat, and an additional 150 acres of rearing habitat, is created in the Lower American River at the most beneficial locations consistent with implementing this additional habitat as soon as possible to maximize its biological value. The map attached as Appendix A-2 depicts the potential locations of these habitat augmentations. (The map is illustrative of the contributions. Actual locations may change, but provide equivalent value.) Maintenance of these habitat contributions following their implementation will be considered as potential habitat contributions in later years. If such maintenance is implemented, the acres of maintenance implementation would count toward the total acres for that sort of habitat contribution.

Nimbus Fish Hatchery Improvements. By the end of the 15-year Voluntary Agreement term and subject to appropriations, Reclamation will make physical and operational improvements to the Nimbus fish hatchery to ensure sufficient production of healthy anadromous fish to meet Reclamation's mitigation spawning requirements associated with Folsom Dam and Reservoir.

American River Science, Governance and Adaptive Management. In cooperation with state and federal agencies, the American River parties and the Water Forum have implemented multiple science, governance and adaptive management measures for many years. These measures would continue in order to ensure biologically appropriate management of American River flows, temperatures and habitat.

As discussed above and subject to Reclamation's operational discretion and any applicable biological opinion terms, the ARG generally operates by consensus and makes recommendations regarding, among other things, potential cold water management alternatives when Reclamation's forecasting indicates that Lower American River temperatures will not meet the Temperature Target.

The "FISH," or "Fish and Instream Habitat," group formed in 2000 and consists of: (a) the Water Forum, which convenes the group; (b) Reclamation; (c) CDFW; (d) NMFS; (e) USFWS; (f) the Sacramento Area Flood Control Agency (SAFCA); and (g) the Sacramento County Parks Department. This group establishes priorities for restoration activities and provides feedback on specific proposed restoration projects. This group generally meets quarterly and in public. Its decisions are made by consensus.

The Gravel Design Team formed in about 2006 and consists of: (a) the Water Forum, which convenes the group; (b) Reclamation; (c) CDFW; (d) NMFS; (e) USFWS; (f) SAFCA; and (g) the Sacramento County Parks Department. This team selects sites for gravel augmentation projects and consults on the details of those projects' designs. Decisions are made by consensus. This team will be involved in the selection of projects to implement Lower American River Habitat Contributions discussed above. This team uses existing bodies for public outreach, including the FISH Group and the Sacramento County Regional Parks Commission.

The Water Forum's technical team of hydrologists, fishery biologists and other experts provides technical support to all of the American River science and adaptive management groups through existing funding arrangements, primarily among the American River parties.

1.4.3 Funding

1.4.3.1 Funding for American River flow measures.

Compensation for American Flow Contributions. The American River parties will be compensated for their Flow Contributions above as follows: (A) for American Flow Contributions 1 and 4, by payment by Reclamation, DWR or another public source of $290 per acre-foot of contribution; (B) for American Flow Contribution 2, by an up-front payment of $15 million from a public source; and (C) for American Flow Contribution 3, by state bond funds from a bond approved by the voters after 2014's Proposition 1, by state funds from other than a bond or federal funds.

Contributions to Water Purchase Program Fund. Other than pre-1914 water-right water delivered under a Warren Act contract, the American River parties will contribute, to the water purchase program fund or equivalent funding mechanism, $5 per acre-foot for all water that Reclamation delivers to them under a CVP water-service contract, a CVP repayment contract or a Warren Act contract. In recognition of the American River parties' longstanding and on-going financial commitments to regional water facilities to reduce reliance on the American River, those parties may make in-lieu contributions to the water purchase program fund by legally obligating themselves to make $5-per-acre-foot contributions to a fund created to support additional regional self-reliance. Disbursements from that fund will not be subject to federal or state budget processes or appropriations. That fund may be used for any legal purpose of the American River parties.

1.4.3.2 Funding for American River non-flow measures

American Spawning Habitat Contribution. The American River parties and Reclamation will bear equal responsibility for funding this habitat contribution (though the parties understand that Reclamation's ability to commit funds is subject to applicable legal requirements including appropriations). All parties may seek, and will support the acquisition of, other sources of funding, including potential state bond funding.

American Rearing Habitat Contribution. This contribution will be funded from the Structural Habitat Science Fund, from state bond funds, from other public or private sources or from a combination of these sources.

Structural Habitat and Science Fund. The American River parties will contribute $2 per acre-foot for all water they deliver for consumptive use in the American River watershed to the Structural Habitat and Science Fund, or an equivalent funding mechanism established to fund habitat and science programs under the Voluntary Agreements. To continue to support the Water Forum's efforts, $1.75 in benefits for each $2 contribution by the American River parties would be returned to the American River region for the purpose of funding local science and habitat by Reclamation or other state or federal entity that operates the fund, with the remaining $0.25 being directed to Delta science and habitat efforts.

1.4.4 Timing

The applicable American River parties' obligation to make an American Flow Contribution will take effect upon the legally-binding commitment to those parties of the funding source associated with that Flow Contribution. The collective obligation of Reclamation, CDFW and the American River parties to implement a given project within American Habitat Contribution 2 will take effect when a sufficient source of funding for it is legally bound to be provided for that project.

1.4.5 Expected Outcomes

The actions taken by CDFW, Reclamation and the American River Parties will result in improved spawning and rearing conditions for Steelhead and Fall-run chinook salmon through improvements in flow timing, water temperature, physical habitat and hatchery improvements. In addition, additional water provided by the American River Parties and managed by Reclamation at Folsom Reservoir will result in additional Spring Delta inflow.

Appendix A5: Mokelumne River

1.5 Mokelumne River

The Mokelumne River Parties propose the implementation of an integrated suite of flow and non-flow measures to improve conditions for anadromous fish in the lower Mokelumne River that is balanced with maintaining water supply reliability, preserving cold water pool, protecting habitat conditions, and improving the Bay-Delta ecosystem. The Mokelumne River Parties include Amador Water Agency (AWA), Calaveras County Water District (CCWD), Calaveras Public Utility District (CPUD), East Bay Municipal Utility District (EBMUD), and North San Joaquin Water Conservation District (NSJWCD).

As described in the *Draft Baseline for the Proposed Mokelumne River Voluntary Agreement*, attached hereto as an Appendix, the Mokelumne River has in place a comprehensive fisheries program that protects and enhances the fishery resources and ecosystem of the lower Mokelumne River and supports Bay-Delta flows and objectives. This program, established under the 1998 Joint Settlement Agreement (JSA) between EBMUD, California Department of Fish & Wildlife (CDFW), and United States Fish & Wildlife Service (USFWS), includes participation by the National Marine Fisheries Service (NMFS) and a broad stakeholders group. The JSA was approved by the Federal Energy Regulatory Commission in 1998 and its flows were adopted by the State Water Board in D-1641. The JSA requires minimum flows in all year types and requires non-flow measures for fishery purposes. (Please see the Appendix for a full description of the Mokelumne River baseline conditions and flows required under all existing requirements.)

The Mokelumne River is uniquely situated as a direct tributary to the Delta. Thirty-seven miles of the North Fork and Main Stem of the Mokelumne River between Salt Springs and Pardee Reservoir were added to the California Wild and Scenic Rivers System. The Mokelumne River Fish Hatchery provides virtually all of the ocean fishery from the San Joaquin Basin, and it accounts for approximately 20% of the commercial fishery and 35% of the recreational fishery from all tributaries of the Bay-Delta.[5] During the period that the JSA has been implemented, salmon escapement on the Mokelumne River has exceeded the doubling goals set forth in the Anadromous Fish Restoration Program (AFRP), 1992 Central Valley Project Improvement Act (CVPIA). As part of the State Water Board's Bay-Delta Water Quality Control Plan (WQCP) Update process, the Mokelumne River Parties propose to increase the existing flow requirements and JSA non-flow measures in a manner that is beneficial to fishery needs and provides additional flows to the Bay-Delta.

1.5.1 Flow Measures

A.1 Measurement, Monitoring, and Reporting

The JSA Partnership Coordinating Committee (CDFW, USFWS, and EBMUD) would develop a compliance plan for measurement, monitoring and reporting the block flows in Table 1 below in order to provide maximum benefit to fish and wildlife in the Mokelumne River and Bay-Delta. The plan shall include some of the following goals and objectives for evaluation purposes: (i) consideration of Camanche Reservoir and Pardee Reservoir cold water storage, (ii) water temperature below Woodbridge Dam, (iii) the timing, magnitude, and protection of flow from other Central Valley systems through the Delta, (iv) Mokelumne River percent of redd emergence by date, (v) in-river temperature projections, migration timing, (vi) percent development of anticipated floodplain habitat and required inundation timing, frequency and duration.

A.2 VA Flows

[5] This is based on the 2017 San Joaquin Basin share of recreational and commercial fishery, and the Chinook salmon stock was primarily from the Mokelumne River Fish Hatchery.

Table 1 shows the flows proposed by the Mokelumne River Parties in addition to all existing minimum flow requirements.

Table 1: Additional Required Release Above Existing Required Minimum Flows

	JSA Year Type			
	Normal and Above	**Below Normal**	**Dry**	**Critically Dry**
Total Block Flow	45,000 AF	20,000 AF	10,000 AF	N/A
Spring Block (March through May)	75-85% of total volume	75-85% of total volume	75-85% of total volume	N/A
Fall Block (Sept. through October)	15-25% of total volume	15-25% of total volume	15-25% of total volume	N/A

Notes:
If flood control releases on a given day are greater than the daily schedule provided by the JSA Partnership Coordinating Committee, then no additional release is required on that day.
March through October additional VA flow requirements are based on JSA year types determined by water year unimpaired runoff into Pardee Reservoir.
In years when EBMUD's March 1st median forecast of Total Combined Pardee and Camanche (P+C) storage by End-of-September is projected to be less than 350 thousand acre-feet, then no VA flow requirement applies, but JSA-required flows would be provided.
In "Critically Dry" years (per JSA definition), no VA flow requirement applies, but JSA-required flows would be provided.
AF is an abbreviation for acre-feet and N/A for not applicable.

A.3 VA Flow Impacts Mitigation Measures

a. Amador Water Agency - AWA will provide 2,000 AF per year of its previously conserved water supplies for 10 years that could be used by the State to increase instream flows and Delta outflows. This flow contribution is inclusive of the flows identified in Table 1. In return, the State would provide $5 million in funding to be used for planning and developing a high-elevation water storage and supply project. AWA also would consider extending these water releases beyond the ten-year period on a year by year basis for an amount of compensation to be determined and subject to written acknowledgement that any supplies provided after the 10-year period are conserved water reserved to AWA for serving planned-for increase in consumptive demands within its service area. The proposed project would capture wet season storm water and store that water for use in dryer periods to increase local water supply reliability in drought periods, mitigate climate change effects, increase the available cold water pool in upstream reservoirs, and to increase opportunities for conjunctive use projects to improve the health of groundwater basins within the Mokelumne River watershed. The Mokelumne Watershed Interregional Sustainability Evaluation (MokeWISE) study would provide the source of preferred projects to be considered. MokeWISE identified and evaluated alternatives to optimize water resource management projects within the Mokelumne River watershed and the final report was broadly supported by water suppliers, non-governmental organizations, and local governmental agencies. AWA may partner with other water purveyors in development of this project and collectively would contribute 20% of the water developed by any project that is finally approved and can be funded and constructed for dedicated instream flows and Delta outflows with timing and rates of releases to be determined by resource agencies within defined use periods. These contributed instream flows and Delta outflows from a constructed project would be in addition to dedicated flows in Table 1 above.

b. North San Joaquin Water Conservation District – The VA will reduce the water available to NSJWCD and adversely impact NSJWCD's ability to conjunctively manage surface and groundwater supplies to correct conditions of groundwater overdraft. NSJWCD will contribute the adverse impact on its water supply to facilitate the VA provided that the dedicated flows in Table 1 shall fully satisfy Term 18 of Permit 10477 during the term of the VA such that NSJWCD will not have to further dedicate a portion of its available Permit 10477 supplies when JSA and Table 1 flows are satisfied. NSJWCD will develop groundwater recharge projects to maximize the use of surface water during wetter years to offset the impacts of the VA and improve groundwater overdraft conditions. The State will agree to provide $5M in funding toward the cost of these facilities. NSJWCD will bear all costs to operate and maintain the facilities.

c. East Bay Municipal Utility District - EBMUD would purchase and install 1,500 to 2,000 acoustic leak detection devices in its treated water distribution system. These devices will substantially increase an existing leak detection system. EBMUD would use the information from these devices to detect and repair distribution system water leaks thereby offsetting a portion of the additional flow measures noted in Table 1. The State would agree to fund purchase and installation of the devices at a one-time cost of $15 million. EBMUD would bear all costs to operate and maintain the devices and for leak repairs.

1.5.2 Non-Flow Measures

The non-flow measures contained within the Mokelumne VA include a variety of habitat improvement and enhancement projects, along with measure to improve survival, genetics, and science related to salmonid resources. The measures will also improve habitats and outcomes for native species within the river corridor. The non-flow component of the proposal is delineated into four main categories designed to address rearing habitat, migration habitat and hatchery management, spawning habitat, and research and monitoring.

B.1 Condition 1: Rearing Habitat

a. Measure 1A: Creation of Floodplain Habitat

Project Description: EBMUD has direct access to, and would commit to creating, approximately 10 acres of juvenile fish rearing habitat (in the form of functional floodplain and side channel habitat) in the first two river miles below Camanche Dam in the Mokelumne River Day Use Area over the next 5 years. Floodplain habitat and side channels would be created by reconnecting isolated pits formed by hydraulic mining and redistributed fines to encourage riparian plant species recruitment.

An additional 50 acres of seasonal floodplain habitat creation has also been identified within the first seven miles of the Lower Mokelumne River (LMR). Restoration of the 50 acres is contingent on willing landowners and permitting support from the CDFW. Upon execution of the VA, EBMUD will immediately commit to finding willing landowners and appropriate habitats to restore at least 50 acres on the LMR between Camanche Dam (RM 64) and Lodi Lake (RM 39).

Seasonal floodplain habitats will be constructed to meet timing, duration and frequency criteria based on supporting the progeny from a doubling target of 5,580 (60% of the 9,300 AFRP target):

1. February 1 – May 31, targeting March-April when juvenile population is highest in the river.
2. Minimum of 15 days, targeting 18 days for optimal growth potential

3. Inundation recurrence is two of every three years

Floodplain duration criteria cannot be met in Dry or Critically Dry years, but the flow proposal provides enough flow for late season pulses to encourage emigration of juveniles in Dry years.

Monitoring: Short-term (objective specific) and long-term (population scale) monitoring would be used to help evaluate the success of juvenile rearing habitat restoration projects. Objective specific monitoring will assess the function and biological use of restored floodplain habitats. Topography surveys, 2D hydrodynamic modeling, and juvenile fish monitoring would be performed before and after restoration takes place. To assess differences in primary production and invertebrate colonization, fish diet samples would be taken and compared between in-channel and newly created floodplain habitats. Rotary screw traps would be used to assess population scale trends and would be operated from December through June, as has been done since the early 1990s, to determine the abundance, timing and size of outmigrating juvenile salmonids.

Permitting: The following permits will be required to successfully implement juvenile salmonid rearing habitat restoration projects on the LMR: Water quality certification from the California Regional Water Quality Control Board pursuant to Section 401 of the Clean Water Act, Streambed Alteration Agreement from the California Department of Fish and Wildlife pursuant to section 1601/03 of the California Fish and Wildlife Code, Mitigated Negative Declaration and Notice of Determination pursuant to section 15074 of the California Environmental Quality Act, Environmental Assessment pursuant to section 102(2)(c) of the National Environmental Policy Act , Compliance with Section 106 of the National Historic Preservation Act, Concurrence from the National Marine Fisheries Service that the project is not likely to adversely affect the Central Valley steelhead, Central Valley spring run, fall/late fall-run, or winter run Chinook salmon. In addition, EBMUD currently holds a scientific collecting entity permit (SC-2990) and an ESA Section 10(a)(1)(A) permit for steelhead (17761) and delta smelt (TE-040541-6), which are required for fisheries monitoring on the LMR. EBMUD also maintains positive working relationships with landowners and irrigators on the LMR, who provide access for LMR fisheries monitoring and potential restoration activities.

Life Stage: Rearing

Stressor: Lack of suitable rearing habitat, food production

Timeline: In years 1-5, ten acres of floodplain restoration in the upper two miles of the LMR: In years 5-10, additional 10 acres in the reach between Hwy 88 and Mackville Rd; and in years 10-15, an additional 40 acres in the reach between Mackville Rd and Elliott Rd will be targeted.

Quantity: 60 acres

b. Measure 1B: Identification of Predation Hotspots and Management Strategies to Reduce Impacts

Project Description: This project is the identification of predation hotspots and management strategies to reduce impacts of high predator- prey contact rates. Actions include enhanced take of predatory species through angling opportunities, removal of predatory species for research, and habitat restoration. This item would be addressed through a cumulative effects analysis which includes assessment of the following: (1) hardened structures that may increase predator prey contact rates (dams, bridge abutments, docks, river pumps, etc.); (2) quantity, quality, and location of predator habitat in the LMR from Camanche Dam to the Delta North and South Forks; (3) predator movement within the LMR using acoustic telemetry, and (4) long-term fish community data.

<u>Actions already initiated:</u>

1. EBMUD is currently partnering with Metropolitan Water District (MWD), NMFS, and USFWS on a predation contact points Charter under CVPIA SIT process. MWD will be assessing predator prey interactions in Delta and tributary habitats using PERS (predation event recorders) and the Mokelumne will be used to represent tributary level interactions.
2. EBMUD has 2 years of predator acoustic tagging with Vemco V-7s and V-9s and is currently assessing predator movements in the non-tidal reaches of the LMR.

<u>Life Stage</u>: Rearing, Migration

<u>Stressor</u>: Predation

<u>Monitoring</u>: EBMUD currently conducts quarterly fish community assessments on the LMR from Camanche Dam to the confluence with the San Joaquin. EBMUD has initiated data collection from stationary acoustic receivers. Additional monitoring required would include budget and staff for mobile tracking predator movements and locations on a monthly basis. Completion of habitat and hardened structures analysis needs to occur. Evaluation would compare the long term population abundance estimates pre-action versus post-action based on rotary screw trap estimates.

<u>Timeline</u>: Evaluation in years 1-2; actions to address results annually beginning subsequently

c. Measure 1C: Screen and/or modify 5-10 high priority irrigation diversions

<u>Project Description</u>: Juvenile anadromous fishes may encounter up to 76 water diversions during their outmigration from the uppermost reaches of the LMR (RM 63) to the tidally influenced LMR (RM 29). The majority of these pumps is located in the upper reaches of the LMR, above Lodi Lake (RM 39), and many lack screens or have dilapidated screens.

Currently, EBMUD has an active Charter within the CVPIA to prioritize unscreened diversions on the Mokelumne River based on their volume, timing, and location to determine which projects would provide the best fish protection. EBMUD and USFWS created a model that ranks and determines the LMR diversions that warrant screening and/or modifications based on operation timing, size, and fish presence.

Under the existing Charter, EBMUD and USFWS would modify and/or screen the three highest priority LMR diversions (having landowner support) with appropriate materials from 2019 to 2022. An additional two to seven diversions would be modified and/or screened contingent on landowner interest and support. The cost of each project is estimated at $200,000.

<u>Monitoring</u>: A combination of short-term (objective specific) and long-term (population scale) monitoring would be used to help evaluate the success of screening and/or modifying 5- 10 high priority diversions. Objective specific monitoring would assess the efficacy of each diversion modification with respect to juvenile fish losses and/or entrainment. Site specific monitoring would be performed before and after each modification takes place using hatchery fish releases. Rotary Screw traps will be used to assess population scale trends and operated from December through June to determine the abundance, timing and size of outmigrating juvenile salmonids.

<u>Permitting</u>: The following permits will be required to successfully implement 5-10 diversion screening projects on the LMR: Water quality certification from the California Regional Water Quality Control Board pursuant to Section 401 of the Clean Water Act, Streambed Alteration Agreement from the California Department of Fish and Wildlife pursuant to section 1601/03 of the California Fish and Wildlife Code, Mitigated Negative Declaration and Notice of Determination pursuant to section 15074 of the

California Environmental Quality Act, Environmental Assessment pursuant to section 102(2)(c) of the National Environmental Policy Act , Compliance with Section 106 of the National Historic Preservation Act, Concurrence from the National Marine Fisheries Service that the project is not likely to adversely affect the Central Valley steelhead, Central Valley spring run, fall/late fall-run, or winter run Chinook salmon. In addition, EBMUD currently holds a scientific collecting entity permit (SC-2990) and an ESA Section 10(a)(1)(A) permit for steelhead (17761) and delta smelt (TE-040541-6), which are required for fisheries monitoring on the LMR. EBMUD also maintains positive working relationships with landowners and irrigators on the LMR, who provide access for LMR fisheries monitoring and potential restoration activities.

Life Stage: Rearing, Migration

Stressor: Lack of suitable migration conditions

Timeline: Years 1-5 three high priority diversions would be screened under the current USFWS charter; years 5-15 one project every other year would be targeted to reach the 10 diversion screen goal.

B.2 Condition 2: Migration Habitat and Hatchery

a. Measure 2A: Marking and Tagging Hatchery Production and related infrastructure improvements

Project Description: the Hatchery Scientific Review Group (HSRG) 2012 report identifies a standard for a Chinook salmon marking and tagging program through hatchery operations that determines all releases should be 100 percent CWT and 25 percent adipose fin-clipped. This non-flow measure provides a commitment for the Mokelumne Fish Hatchery to meet this standard. This measure also includes the capital appropriations for infrastructure to implement the action, including the purchase and O&M of one or more additional tagging trailers, and coded wire tags. Additional staffing by CDFW may be needed in addition to infrastructure improvements to achieve implementation.

Life Stage: Adult Migration, Spawning

Monitoring: Monitoring programs for Chinook salmon would allow for estimation of the following on an annual basis.

1) Total recreational and commercial ocean harvest, and harvest of hatchery-origin fish at the age-, stock-, and release group-specific (CWT) level,
2) Total freshwater harvest, and harvest of hatchery-origin fish at the age-, stock-, and release group-specific (CWT) level,
3) Total returns (hatchery -and natural-origin) to hatchery, and returns at the age-, stock- and release group-specific (CWT) level,
4) Age composition of hatchery returns,
5) Total escapement by tributary and by species/run,
6) Proportion of hatchery-origin fish among natural area spawners (pHOS) by tributary and at age-, stock-, and release group-specific (CWT) level,
7) Age composition of individual tributaries important for natural production.

   Use tag recovery data and cohort reconstruction (cohort analysis) methods to estimate the following quantities:

- Brood survival from release to ocean age-2 at the release group-specific (CWT) level,
- Brood maturation schedule (age-specific conditional maturation probabilities) at the

release group-specific (CWT) level,
- Straying and geographic distribution of stray hatchery-origin fish at the release group-specific (CWT) level,
- Age-specific ocean and freshwater fishery contributions and exploitation rates at the release group-specific (CWT) level.

Stressor: Contribution rates of natural and hatchery fish

Timeline: Years 1-3 will target infrastructure improvements necessary to accommodate increased mark/tag rates; years 4 -15 implementation of 100% mark and 25% tag will occur.

b. Measure 2B: Completion and Implementation of the Hatchery Genetics Management Plan

Project Description: This measure would ensure the timely completion and submittal of the Hatchery Genetics Management Plan (HGMP) to National Marine Fisheries Service to ensure proper coverage for, and to guide, ongoing hatchery actions for fall run Chinook salmon and Central Valley steelhead.

Life Stage: Spawning

Stressor: Hatchery

Timeline: Fall run Chinook HGMP – years 1-2; Mokelumne River Central Valley Steelhead HGMP – years 3-5

Timeline: Fall run Chinook HGMP – years 1-2; Mokelumne River Central Valley Steelhead HGMP – years 3-5

c. Measure 2C: Hatchery Improvement Program

Project Description: The Mokelumne River Fish Hatchery was substantially rebuilt in 2003. At that time, a $13 million rebuild increased raceway capacity, incubation capacity, provided chillers to improve water temperature, and sand and UV filtration to improve water quality into the facility. With the addition of increases to marking/tagging rates, prospective increases in steelhead population size, and a potential need for more rearing space to provide more juvenile Chinook based on release location changes recommended in the Hatchery Scientific Review Group (HSRG) report (2012), there is the potential need for more capital infrastructure improvements to the existing facility. Moreover, specific improvements may be needed to support efforts related to moving anadromous salmonids up stream of rim dams (including Camanche/Pardee). This measure would include identification, selection, and implementation of infrastructure improvements to achieve the goals described above, in collaboration with CFDW.

Life Stage: Adult Spawning, Incubation, Rearing

Stressor: Hatchery

Timeline: 0-5 years

d. Measure 2D: Implement and Evaluate Optimized Release Program

Project Description: Barging provides an alternative and interim release strategy that may help to reduce hatchery stray rates associated with net pen releases, as well as improve adult returns of natural origin fish during dry and critically dry years. Barging allows fish to avoid the issues associated with water quality, disorientation, and predation in the Delta while still allowing fish to imprint on the chemical signatures of the water from their basin of origin. A monitoring program would be developed to provide an evaluation of juvenile Mokelumne River Chinook salmon survival and straying rates over the life of this agreement. An adaptive management framework would be used to phase out alternative release strategies in support of in river releases, once parties agree that sufficient improvements in environmental conditions exist to sustain a healthy natural and hatchery population.

The primary objectives of this measure are the following:

1) Achieve a trend of decreasing stray rates of hatchery origin Mokelumne Chinook salmon over the period of the effort, or term of the VA whichever comes first.
2) Maintain abundance of hatchery origin Mokelumne Chinook salmon from a predetermined baseline to be set by the VA parties.
3) Improve abundance of Mokelumne Chinook salmon to support the Mokelumne River natural production goals identified in the VA.

This measure includes the construction and operation of one self-powered Barge Platform. The design would accommodate approximately 200,000 salmon smolts per barge trip. The measure would barge up to one million of the 3.4 million mitigation Chinook salmon produced at MRFH. In critically dry years, the measure updates Section 7 of the JSA regarding the trapping and transporting of salmonids by instead barging up to 25% of the naturally produced Chinook salmon smolts.

Life Stage: Migration

Stressor: Lack of suitable migration conditions

Timeline: year 1-3 infrastructure and capital costs to develop equipment needed to implement program. Years 3-15 hatchery fish in all years; natural fish in dry and critically dry only. This would commence when infrastructure and funding are in place.

B.3 Condition 3: Spawning Habitat

a. Measure 3A: Gravel Enhancement Maintenance Program

Project Description: Reach-scale restoration of the LMR began over a decade ago, in the upper one-mile reach of the river (SHIRA reach), just downstream of Camanche Dam. Rehabilitation to the river's longitudinal profile raised the river bed elevation to pre-dam conditions, expanded and improved salmonid spawning habitat, and increased bed slope and floodplain connectivity.

It is estimated that an annual injection of 500-1,000 cubic yard of gravel will be needed to maintain the reach, variable water year types and resulting river flows may require more or less than the recommended quantity. This measure would include the injection of the needed quantity of gravel, and resurveying every 3-5 years to determine loss of sediment over time.

Monitoring: Short-term (objective specific) and long-term (population scale) monitoring would be used to help evaluate the success of long-term maintenance of the restoration reach. River bathymetry surveys after high flow events to monitor scour and deposition and long term suitability, salmonid redd surveys to monitor use, and rotary screw traps would be used to assess population productions.

Permitting: The following permits will be required to successfully implement long-term maintenance of the restoration reach: Water quality certification from the California Regional Water Quality Control Board pursuant to Section 401 of the Clean Water Act, Streambed Alteration Agreement from the California Department of Fish and Wildlife pursuant to section 1601/03 of the California Fish and Wildlife Code, Mitigated Negative Declaration and Notice of Determination pursuant to section 15074 of the California Environmental Quality Act, Environmental Assessment pursuant to section 102(2)(c) of the National Environmental Policy Act , Compliance with Section 106 of the National Historic Preservation Act, Concurrence from the National Marine Fisheries Service that the project is not likely to adversely affect the Central Valley steelhead, Central Valley spring run, fall/late fall-run, or winter run Chinook salmon. In addition, EBMUD currently holds a scientific collecting entity permit (SC-2990) and an ESA Section 10(a)(1)(A) permit for steelhead (17761) and delta smelt (TE-040541-6), which are required for fisheries monitoring on the LMR. EBMUD also maintains positive working relationships with landowners and irrigators on the LMR, who provide access for LMR fisheries monitoring and potential restoration activities.

Life Stage: Spawning, Incubation

Stressor: Lack of suitable substrate

Timeline: Annual placement of 500-1,000 cubic yard of spawning gravel in the upper reach of the LMR in years 1-15

Quantity: 500-1,000 cubic yards

b. Measure 3B: Gravel Augmentation Program

The CVPIA doubling goal for the Mokelumne River is 9,300 spawners. Based on a 40% hatchery proportion (60% natural production), the goal for the river is 5,580 spawners. Using https://flowwest.shinyapps.io/rearing-habitat , the visualization tool utilizing data compiled as part of the CVPIA Science Integration Team data (representing the best available data for the Mokelumne River), the following criteria were established. The total acreage needed to support 5,580 adult spawners is 8.55 acres, and the Mokelumne River already provides 11.94 acres. Due to 20+ years of gravel augmentation, the Mokelumne River is not limiting for spawning habitat.

Project Description: While the quantity of habitat is not limiting, this measure would improve the spatial distribution of spawning in the Mokelumne River by restoring up to four individual sites downstream of the Mokelumne River Day Use Area. Restoration of additional sites is contingent on willing landowners and permitting support from the CDFW. Some sites, previously restored over 10 years ago, may continue to have landowner support and likely require maintenance or even re-establishment. These sites include the following locations: 2002 Hogwire Island (RM 62.5), 1996 Enhancement (RM 59.5), 1997 Below Mackville Rd. (RM 58.9), and 1998 George Reed (RM 58).

Monitoring: Short-term (objective specific) and long-term (population scale) monitoring would be used to help evaluate the success of long-term maintenance of the restoration reach. River bathymetry surveys pre and post restoration would feed a 2D hydraulic model for suitability, salmonid redd surveys to monitor use, and rotary screw traps would be used to assess population productions.

Permitting: The following permits will be required to successfully implement long-term maintenance of the restoration reach: Water quality certification from the California Regional Water Quality Control Board pursuant to Section 401 of the Clean Water Act, Streambed Alteration Agreement from the California Department of Fish and Wildlife pursuant to section 1601/03 of the California Fish and Wildlife

Code, Mitigated Negative Declaration and Notice of Determination pursuant to section 15074 of the California Environmental Quality Act, Environmental Assessment pursuant to section 102(2)(c) of the National Environmental Policy Act, Compliance with Section 106 of the National Historic Preservation Act, Concurrence from the National Marine Fisheries Service that the project is not likely to adversely affect the Central Valley steelhead, Central Valley spring run, fall/late fall-run, or winter run Chinook salmon. In addition, EBMUD currently holds a scientific collecting entity permit (SC-2990) and an ESA Section 10(a)(1)(A) permit for steelhead (17761) and delta smelt (TE-040541-6), which are required for fisheries monitoring on the LMR. EBMUD also maintains positive working relationships with landowners and irrigators on the LMR, who provide access for LMR fisheries monitoring and potential restoration activities.

Life Stage: Spawning, Incubation

Stressor: Lack of suitable migration conditions

Timeline: Target of 1-2 projects every 5 years of the VA to a maximum of 4 projects total

Quantity: 500-1,000 cubic yards per project

B.4 Condition 4: Research and Monitoring

a. Measure 4A: Fish Community Assessment

Project Description: EBMUD continues to monitor the relationship between fish assemblages and physical and biological parameters. The goal of this monitoring is to facilitate management actions (flow and non-flow) that support healthy native fish populations in the LMR. Previous reports have described the abundance, richness and diversity of native and introduced fish species occurring seasonally and habitat associations of these fish species within the LMR. In addition, fish community sampling events have and continue to provide opportunities to collect fish for diet analyses, predation studies, and/or assist other state, federal, and academic researchers. This ongoing work expands on the requirements of the JSA. Under this measure, EBMUD would commit to continue this work for the duration of the VA.

Monitoring: Electrofishing surveys within the six reaches of the LMR (through the Delta Forks) currently and would continue to take place on a quarterly basis. The six reaches are separated based on stream confluences, gradient, tidal influence, and substrate characteristics:

1) Reach I (Mokelumne River Mouth to Cosumnes River confluence), RM 0-23.3
2) Reach II (Cosumnes River confluence to Woodbridge Irrigation District Dam), RM 23.3-38.6
3) Reach III (Woodbridge Irrigation District Dam to Highway 99), RM 38.6-43
4) Reach IV (Highway 99 to Elliott Road), RM 43-53.5
5) Reach V (Elliott Road to Mackville Road), RM 53.5-59
6) Reach VI (Mackville Road to Camanche Dam), RM 59-64

The sample areas would include historic and intermittent sites. Selected deep and swift water habitats are sampled with a Smith-Root SR-18E electrofishing boat. Data will be analyzed in five year increments or longer to assess population trends and their relationship with environmental parameters.

Permitting: EBMUD currently holds all permits required for fisheries monitoring on the LMR. This includes a scientific collecting entity permit (SC-2990) and an ESA Section 10(a)(1)(A) permit for steelhead (17761) and delta smelt (TE-040541-6). EBMUD also maintains positive working relationships with many landowners on the LMR, who frequently provide access for LMR fisheries monitoring.

Life Stage: All

Stressor:

Ecosystem

Health Timeline:

Annual

b. Measure 4B: Steelhead Population Assessment

Project Description: We would commit to Passive Integrated Transponder (PIT) tag evaluations to monitor O. mykiss populations, pursue additional locations for stationary PIT tag array placements, and continue to collaborate with CDFW, and NMFS to improve conditions for O. mykiss and their population structure.

Monitoring: PIT tagging would be conducted on natural O. mykiss during quarterly fish community monitoring. Data collected would be used to determine site fidelity, annual growth rates, population demographics, incorporation of natural fish into the hatchery population. In the hatchery, genetic monitoring of the O. mykiss population is currently being planned and coordinated with NMFS Southwest Science Center.

Life Stage: All

Stressor: Minimal anadromy and small

population size Timeline: 1-15 years,

annually

1.5.3 Independent Assessment of the Proposed Mokelumne River VA

The Mokelumne River VA Proposal was evaluated by FlowWest Analytics at the direction of the California Department of Fish & Wildlife. FlowWest assessed how the VA measures support habitat quantity and quality required to maintain the natural production component of the CVPIA doubling goal population target. Based on the criteria set forth in FlowWest's Shiny App, FlowWest determined the following as to the Mokelumne River VA flow and non-flow measures:

- The lower Mokelumne River currently has sufficient spawning habitat to support the natural production of the doubling goal, but the VA non-flow measures will further improve the quality of existing spawning habitat and create new habitat.
- Instream juvenile rearing habitat is currently not sufficient to support the progeny of the doubling target natural production. To address this, the VA non-flow measures would increase the quantity and quality of instream rearing habitat.
- Floodplain habitat limitations can be met with the VA flow measures alone, however the VA non-flow measures will create additional floodplain habitat.

1.5.4 Agreement Term

The VA shall have a term of fifteen (15) years. Upon execution of a final VA, the parties agree to expeditiously implement the terms of said VA. However, the VA will provide that the following conditions will suspend the additional flow requirements in Table 1 until such time as the parties reconvene to reconsider those measures and mutually agree upon replacement measures:

1. Any action by the SWRCB, other state or federal authority or court of law, which suspends or cancels the current WQCP Update process, thereby suspending or cancelling the need for an agreement which substitutes for that process;

2. Any action by the SWRCB, other state of federal authority or court of law, which would allow the additional flow measures identified in Table 1 to be diverted by another party or result in a reduced Delta outflow obligation of another party.

1.5.5 Mokelumne River Appendices

APPENDIX

DRAFT BASELINE
PROPOSED MOKELUMNE RIVER VOLUNTARY AGREEMENT
February 26, 2019

I. Background

The Mokelumne River is a relatively small Eastside river that is directly tributary to the Delta. It comprises 1.5% of the total Delta watershed and 2.5% of the average unimpaired flow into the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. The Mokelumne River serves a variety of uses, including agriculture, fisheries, hydropower, recreation, and municipal and industrial use. Figure 1 provides a general overview of the Mokelumne River diversions, releases and losses and conceptually illustrates how the river's flow is allocated among the various users and uses.

The State Water Board explicitly addressed the Mokelumne River's existing uses and obligation to release water to benefit the Bay-Delta in its Decision 1641 (D-1641). In that decision, the State Water Board expressly modified EBMUD's Mokelumne River water rights to require the release of specified quantities of water year-round, in all year types. It also modified the rights of Woodbridge Irrigation District (WID) and North San Joaquin Water Conservation District (NSJWCD) to ensure the water was bypassed and allowed to flow into the Bay-Delta. The context within which the State Water Board made these D-1641 determinations, and the determinations themselves, form a key underlying baseline for the Board's current consideration of updating the Bay-Delta Plan as it applies to the Mokelumne River.

II. Overview of Mokelumne River Hydrology

The upper Mokelumne River watershed lies on the western slope of the Sierra Nevada in Alpine, Amador, and Calaveras Counties. The watershed feeding into EBMUD's storage facilities covers an area of 627 square miles and extends from the peak of Round Top (elevation 10,364 feet) near the crest of the Sierra Nevada to Camanche Reservoir (elevation 235 feet) located in the lower western foothills near Clements. Most of the watershed is forested land within the El Dorado and Stanislaus National Forests. The lower Mokelumne River watershed, downstream of Camanche Dam, is located in the Central Valley and the Sacramento-San Joaquin Delta (Delta) in San Joaquin and Sacramento Counties. Downstream of Camanche Dam the river runs southwesterly through Lodi and then northwesterly until it is joined by the Cosumnes River. It then enters the Delta, splitting into the North and South Fork channels near the Delta Cross Channel.

Annual precipitation and streamflow in the Mokelumne River watershed are extremely variable from month to month and from year to year. Most precipitation normally falls between November and May, and very little falls between late spring and late fall. Peak flows in the Mokelumne River normally occur during winter storms or during the spring snow-melt season from March through June. These flows decrease to a minimum in late summer and fall, and in some years, natural unimpaired flows into Pardee Reservoir in late summer and fall may be minimal to non-existent.

Variations in rainfall and runoff have a major effect on the ability to manage Mokelumne River water supply during normal and drought-year conditions. Figure 2 demonstrates natural Mokelumne River runoff by water year, illustrating the wide variability in runoff. Long-term average unimpaired flow equals 734 thousand acre-feet (TAF) during the last 97 years, and has ranged from a high of 1, 929 TAF to a low of 129 TAF.

III. Existing Conditions

A. Mokelumne River Existing Flow Release Requirements

Current flows for Mokelumne River fishery protection and Bay-Delta inflow consist of the following release requirements:

A.1 The Joint Settlement Agreement

In 1998, EBMUD entered into a long-term partnership with the CDFW and USFWS by entering the Joint Settlement Agreement (JSA) for the Mokelumne River. Its purpose is to protect and enhance conditions for the anadromous fish population and the associated ecosystem of the lower Mokelumne River while simultaneously protecting EBMUD's Lower Mokelumne River Project as a reliable, high-quality water supply for EBMUD. Following completion of processes under the Endangered Species Act by USFWS and NMFS, the Federal Energy Regulatory Commission (FERC) issued its Order Approving Settlement Agreement and Amending License on November 27, 1998, amending EBMUD's FERC License for its Mokelumne Project (FERC Project No. 2916) by requiring EBMUD to meet the JSA.

As specified in the JSA, EBMUD, U.S. Fish and Wildlife Service and California Department of Fish and Wildlife established the Lower Mokelumne River Partnership (Partnership) in 1998 and each agency has participated in an annual meeting to measure the success of the JSA flow requirements, non-flow measures and other actions pursuant to implementation of the JSA. The Partnership also established the Partnership Coordinating Committee consisting of technical representatives of each agency that meets semiannually to ensure timely implementation of the measures identified in the JSA.

The provisions of the JSA build upon and expand on some of the requirements of the prior agreement with CDFW (The 1961 Agreement). The 1961 Agreement required EBMUD to release 13 TAF annually from Camanche Reservoir to the lower Mokelumne River to benefit aquatic habitat and fish production. These 13 TAF were in addition to releases for WID, riparian and senior appropriators, and channel losses.

The JSA contains a comprehensive, integrated suite of flow and non-flow measures. As to flows, the JSA fishery flow releases from Camanche Dam are significantly higher than the prior releases required under the 1961 Agreement and follow a more complex release schedule based on life stage of anadromous fish in the system. Figure 3 shows a comparison of fishery flows required under the JSA and the 1961 Agreement.

As to non-flow measures, the JSA requires implementation of non-flow enhancement measures, such as gravel augmentation, creation of rearing side channels, and new monitoring and reporting objectives. These measures are described more fully below. In addition, EBMUD also agreed to expand and upgrade the hatchery in consultation with CDFW, USFWS, and NMFS. Reconstruction was completed in 2002 at a cost of about $12.5 million. CDFW continues to operate the Hatchery.

A.2 State Water Board Decision 1641

In D-1641, the State Water Board closely examined the JSA flows to determine what they were and how they might benefit the Bay-Delta. The Board ultimately found that the JSA flows would provide additional flows to the Delta[1] and that those flows satisfied EBMUD's responsibility to help meet the Bay-Delta objectives in the 1995 Bay-Delta Water Quality Control Plan.[2] Consequently, in the ordering section of D-1641, the State Water Board incorporated the JSA's flow tables and year-type definitions into EBMUD's Mokelumne River water rights.[3] By that action, the State Water Board replaced the 1961 Agreement flows with the JSA flows in EBMUD's water rights and required EBMUD to release the JSA's Agreed Releases From Camanche Dam.

Additionally, the State Water Board also added conditions to DWR and USBR water rights stating DWR and USBR are jointly responsible for providing Delta flows that otherwise might be allocated to Mokelumne River water right holders in excess of the JSA flows.

EBMUD continues making fish releases to the lower Mokelumne River consistent with the JSA. In addition, D-1641 made corresponding changes to the water rights of WID to ensure additional flows passed Woodbridge Dam.[4]

[1] State Water Board Decision 1641, issued in final, revised form on March 15, 2000, page 58.

[2] D-1641, page 57.

[3] D-1641 contains several pages of tables setting forth the JSA water that EBMUD must release from Camanche Dam, as well as additional flow-related conditions. (D-1641, pages 170-177.)

[4] D-1641, pages 177-179.

Specific Components of the JSA are described in more detail below.

A.3. Amended Water Right Permit 10478 (A13156) Term 20

As part of the environmental documentation for its Permit 10478 Time Extension Project, EBMUD included a new mitigation measure to commit additional fishery flows over and above the JSA flows.

EBMUD committed to the following actions that will ensure that adequate flows remain in the Mokelumne River to maintain adequate water depths for salmon passage. If expected flows below Woodbridge Dam impair adult salmonid migration from September through February, one of the following measures will be implemented depending on EBMUD reservoir carryover storage conditions and water year runoff:

(1) EBMUD will release from Camanche Dam up to a total of 2,000 acre-feet of additional water above required releases during the September through February period in Below Normal and Dry water years to facilitate adult salmonid fish passage below Woodbridge Dam.

(2) During Critically Dry water years, EBMUD will survey the reach below Woodbridge Dam prior to spawning season to identify any significant blockages or obstructions to instream passage. Adequate water depths of sufficient width are necessary to promote passage of adult salmonids at critical passage sites. At least 25% of the entire width of a potential passage impediment will be reconfigured to provide at least 0.9 foot in water depth. If a blockage is identified EBMUD will work with the appropriate entity to remove or reduce the impediment, to ensure that there is a depth of at least 0.9 foot to facilitate adult salmonid fish passage.

The magnitude, frequency, and duration of the additional flows set forth in number (1) above, are to be determined by the JSA Partnership Steering Committee based on Camanche cold water storage, and water temperatures below Woodbridge Dam. Instream passage improvements are to be determined by the JSA Partnership Steering Committee based on EBMUD assessment of potential passage impediments from Woodbridge Dam downstream to tidal influence during July or August of current (April through September) or anticipated (October through March) Critically Dry water years.

A.4. Flood Control Requirements

EBMUD manages Pardee and Camanche Reservoirs for flood control purposes per the US Army Corps of Engineers (Corps) Flood Control Guidelines. Figure 4 provides a summary of the flood control requirements, which are fully described in a flood control manual prepared by the Corps. EBMUD must begin to create flood control reservation in Camanche and/or Pardee Reservoir(s) in mid-September of each year. By November 5th, between 130,000 and 200,000 acre-feet of flood control reservation (depending on how full PG&E's

upstream reservoirs are at the time) must have been created. The flood control reservation must be maintained if possible at least through mid-March, and potentially into July in years of heavy snow accumulation.

The flood control agreement with the Corps also provides a release schedule from Camanche Reservoir whenever encroachment into the flood control reservation occurs. The schedule specifies that the maximum release from Camanche Reservoir should be limited to 5,000 cfs, insofar as possible, and the rate of change in release shall not exceed 1,000 cfs per 2-hour interval.

B. JSA Flow Measures

B.1. Minimum Flow Release Requirements

The JSA specifies minimum flow releases by EBMUD from Camanche Dam in all year-types, year-round, to attain expected flow below Woodbridge Dam based on time of year (corresponding to fish life stages) and water year types.[5]

- For the October through March releases, water year types are determined based on combined storage in Camanche and Pardee Reservoirs on November 5. For the April through September releases, water year types are determined based on the unimpaired runoff into Pardee Reservoir unless the projected combined storage for November 5 is less than 200 TAF, in which case, the water year would be critically dry.
- The JSA establishes four year-types. Within each year-type, the JSA establishes Camanche Dam release requirements that vary throughout the year to meet the needs of the life stages of anadromous fish. Minimum release requirements range from 100 to 325 cfs during normal and above-normal runoff water year types, 100 to 250 cfs during below-normal years, 100 to 220 cfs during dry years, and 100 to 130 cfs during critically dry years.
- Additional releases up to 200 cfs are required for juvenile salmonid migration in April, May, and June, depending on the combined storage in Camanche and Pardee Reservoirs.

Minimum JSA flow releases from Camanche Dam and the expected flows below Woodbridge Dam are designed to protect fish resources in the lower Mokelumne River. Actual flows from 1998 to date have met or exceeded the required JSA flows below Camanche and Woodbridge Dams. For the more than 100 years from water years 1901 through 2012), annual Mokelumne River flows just upstream of Pardee Reservoir (Mokelumne Hill Station) ranged from 129 TAF to 1.9 million acre-feet. Since

[5] D-1641 contains JSA flows that EBMUD must release from Camanche Dam, as well as additional flow-related conditions. (D-1641, pages 170-177.)

implementation of the JSA in 1998, flow releases below Camanche Dam have ranged from 178 TAF to 1.7 million acre-feet.

B.2. JSA Section F.2. Gainsharing Increases in Flow

The JSA gainsharing provision provides that 20% of the actual yield from new water supplies is required to be used to augment instream flows, up to a volume of 20 TAF per drought cycle. Examples of these new water supplies include development of additional storage capacity on the Mokelumne River and groundwater from a conjunctive use program. Water from conservation programs, recycled water projects, or the Amador Canal pipeline project, are not subject to gainsharing. In essence, gainsharing is a mechanism to allow fishery resources to receive a portion of the yield from new water supply projects, further boosting fishery flows above the base JSA amounts. Allocation of gainshare water is determined through the Partnership Steering Committee.

C. JSA Non-Flow Measures

The JSA includes a suite of non-flow measures, including:

C.1. Cold Water Management – Protecting the Hypolimnion

Given the importance of preserving cold water for the anadromous fishery, the JSA specifies temperature management goals for the hypolimnion in Camanche Reservoir. EBMUD commits to using its best efforts to maintain the volume of the hypolimnion in Camanche Reservoir above 28 TAF through October if Pardee Reservoir storage is more than 100 TAF. This temperature management involves operating both Camanche and Pardee Reservoirs in concert to allow storage of an adequate volume of cold water during the winter and spring to prevent early turnover (destratification) in Camanche Reservoir, and provide sufficient cold water for release in the lower Mokelumne River through early November. This provides long-term benefits to salmonids and other native fish species in the lower Mokelumne River.

The JSA states that water quality in the hypolimnion should be preserved by maintaining adequate oxygenation and reducing the presence of hydrogen sulfide levels by use of the Hypolimnetic Oxygenation System.

C.2. Additional Water Quality Measures

- Sustaining the long-term viability of the salmon and steelhead fishery while protecting the genetic diversity of naturally producing populations in the lower Mokelumne River. This involves supporting the development and implementation of Mokelumne River steelhead and fall-run Chinook Hatchery Genetics Management

Plan (HGMP) to minimize adverse effects on the wild stocks. CDFW operates the Mokelumne River Fish Hatchery. Section 7 of the ESA obligates consultation with NMFS on any activities that may affect a listed anadromous fish species, including hatchery programs. HGMPs are a mechanism for addressing the take of certain listed species that may occur as a result of artificial propagation activities. NMFS uses the information provided by HGMPs to evaluate impacts on anadromous salmon and steelhead listed under the ESA, and in certain situations, the HGMPs will apply to the evaluation and issuance of Section 10 take permits. Completed HGMPs also may be used for regional fish production and management planning by federal, state, and tribal resource managers. The primary goal of the HGMP is to devise biologically based artificial propagation management strategies that ensure the conservation and recovery of listed ESUs.

- Use coded-wire tagging on a greater proportion or all of the juvenile Chinook salmon produced at the Mokelumne River Fish Hatchery, if it is part of a statewide program. Currently the proportional coded-wire tagging and marking program for Central Valley Chinook salmon is 25% of the salmon released, and all steelhead released are tagged with an adipose fin clip but no coded-wire tag. The tagging program is a cooperative effort between CDFW, California Department of Water Resources, USFWS, Pacific States Marine Fisheries Commission, U.S. Bureau of Reclamation, and EBMUD.
- Activities that enhance habitat conditions:
  - Plant trees and shrubs along the river for shade and remove undesirable vegetation. EBMUD initiated efforts in the early 2000s to improve the river's ecosystem, including riparian restoration and enhancement on private lands. Improve spawning gravels through continued implementation of the spawning gravel augmentation plan for the lower Mokelumne River. This plan, developed in cooperation with the University of California, Davis, has resulted in the placement and configuration of more than 65,000 cubic yards of suitable-sized salmonid spawning gravel. Additional gravel placement to replace gravel lost to historical mining, scouring and subsidence, and annual supplementation to compensate for the lack of gravel recruitment is needed for the long term. This action will provide long-term benefits to salmonid and other native fishes spawning and incubation habitat.
  - Create side channels adjacent to the main channel of the lower Mokelumne River to provide suitable and beneficial habitat to juvenile Chinook salmon and steelhead, as well as habitat for a community of other fish and aquatic invertebrates. Two side channels were created in 2005 (Channel 1 has a length of approximately 300 feet and a mean width of 17 feet; Channel 2 has a length of 200 feet and a mean width of 27 feet).

- Work cooperatively with local landowners along the lower Mokelumne River to implement the conservation practices and restoration and enhancement projects identified in the San Joaquin County Resource Conservation District's Lower Mokelumne River Conservation Handbook.
- Identify, design, and install fish screens on diversion facilities in cooperation with diverters. CDFW is the lead for this activity subject to available funding.
- Perform monitoring to gage success.
- Update and maintain a Mokelumne River science database.

C.3. Lower Mokelumne River Partnership

As part of the JSA, a Lower Mokelumne River Partnership has been established to support the protection of anadromous fish and the ecosystem of the lower Mokelumne River, encourage stakeholder participation, and integrate Mokelumne River strategies with other programs. The steering committee for the partnership is composed of one representative each from EBMUD, CDFW, and USFWS. The partnership program is funded by earnings from the $2 million Partnership Fund established by EBMUD in 1998 and any additional funding sources that can be secured. As of December 2018the Partnership Fund has earned about $897,000, has received about $186,000 in grants, and has spent about $897,000 on projects in the lower Mokelumne River. In addition to the steering committee, the partnership includes a group of stakeholders with an interest in the lower Mokelumne River. The purpose of having a stakeholder group is to foster communication, make recommendations to the steering committee, and participate in enhancement work.

To facilitate operation of the JSA Partnership Steering Committee, a coordinating committee was formed. The JSA Coordinating Committee includes biologists and related staff of CDFW, EBMUD, USFWS, and NMFS. The Coordinating Committee meets in April and October of each year, and its work includes assessing the upcoming water year type and flow conditions; developing habitat projects and making recommendations to the JSA Partnership Steering Committee for expenditure of the Partnership Fund; and developing proposed adaptive management flow modifications to benefit the fishery.

C.4. Adaptive Management

To optimize habitat, the JSA provides that river operations can be modified if warranted by river conditions and scientific information. With concurrence from CDFW, USFWS, and NMFS, and approval from the State Water Board, EBMUD may modify the JSA Camanche releases as long as the total volume released during the year would not be less than that specified in the JSA for the water year type.

Adaptive management flow modification occurred in March 2004, when WID requested EBMUD delay planned April flow increases required by the JSA and instead release the deferred water in May to allow completion of the fish bypass pipeline component of their dam construction. With concurrence of CDFW, USFWS, NMFS, and approval from the State Water Board, EBMUD maintained Camanche release at the lower rate of 330 cfs until mid-April, when WID completed the portion of the work that would have been affected by a higher release rate. The release then increased to 515 cfs by the end of April as WID initiated its seasonal diversions. The deferred volume of water originally scheduled to be released during April was released in addition to JSA requirements in May to coincide with outmigration of juvenile Chinook salmon and the volitional release of juvenile Chinook salmon from the Mokelumne River Fish Hatchery.

With prior concurrence from CDFW, USFWS, and NMFS, and approval from the State Water Board, EBMUD modified the below-normal JSA minimum flows in April and May 2009 to provide a fall pulse flow to attract adult fall-run Chinook salmon into the Mokelumne River. A total of 5,183 acre-feet of water was reallocated from the spring to provide flows in October that ranged from 308 cfs to 2,275 cfs.

In October, adult fall-run Chinook salmon move up through the Bay-Delta estuary toward their natal spawning grounds. Open Delta Cross Channel (DCC) gates can result in straying of adult salmon as Sacramento River water is routed into the Mokelumne and San Joaquin Rivers. To maximize the effectiveness of fall pulse flows, the Lower Mokelumne River Partnership sent a letter to the U.S. Bureau of Reclamation (USBR) requesting the closure of the DCC for a 10-day period in October 2011. Similar requests were made in 2009 and 2010 resulting in a 48-hour closure in October 2010. Through efforts by the partnership, USBR, and DWR, a 10-day closure of the DCC was initiated from October 4 through October 14, 2011. The closure coincided with the first of four fall pulse flows with a peak magnitude of 1,800 cfs. Recent studies in the Mokelumne River have shown that a combination of pulse flows along with closure of the DCC gates in October can not only increase the number of Chinook salmon returns, it can also reduce straying of Mokelumne-origin salmon to the lower American River (California Department of Fish and Game 2012).

Upon recommendation from the JSA Partnership and approval from the State Water Resources Control Board, minimum JSA flow releases from Camanche Dam were reduced in March 2012 to provide additional Chinook salmon attraction flows in October 2012. A series of pulse flows totaling 5,140 acre feet was released from October 8 through November 8, 2012 to facilitate passage of adult Chinook salmon in the lower Mokelumne River. Similar adaptive management actions were carried out with State Water Board approval in 2013 and 2014. In addition, adaptive management has continued to be employed as warranted in years following 2014.

C.5. Water Quality and Resource Management Program

One of the first tasks of the steering committee for the Lower Mokelumne River Partnership was to develop a Water Quality and Resource Management Program (WQRMP) to define reasonable goals, measures, performance criteria and responsive actions associated with implementing the JSA. The WQRMP was prepared by the Partnership, submitted to FERC in June 1999, and approved by FERC in May 2001.

D. **JSA Outcomes**

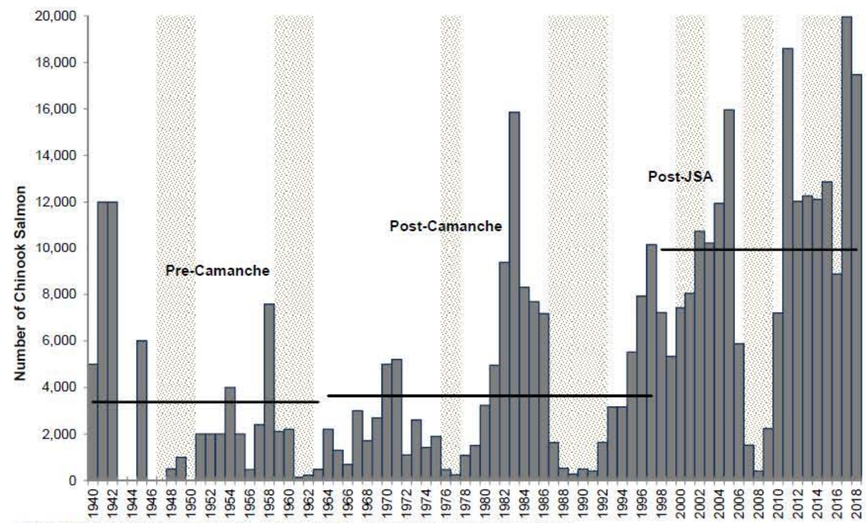
D.1. Ten-Year Review of Joint Settlement Agreement Accomplishments

The Lower Mokelumne River Partnership steering committee (CDFW, USFWS, and EBMUD) conducted a 10-year review of the JSA in 2008. The committee found that most of the goals and actions described in the JSA and WQRMP continue to be pursued in one form or another. Some actions, such as meeting minimum flow requirements, are continuing unchanged. Other actions have been modified to enhance the successful attainment of JSA objectives. Several JSA objectives were successfully completed:

- improvement of the fish bypass at Woodbridge canal;
- collaboration with WID to improve fish passage at Woodbridge Dam;
- modification of the channel downstream of Woodbridge Dam to reduce predation; and,
- expansion and improvement of the Mokelumne River Fish Hatchery;
- The 10-year review included some new or modified actions recommended by the steering committee that are being implemented:
  - develop an integrated reservoir/stream temperature model to predict water temperatures and operate reservoirs to optimize water temperatures for all salmonid life stages;
  - work with landowners to implement the practices described in the San Joaquin County Resource Conservation District's Lower Mokelumne River Conservation Handbook;
  - depending on funding, implement the Mokelumne River Day Use Area Recreation and Resource Management Plan;
  - use the Spawning Habitat Integrated Rehabilitation Approach for annual gravel supplementation;
  - create an HGMP for the Mokelumne River Fish Hatchery in cooperation with NMFS and CDFW; and,
  - continue constant fractional marking of hatchery fish.

February 26, 2019

D.2 Improved Mokelumne River Fishery



Horizontal lines indicate pre-Camanche, post-Camanche, and post-JSA periods, respectively.
1. "Pre-Camanche" escapement (3,374) is the average estimate at Woodbridge Dam for the period from 1940 through 1963 (excluding years when no data were recorded: 1943, 1944, 1946, 1947, and 1950).
2. "Post-Camanche" escapement (3,636) is the average estimate at Woodbridge Dam for the period 1964 through 1997.
3. "Post-JSA" escapement (9,542) is the average estimate at Woodbridge Dam since implementation of the JSA in 1998.
4. Dithered shaded areas are periods of drought in California. Historical drought data are based on California Department of Water Resources, *California's most Significant Droughts: Comparing Historical and Recent Conditions*, February 2015.

Salmon returns under the JSA are well above the 75-year-plus historic average. In 2008 , the Central Valley-wide salmon stock collapsed, and the Mokelumne River was no exception. A population that had exhibited strong resilience and multiple years of above average returns was reduced to just over 400 fish in 2008. Recognizing its responsibility to the community, resources and agreement, EBMUD implemented a number of adaptive management actions and expanded its efforts to advocate for the resource by reaching out to regulatory agencies and NGOs.

The adaptive management actions focused on improving survival of juvenile salmon and providing optimal conditions for returning adult salmon. EBMUD Fisheries and Wildlife Division staff analyzed the return data from 2008 and years previous, which indicated that a significant portion of the Mokelumne returning salmon were migrating to other systems. In the salmon literature this is referred to as straying. In fact, in 2008 70% of the Mokelumne population returning to the Central Valley ended up in other rivers. Working primarily with CDFW, EBMUD identified a new release site for hatchery fish that would likely reduce the stray rate of Mokelumne River salmon. Additionally, EBMUD constructed a floating netpen that would facilitate towing fish to the center of the channel for release to reduce the risk of predation, and improve survival to adult returns.

February 26, 2019

The resilience of the population can be seen by the recovery of the population in just a few years following the collapse and into the 2012-2015 drought period, where the Mokelumne salmon population performed well even under less than optimal conditions.
EBMUD has also coordinated with CDFW and NGOs to conduct pilot studies to determine the effectiveness of barging juvenile salmon through the most dangerous segment of the Delta. Although there is a remaining year of data to collect, the results to date indicate the barging substantially increases the survival rate of salmon and may reduce straying. Next steps will include a feasibility assessment for constructing a purpose built barge and collection facilities.

Concurrent with the improved release strategies, EBMUD worked to implement two flow related actions. The first of these actions was to collaborate with the U.S. Bureau of Reclamation (USBR) to modify operations at one of its facilities (Delta Cross Channel). The facility conveys water to supply the southern portion of California and is used to manage water quality in the central Sacramento – San Joaquin Delta. Unfortunately, the facility also provides an artificial migration route and cue that contributes to Mokelumne fish straying to the Sacramento River. Working with the USBR, a 5 year study plan was developed in 2011 to close the gates during portions of the fall migration season. Subsequent closures have occurred sporadically since 2011. In 2017 the gates were closed approximately 5 days per week beginning in September, which resulted in reduced straying and a record return of 20,000 salmon to the Mokelumne.

In addition to addressing the Delta Cross Channel issue, EBMUD looked to improve the flow conditions in the river during the migration season. It is generally recognized that migrating salmon are cued by changes in environmental conditions, particularly flow. Since 2009, EBMUD has conducted pulse flows in the lower Mokelumne River from October – December. These pulses act to mimic natural precipitation events and help to attract adult salmon into the system and in most instances require little to no additional water above and beyond required flow releases. The water for these pulses has been made available through rescheduling late winter flows to save water for fall with the approval and support of CDFW, USFWS, National Marine Fisheries Service, and the California State Water Resources Control Board.

The population response to the management actions implemented since 2008 has been remarkable. The stray rate has been reduced from 70% to approximately 25%, which not only improves the returns but also helps to maintain genetic integrity of the Mokelumne stock as well as neighboring salmon stocks. Within the 2009-2018 period, the Mokelumne has had four of the best returns recorded since 1940, including a record return of nearly 20,000 salmon in 2017 and returns topping 12,000 fish in 7 of last 8 years. Through EBMUD's actions, the average salmon returns to the river have doubled from 3,434 (1940 to 1997 average) to 9,929 (1998 – 2018). The recovery of the Mokelumne River salmon population from the 2008 stock collapse far outpaced other Central Valley populations with sustained returns averaging double or more of the long-term average. In addition to excellent returns to the river, the Mokelumne salmon population makes up a significant portion of the fisheries catch off the California coast. In 2017, 20% of the commercial harvest and 35% of the recreational catch was comprised of San Joaquin Basin marked salmon which are primarily Mokelumne origin salmon.

As part of the Central Valley Project Improvement Act of 1992 a fall-run Chinook salmon production target (commonly referred to as the doubling goal) was established for each tributary. In the case of the Mokelumne River the production target is 9,300 salmon, which is based on a 1967 – 1991 baseline period average of 4,680. As of the latest published USFWS calculations the 1992 – 2015 doubling period average for the Mokelumne River is 8,976 or 96.5% of the production target. This performance by far exceeds all the major Central Valley tributaries and is indicative of the effectiveness of the existing program on the Mokelumne River including operations, flow and non-flow measures, and established multi-stakeholder science teams.

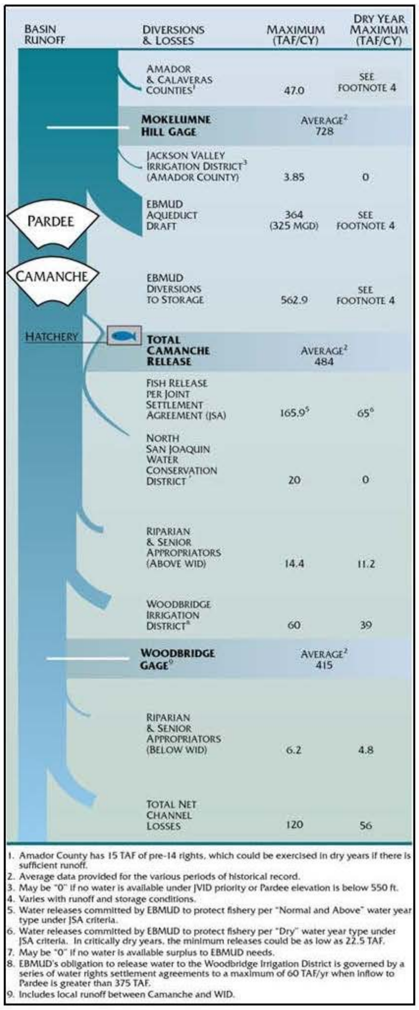
In addition to changes directly related to salmon management, EBMUD operators have perfected the ability to manage our two main reservoirs, Pardee and Camanche, in order to preserve coldwater in the deeper Pardee Reservoir and strategically release the water in a way that minimizes the temperature increase through the shallower Camanche Reservoir, which supplies the releases to the lower Mokelumne River. In fact, EBMUD was so successful in supplying coldwater that during the drought the Mokelumne River Fish Hatchery served as a refuge for rainbow trout from the American River Trout Hatchery where water temperatures would have proven lethal. While the actions implemented since 1998 have proven to be beneficial to the Mokelumne River salmon population, EBMUD and its partners continue to look for ways to further improve the resource and its benefit to Californians.

February 26, 2019

FIGURES

February 26, 2019

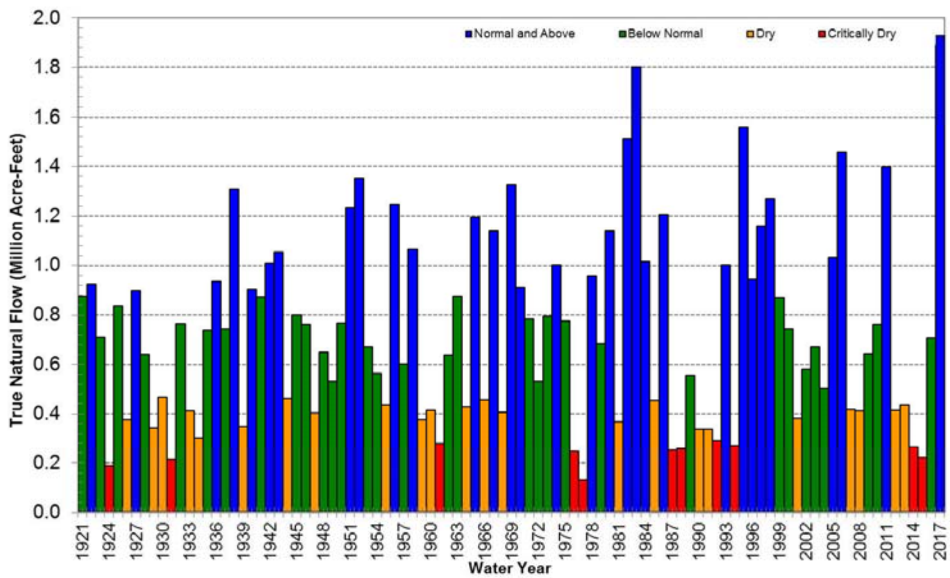
Figure 1. Mokelumne River Releases, Diversions and Losses



(Source: EBMUD Water Resources Planning)

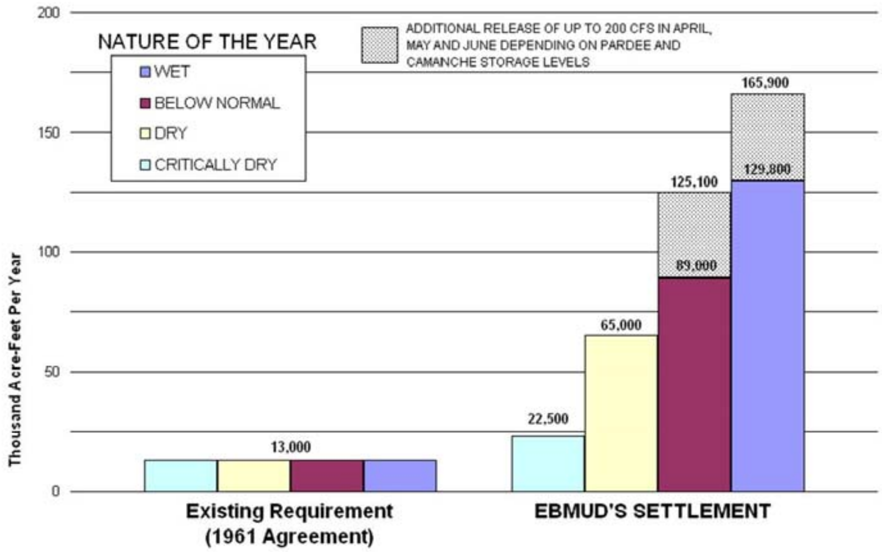
February 26, 2019

Figure 2. Mokelumne River Historical Water Supply Variability (WY 1921-2017)



(Source: EBMUD Water Supply Database)

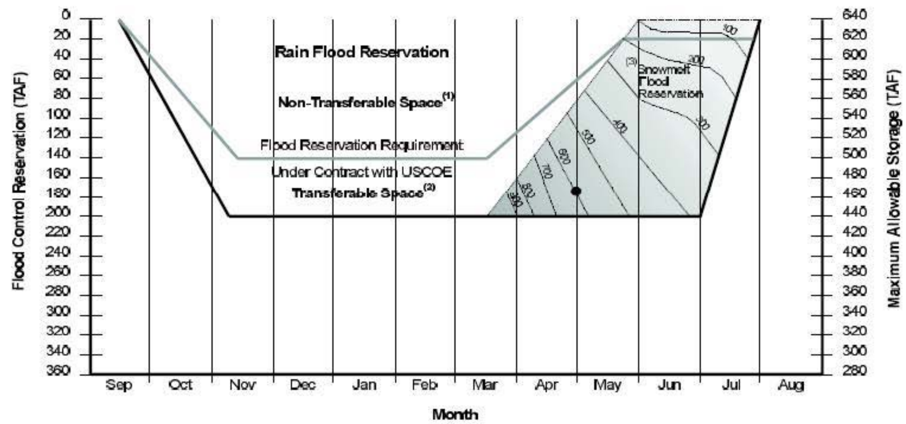
Figure 3. Water Releases Committed by EBMUD for Fish in Addition to All Other Release



(Source: EBMUD Exhibit No. 10. in 1998 State Water Resources Control Board Bay-Delta Water Rights Hearing)

February 26, 2019

Figure 4. Flood Control Requirements Rule Curves



Notes:
[1] Non-transferable Space = minimum flood control space that must be maintained in Pardee and Camanche Reservoirs.
[2] Transferable Space = reduction of flood control space requirement provided by upstream (PG&E) reservoirs.
[3] Snowmelt Flood Reservation is dependent on estimated runoff-to-follow in TAF.

Example shown by ●: If on May 1, 600 TAF or more of runoff is expected through July 31, the portion of the curve above this line is used to estimate minimum transferable space.

Source: US Corps of Engineers Water Control Manual for Camanche Dam and Reservoir, September 1981

Appendix A6: Tuolumne River

1.6 Tuolumne River

1.6.1 Flow Measures, including seasonal and WY variations[6]

1.6.1.A Methodology

For all flow-related measures contained in the Tuolumne River VA, the flow schedules are based on using five water-year (WY) types determined using the 60-20-20 San Joaquin River Index (SJI). The five water year types are Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critical (C). Table A below provides the classification of each water year for the 1971 to 2012 modeling period of record.

Table A. Classification of each water year for the 1971-2012 modeling period of record.

Water Year	San Joaquin Index	Water Year	San Joaquin Index
1971	BN	1992	C
1972	D	1993	W
1973	AN	1994	C
1974	W	1995	W
1975	W	1996	W
1976	C	1997	W
1977	C	1998	W
1978	W	1999	AN
1979	AN	2000	AN
1980	W	2001	D
1981	D	2002	D
1982	W	2003	BN
1983	W	2004	D
1984	AN	2005	W
1985	D	2006	W
1986	W	2007	C
1987	C	2008	C
1988	C	2009	BN
1989	C	2010	AN
1990	C	2011	W
1991	C	2012	D

Preliminary WY determinations will be made by the Districts on February 1, March 1 and April 1 of each year using a 90% exceedance. Final WY determination will be made by DWR on May 1 of each year using a 75% exceedance.

There will be two monitoring locations for instream flow compliance: (1) the existing USGS Tuolumne River at La Grange gage and (2) a new measurement point(s) measuring the combined flows diverted into the two infiltration gallery (IG) pipelines to be installed and operated as discussed below. The La Grange gage will monitor compliance for flows at La Grange gage. Subtracting the measured "IG pipeline flows" from La Grange gage yields the instream flows to be provided downstream of RM 25.5, the second flow compliance point.

[6] The flow measures identified herein may not match those identified by FERC in its February 11, 2019 DEIS, and may not match those in FERC's FEIS. It is anticipated that the flow measures identified herein will become part of the FERC licenses for the Don Pedro and La Grange Projects through the SWB's 401 certification process in the event the proposed terms are included in any future water quality control plan amendment as requested.

1.6.1.B Base Flows

Year-round base flows shall be provided to support all lifestages of native fish located in the lower Tuolumne River. A summary of the year-round base flows is provided in Table B. These base flows have been generated based on science developed on the Tuolumne River over several decades with the most recent set of studies completed as part of the Federal Energy Regulatory Commission (FERC) relicensing of the Don Pedro hydroelectric project and licensing of the La Grange hydroelectric project. Many of these studies are referenced[1] throughout this project description and are part of the Amended Final License Application (AFLA) submitted to FERC October 11, 2017 and further amended on November 14, 2018. Pulse flows that augment these base flows are described in Section 1.6.1C and Section 1.6.1.D.

Table B. Summary of the Tuolumne River VA proposed minimum instream flows[2]

Water Year / Time Period	Proposed Instream Flows with IGs (cfs)	
	La Grange Gage	RM 25.5
Wet, Above Normal, Below Normal		
Jun 1 – Jun 30	200	100
Jul 1 – Oct 15	300	150
Oct 16 – Dec 31	275	275
Jan 1 – Feb 28/29	225	225
Mar 1 – Apr 15	250	250
Apr 16 – May 15	275	275
May 16 – May 31	300	300
Dry		
Jun 1 – Jun 30	200	125
Jul 1 – Oct 15	300	125
Oct 16 – Dec 31	225	225
Jan 1 – Feb 28/29	200	200
Mar 1 – Apr 15	225	225
Apr 16 – May 15	250	250
May 16 – May 31	275	275
Critical		
Jun 1 – Jun 30	200	125
Jul 1 – Oct 15	300	125
Oct 16 – Dec 31	200	200
Jan 1 – Feb 28/29	175	175
Mar 1 - Apr 15	200	200
Apr 16 – May 15	200	200

A more detailed breakdown of the year-round base flows is provided below.

Early Summer Flows (June 1 – June 30)

Studies show (AFLA W&AR-05, W&AR-06, rotary screw trap (RST) results) that except in wet (W) water years when high flows may extend well into June and even beyond, fall-run Chinook salmon juveniles and smolts have left the Tuolumne River by the end of May (see Figure 1 below).

[1] The FERC studies submitted with the AFLA are referenced by letters and numbers. For example, W & AR-05 stands for water and aquatic resources study number 5. All of the studies referenced can be found in the AFLA, which can be accessed through the Don Pedro Relicensing website: www.donpedro-relicensing.com.
[2] For compliance purposes, the flow requirement below the IGs is determined by subtracting the measured water withdrawal by the IGs from the measured flow at the USGS gage at La Grange.

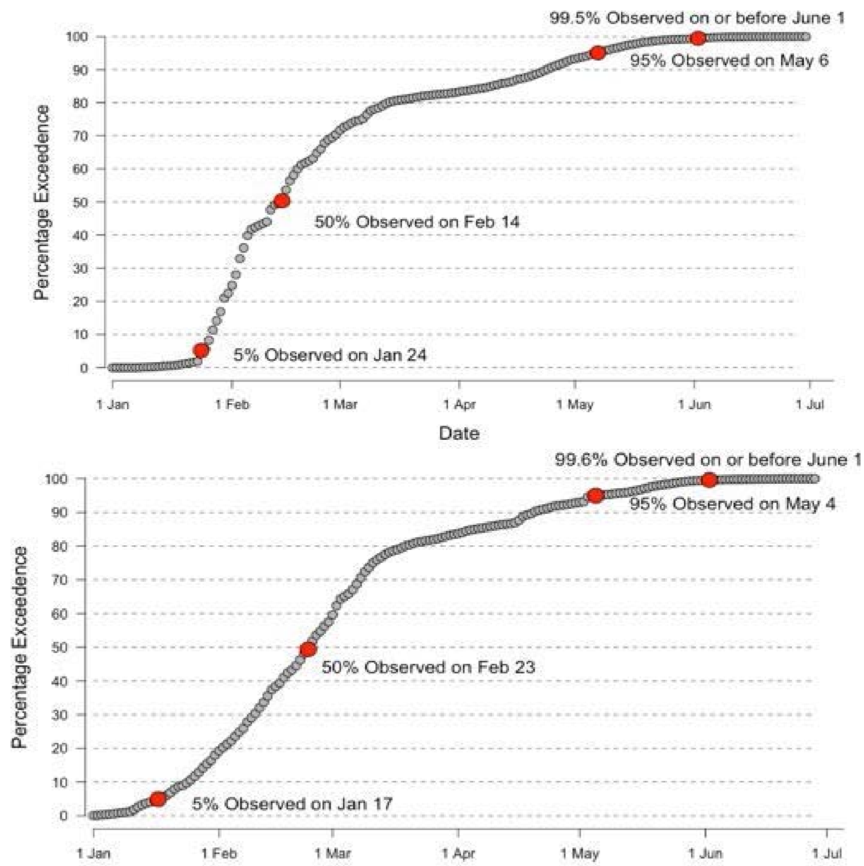


Figure 1. *Long-term migration pattern of observed juvenile Chinook salmon captured at the Waterford RST (top; RM 30) and the Grayson RST (bottom; RM 5) on the Tuolumne River (2006 – 2016). Key dates of passage are highlighted with red circles.*

Given the general absence of fall-run Chinook salmon in the river, the primary benefit of early summer (June 1 – June 30) flows is the maintenance of suitable thermal conditions for *O. mykiss* populations. Based on *O. mykiss* redd surveys, *O. mykiss* may spawn any time from January through early May, with peak redd counts in 2013 being in March and early April (Don Pedro Updated Study Report, January 2014; Fig 5.1-3). Years of monitoring studies indicate that *O. mykiss* are predominantly found upstream of RM 43 with peak fry densities potentially occurring into June. For the period from June 1 to June 30, base flows will be provided primarily to support *O. mykiss* fry rearing.

Flow management for the benefit of *O. mykiss* in June consists of striking a balance between providing hydraulic habitat suitability and temperature suitability for fry and adult life stages. Flow-habitat study results (Stillwater Sciences, 2013; see Figure 2 below) indicate that at 100 cfs, hydraulically suitable habitat for *O. mykiss* fry is 85% of the maximum weighted usable area (WUA), at 150 cfs it is 78% of maximum WUA, and at 200 cfs it is 71% of maximum WUA.

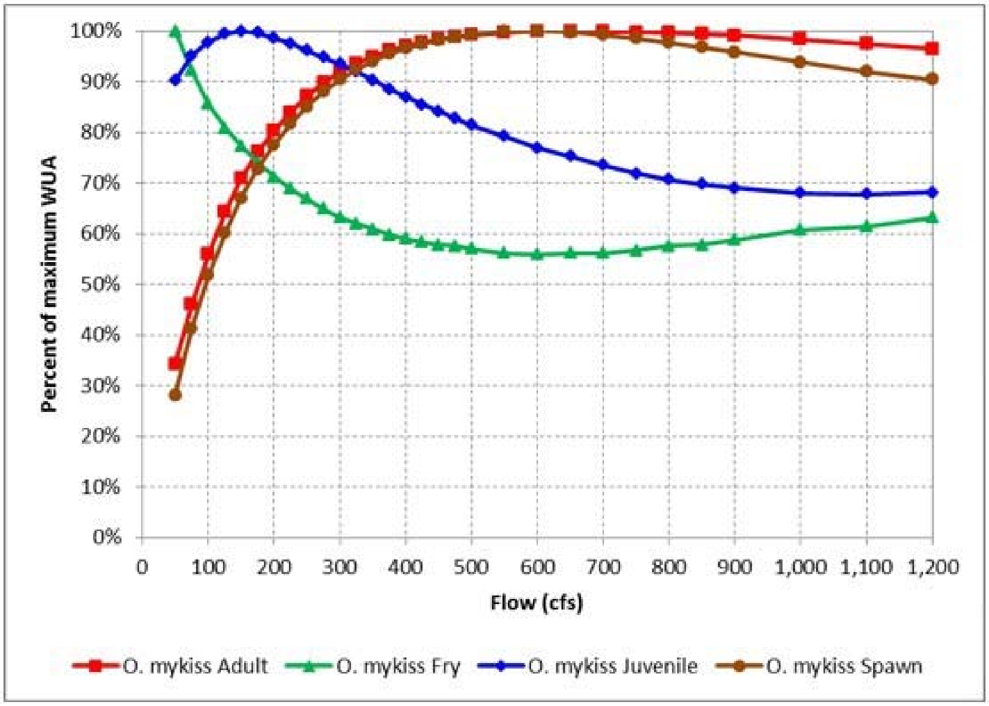


Figure 2. *O. mykiss WUA results for the Tuolumne River from Stillwater Sciences (2013).*

Considering thermal suitability for *O. mykiss* during June conditions, water temperature modeling shows that at RM 47, a flow of 200 cfs will maintain average daily water temperatures to less than 18°C, and at RM 43 average daily water temperatures will be less than 20°C, except when daily maximum air temperatures along the river exceed 100°F, which on average occur 1 to 2 days in June (see Figures 3 and 4 below).

Adult *O. mykiss* habitat is 78% of maximum WUA at 200 cfs. An alternative flow of 150 cfs was considered, which improves fry habitat to 78% of maximum WUA, but decreases adult habitat to 70% of maximum WUA. At 150 cfs, average daily water temperatures at RM 43 are less than 20°C until maximum daily air temperature exceeds 95°F, which occurs on average three days in June. An alternative flow of 300 cfs increases adult WUA to 90%, but decreases fry to just over 60% of maximum WUA. Considering that adults must first successfully pass through fry stage, it is counterproductive to over-emphasize adult habitat at this sensitive period for the fry life stage.

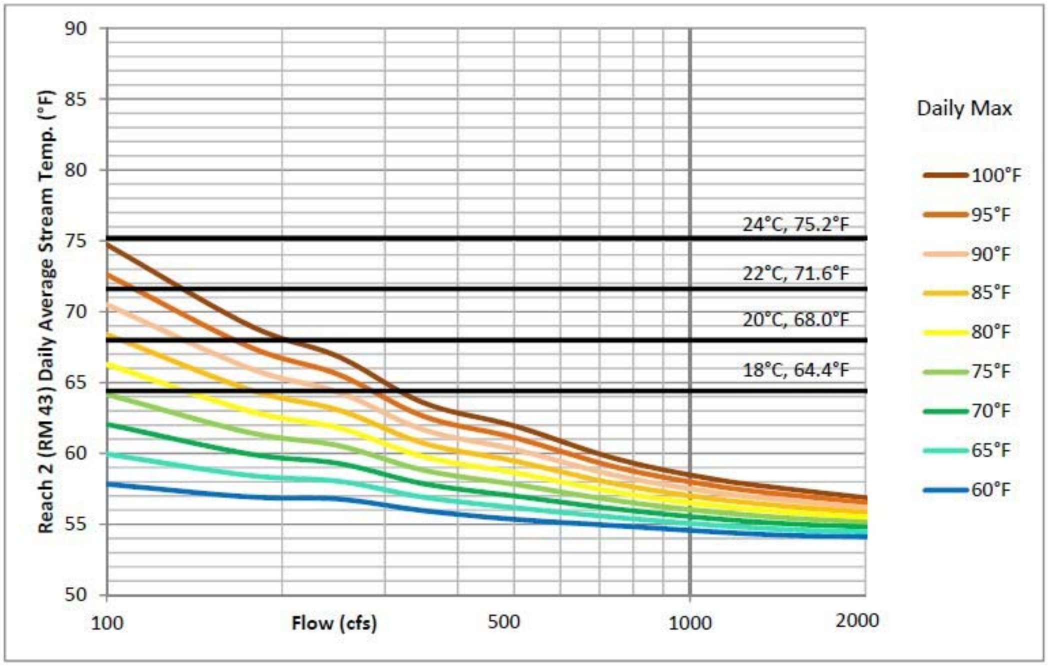


Figure 3. *Estimated average daily river temperatures at RM 43 based on river flow and maximum daily air temperature.*

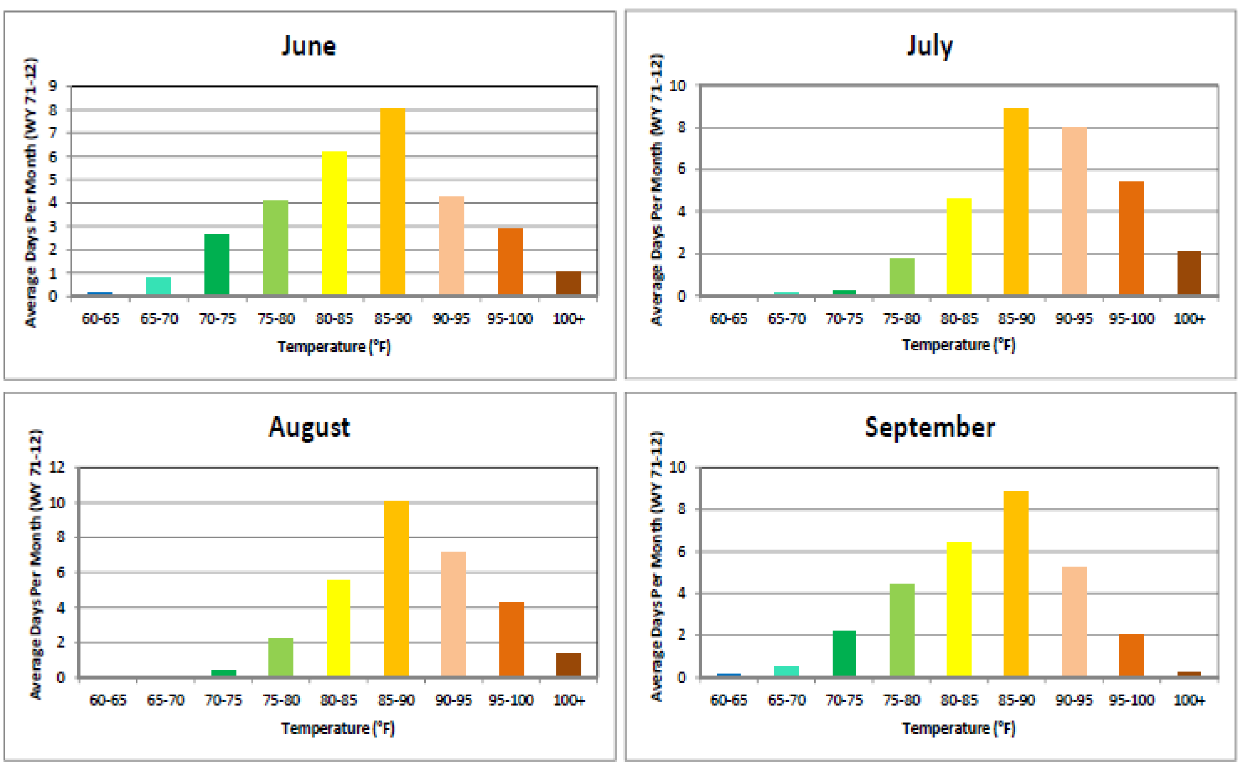


Figure 4. *Average days per month when maximum daily air temperature falls within specified ranges as estimated at approximately RM 40 on the Tuolumne River (WY '71-'12).*

Therefore, early summer flows (June 1 – June 30) of 200 cfs at La Grange gage under all WYs will reasonably protect *O. mykiss* fry while also being protective of *O. mykiss* adults. Under the current FERC-required flows, in 20% of the WYs, the required instream flow is 50 cfs, in 30% of the WYs it is 75 cfs; and in 50% of the WYs it is 250 cfs. Therefore, in 50% of the WYs, the instream flow provided under the Tuolumne River VA will be substantially greater than the current flow (up to 4 times greater). In 50% of the WYs (Wet and Above Normal), the new required instream flow will be reduced by 20% (200 vs. 250 cfs), but will nonetheless be more protective of *O. mykiss* fry due to increased habitat suitability at the slightly lower flow.

Late Summer Flows (July 1 to October 15)

By July, the *O. mykiss* life stages occurring in the lower Tuolumne River are juveniles and adults. Juveniles are stronger swimmers than fry and can maintain position in the river at higher flows. The primary habitat concern during this period is to maintain adequate river temperatures through approximately RM 43.

Fish biology researchers from the University of California at Davis (UC Davis), in conjunction with *O. mykiss* experts from University of British Columbia (UBC), conducted field tests of the thermal capacity of wild Tuolumne River *O. mykiss* juveniles (see AFLA Water &Aquatic Resources (W&AR)-14).[3] This study, and additional observations of in-situ wild juveniles (FISHBIO 2017), demonstrated that Tuolumne River *O. mykiss* juveniles had optimum metabolic capacity between 21˚C and 22˚C, and maintained 95% of optimum capacity between 18˚C and 24˚C. A flow of 300 cfs maintains the average daily water temperature below 19˚C as far downstream as RM 43, even when daily maximum temperature exceeds 100˚F (see Figure 3 above), providing favorable thermal conditions for Tuolumne River *O. mykiss* through the summer months. Therefore, the Tuolumne River VA includes a flow requirement of 300 cfs at the La Grange gage in all WYs from July 1 through October 15.

In early fall, fall-run Chinook salmon normally begin to enter the lower Tuolumne River. Since 2009, the Districts have maintained an adult counting weir at RM 24.5, corresponding to the approximate downstream end of the gravel-bedded reach of the river. As indicated in Figure 5 below, few fish enter the spawning gravels above the counting weir until after mid-October. The fall-run Chinook salmon upstream migration peaks from late-October through November, and can extend into late December, and occasionally early January.

---

[3] The UC Davis and UBC researchers subsequently published this study and its results in the peer reviewed journal *Conservation Physiology* in 2016 (see Verhille et al. 2016).

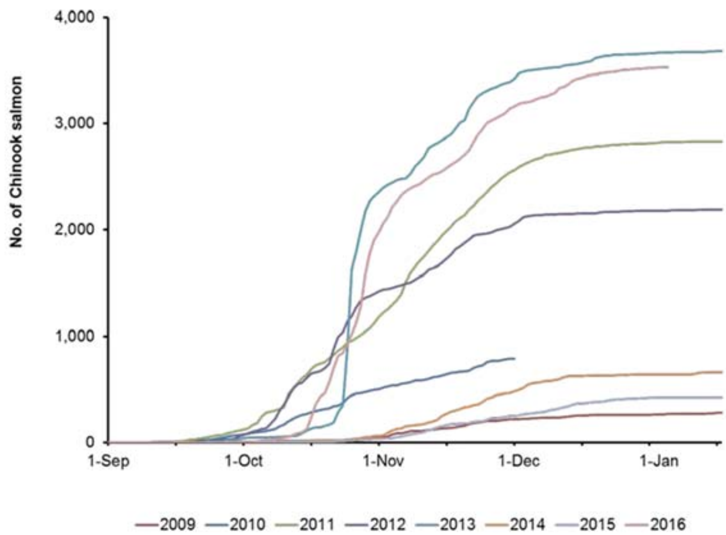


Figure 5. *Adult fall-run Chinook passage at the fish counting weir at RM 24.5 for 2009 through 2016.*

There will be a pre-spawning season flushing flow to clean gravels of built up algae, debris, and surface fines prior to the start of substantial spawning. A flushing flow of approximately 1,000 cfs on October 5, 6 and 7 (total volume not to exceed 5,950 AF), with appropriate up and down ramps, will be provided in wet (W), above normal (AN), and below normal (BN) water years. In Dry (D) and Critical (C) water years, the instream flow at La Grange gage will be maintained at 300 cfs with no flushing flow provided.

Operation of Infiltration Galleries
Instream infiltration galleries (IG-1 and IG-2) will be completed/constructed and operated near RM 26 for the purpose of benefiting lower Tuolumne River cold-water fisheries, notably *O. mykiss*, while at the same time protecting the Districts' water supplies. The gravel-bedded reach of the lower Tuolumne River extends to approximately RM 30 and habitats preferred by *O. mykiss* based on directed searches and snorkel surveys are located generally above RM 43. In the vicinity of Geer Road at RM 26, TID's Ceres Canal approaches reasonably close to the left bank of the lower Tuolumne River, enabling cost-effective delivery of water withdrawn from the river to TID's irrigation customers, while benefiting habitat for *O. mykiss* between RM 51 and RM 43, and perhaps further downstream, depending on local acclimation by the Tuolumne River *O. mykiss* population.

The Districts will complete construction of IG-1[4] and undertake construction of IG-2 in the same general locale as IG-1 near RM 26. IG-1 has a design capacity of approximately 100 cfs and IG-2 will have a design capacity of 100-125 cfs. Consistent with the scope of its authority and jurisdiction, DFW shall facilitate, license and permit the construction, operation and maintenance of the IGs.

The IGs will withdraw water from the river from June 1 through October 15 of each year. While there are times when both IGs will be in operation, there are also times when IG-1 will be adequate to withdraw the full amount planned. Having some redundancy minimizes the potential for the IGs to be unable to withdraw the amount of water planned. There is still the possibility, however low, that with either one or both of the IGs out of service the Districts will be unable to withdraw water at this location. Any IG outage which prevents the planned amount to be withdrawn and lasting for more than

[4] The infiltration pipeline network for IG-1 was installed in the riverbed during the 2003 river restoration project isolating SRP-9 from the river and restoring riffle habitat in the reach.

three consecutive days will result in the minimum instream flows required at La Grange gage to be reduced by two-thirds of the amount that would have been withdrawn.

As an example of such an outage and the resulting flows, in an AN water year in July, the La Grange gage flow would be 300 cfs and the flow to be withdrawn at the IGs is 150 cfs, thereby leaving a flow in the river of 150 cfs below RM 25.5.[5] If one of the three 60 cfs pumps in the IG pump station experienced an unexpected extended outage under these conditions, then the required flow at the La Grange gage would be reduced to 280 cfs (300 cfs-20[6] cfs) instead of 300 cfs, and the flow below RM 25.5 would be 160 cfs (280 cfs–120 cfs) instead of 150 cfs. Under this arrangement, all concerned entities are motivated to put the non-functioning portion of the IG back into service promptly.

Fall-run Chinook Spawning (October 16 – December 31)

Studies conducted as part of relicensing (AFLA W&AR-04 – *Spawning Gravel in the Lower Tuolumne River*) found sufficient spawning gravels currently exist in the lower Tuolumne River to support a fall-run Chinook spawning population of over 50,000 fish. Timing of fall-run Chinook spawning in the lower Tuolumne River occurs predominantly from mid-October through the end of December based on data collected at the Districts' counting weir located at RM 24.5. In 2012/2013, 1.4% of new redds were documented to occur after December 15; in 2014/2015, 8.5% of new redds were observed after December 31. Instream flow studies (Stillwater Sciences 2013) indicate that 100% of the maximum WUA for fall-run Chinook spawning occurs at approximately 300 cfs and 90% of the maximum WUA or greater occurs from 210 to 400 cfs (see AFLA, Exhibit E, Figure 5.6-8).

Based on this site-specific data for the Tuolumne River, the Tuolumne River VA includes spawning flows for the October 16 through December 31 spawning period in accordance with the following schedule:

- For BN, AN, and W WYs 275 cfs
- For D WYs 225 cfs
- For C WYs 200 cfs

At a flow of 275 cfs, hydraulically suitable spawning habitat is 98% of maximum WUA, at 225 cfs spawning habitat is at 92% of maximum WUA, and at 200 cfs it is 89% of maximum WUA. These flows, in combination with the other spawning habitat improvements provided by the Tuolumne River VA, will significantly improve overall spawning habitat quantity and quality.

Fall-Run Chinook Fry-Rearing (January 1 – February 29)

A study of adult fall-run Chinook otoliths taken from Tuolumne River fish (AFLA W&AR-11) shows that fall-run Chinook salmon that leave the lower Tuolumne River as fry typically make up a very small percent (<5%) of the subsequent adult escapement. Under the conditions existing in the lower reaches of the lower Tuolumne River, the San Joaquin River, and Bay-Delta, fry mortality is high. Efforts to

---

[5] The Districts are not responsible for making up for losses in the river due to depletions to groundwater, riparian withdrawals, evapotranspiration losses or any other losses that occur between La Grange gage and the IGs; nor can the Districts' instream flows at La Grange be reduced, or withdrawals at the IGs be increased, if the river is a gaining stream. In-situ flow measurements performed during relicensing generally show the lower river is a gaining stream.

[6] The 20 cfs reduction is two-thirds of the total reduction in pumping capacity of 30 cfs because the two remaining pumps would each pump at capacity (about 60 cfs each).

increase suitable fry habitat in the upper reaches of the lower Tuolumne River (above RM 30) should increase the number of fall-run Chinook leaving the river as parr and smolts, and thereby increase fall-run Chinook production on the lower Tuolumne River and, all else being equal, increase subsequent adult returns. Based upon PHABSIM modeling of in-channel habitat conditions in the lower Tuolumne River, the maximum suitable Chinook fry habitat occurs at 50 cfs. At 100 cfs, Chinook salmon fry habitat is reduced to 88% of maximum WUA, at 150 cfs it is 75% of maximum, at 225 cfs it has dropped to about 67%, and at 300 cfs it is less than 60% of maximum WUA. High flows in the river during the early fry rearing period (January-February) tend to result in downstream displacement of fry into the lower, more confined reaches of the lower Tuolumne River and potentially into the San Joaquin River, areas with higher densities of predatory fish species (AFLA W&AR-05; W&AR-06), thereby adversely affecting later adult returns and escapement.

In-channel fry rearing habitat is not a limiting factor for the lower Tuolumne River fall-run Chinook salmon population. As shown in Figure 6 below, in-channel fry rearing capacity above Hickman Bridge (RM 31.7) exceeds 6 million fry at a flow of 100 cfs and 5 million fry at a river flow of 200 cfs.

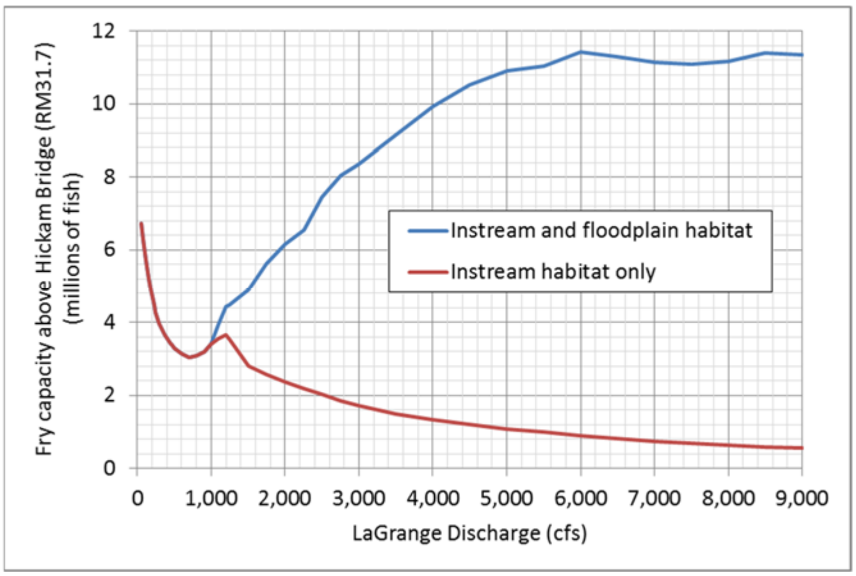


Figure 6. *Fry carrying capacity (millions of fish) in the lower Tuolumne River inclusive of both in-channel and floodplain habitat above RM 31.7.*

As shown in Figure 6, and applying the results of the *Floodplain Hydraulic Analysis* study (W&AR-21), river flows exceeding 2,000 cfs provides the same level of rearing capacity as that provided by in-channel rearing achieved at flows of about 100 cfs. Floodplain rearing is discussed further in Section 1.6.1.C. Additionally, implementation of the Lower Tuolumne River Habitat Improvement Program (LTRHIP) described in Section 1.6.2.D below, particularly in-channel LWD enhancements, will contribute to increasing in-channel fry habitat and densities in the upper reaches of the lower Tuolumne River. To promote fry rearing upstream of the general area of the Waterford RST (RM 30), and striking an appropriate balance between spawning and rearing flows, the following minimum instream flow releases will be provided from January 1 through February 29:

- BN, AN, W WYs 225 cfs
- D WYs 200 cfs
- C WYs 175 cfs

These flow levels are slightly lower than those provided during the spawning period; however, they remain sufficiently high so as not to result in significant riverine hydraulic changes or redd dewatering. The mean pot depth of fall-run Chinook salmon redds found during the 2012 redd survey was 1.9 feet and the minimum observed depth was 0.9 feet (AFLA W&AR-08, Figure 5.3-4). Based on the rating curve for the USGS gage at La Grange shown in Figure 7 below, the change in flow from 275 cfs to 225 cfs results in a 0.4 ft (+/-) change in stage, and from 225 cfs to 200 cfs results in a 0.2 ft (+/-) change in stage. These small changes in river stage when moving from spawning flow to rearing flow are unlikely to adversely affect fall-run Chinook salmon egg incubation.

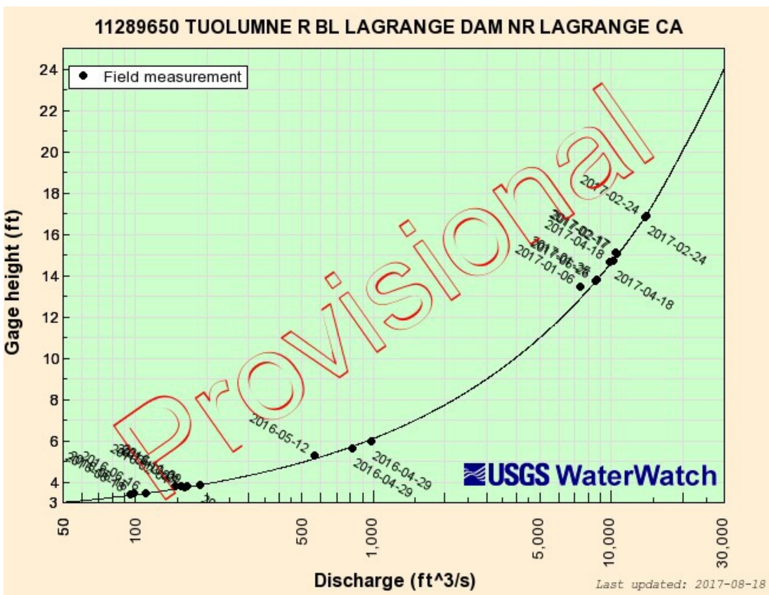


Figure 7. *Stage-discharge rating curve of the USGS Tuolumne River at La Grange gage.*

Fall-Run Chinook Juvenile Rearing (March 1 – April 15)

In the lower Tuolumne River, the juvenile rearing life stage dominates the time frame from March through mid-to-late April. Hydraulically suitable habitat for juvenile fall-run Chinook salmon rearing is maximized at 150 cfs and exceeds 97% of the maximum WUA at flows from 100 to 200 cfs. At 300 cfs, it drops to 90%. At 250 cfs, average daily water temperatures stay below 18°C at RM 39.5 until maximum daily air temperatures exceed about 80°F, which occurs on average about three to four days in April, and stays below 20°C at RM 39.5 until maximum daily air temperature exceeds 85°F, which occurs about one day in April (see Figure 8 below).

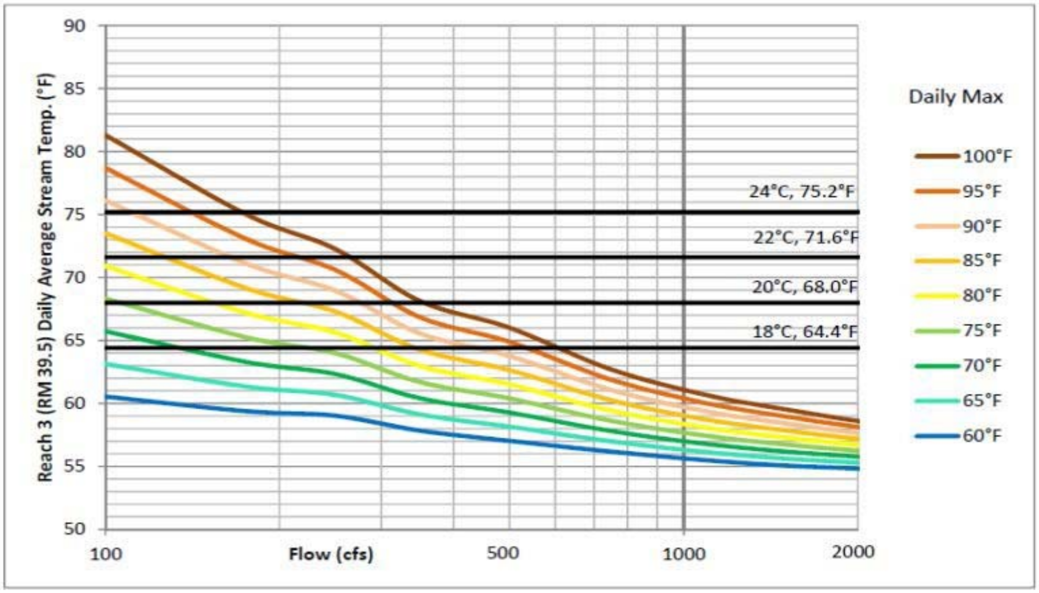


Figure 8. *RM 39.5 daily average water temperatures versus flow and maximum air temperatures.*

In-channel juvenile rearing habitat is not a limiting factor for fall-run Chinook salmon in the lower Tuolumne River. At a flow of 250 cfs, in-channel rearing habitat supports 3 million juvenile fall-run Chinook salmon above RM 31.7 (see Figure 9). Therefore, providing juvenile rearing flows that maximize in-channel rearing habitat is an important consideration. This portion of the base flow is targeting in-channel rearing. The importance of floodplain rearing, and the flows necessary to achieve floodplain rearing, is discussed in Section 1.6.1.C below.

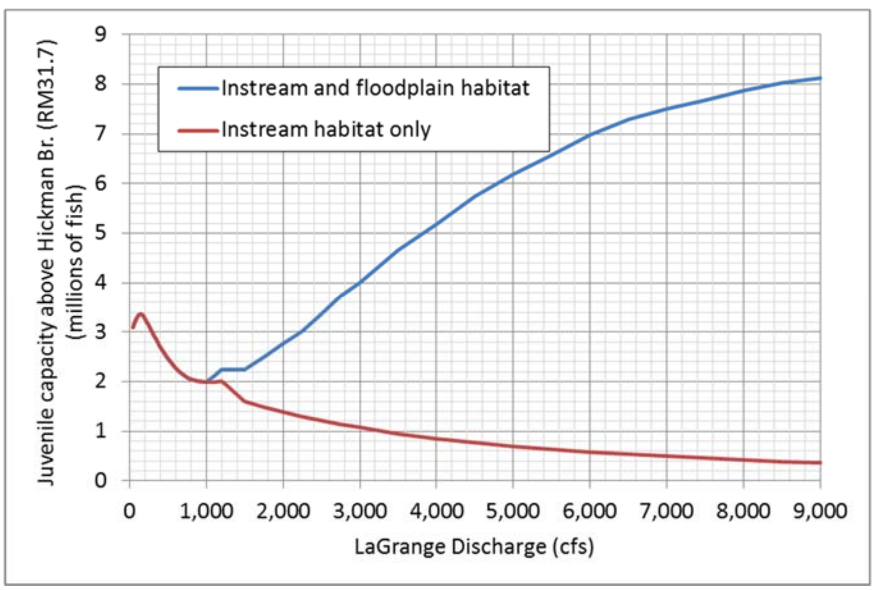


Figure 9. *In-channel and floodplain juvenile rearing capacity in the lower Tuolumne River (millions of fish) above RM 31.7.*

Another fisheries related consideration in the March to mid-April time frame is *O. mykiss* spawning. As shown above in Figure 2, at a flow of 250 cfs, spawning habitat for O. *mykiss* is about 85% of maximum WUA and at 200 cfs it is about 78% of maximum WUA. At RM 43, which is the approximate downstream limit of preferred *O. mykiss* habitat, average daily water temperatures stay below 15˚C at a flow of 225 cfs until maximum air temperatures exceed 75˚F (on average two days in March and eight days in April). Therefore the base flows in the Tuolumne River VA intended to promote and protect fall-run Chinook salmon juvenile rearing are not inconsistent with protecting *O. mykiss* spawning in the upper nine miles of the lower Tuolumne River.

To benefit fall-run Chinook salmon juvenile rearing, while being protective of *O. mykiss* spawning, the following minimum instream flow releases will be provided from March 1 through April 15:

- BN, AN, W WYs 250 cfs
- D WYs 225 cfs
- C WYs 200 cfs

Outmigration Base Flows (April 16 through May 15)

Fall-run Chinook salmon leaving the lower Tuolumne River as large parr or smolts return as adults in a much higher percentage than those leaving as fry (almost a 20:1 ratio based upon testing of otoliths of adults from the outmigration years of 1998, 1999, 2000, 2003, 2009; see AFLA W&AR-11); therefore, maintaining favorable growth conditions and reducing predation throughout the fry to smoltification life stages is beneficial to fall-run Chinook salmon production on the lower Tuolumne River. As juvenile fall-run Chinook salmon grow, their ability to hold station and simultaneously conduct life functions under higher flows also increase.

Increasing base flows above those in the March 1 to April 15 period serves to maintain favorable river temperatures during the mid-April through mid-May period. At RM 39.5, a flow of 275 cfs keeps average daily river temperatures below 21˚C until maximum daily air temperatures exceed 100˚F, which occurs on average one day in May. At RM 39.5, at a flow of 225 cfs, water temperatures are below 21˚C until maximum air temperatures exceed 95˚F, which occurs on average about two days in May. In April and potentially through mid-May, incubation of *O. mykiss* may be occurring. At RM 43, a flow of 275 cfs maintains average daily water temperatures below 15°C until maximum daily air temperatures exceed 80˚F, which occurs about three to four days in April and 15 days in May. However, in May *O. mykiss* fry habitat is more of a concern because this is late in the incubation period and most fry have emerged. At 275 cfs, fry habitat is 64% of maximum WUA.

Studies of fall-run Chinook salmon growth by Sommers et al. (2001; 2004) on the Sacramento River (Yolo Bypass reach) and by Jeffres et al. (2008) on the nearby Cosumnes River both found that juvenile salmon grow well at temperatures exceeding 21˚C as long as available food sources are favorable. Jeffres et al. reports “[t]emperatures on the floodplain for a 1-week period had a daily average of 21˚C and reached a daily maximum of 25˚C and fish continued to grow rapidly.” In-river benthic macroinvertebrate studies on the Tuolumne River demonstrate robust populations of BMI in the Tuolumne. Poletto et al. (2017) reported on testing of the thermal capacity of fall-run Chinook juveniles taken from the Mokelumne River hatchery and found this stock juvenile fall-run Chinook “shows an impressive aerobic capacity when acutely warmed to temperatures close to their upper thermal tolerance limit, regardless of the acclimation temperature”.[7]

Considering the balance to be struck between Chinook and *O. mykiss* life stages which are occurring at the same time in this period, the following minimum instream flow releases will be provided from April 16 to May 15:

- BN, AN, W WYs 275 cfs
- D WYs 250 cfs
- C WYs 200 cfs

An outmigration pulse flow to augment these base flows is described in Section 1.6.1.D.

Outmigration Base Flows (May 16 through May 31)

While in most years juvenile fall-run Chinook salmon have left the lower Tuolumne River by mid-May (see Figure 1 above), in some years there are still large parr and smolts in the river beyond May 15.

To reduce water temperatures during this period, the following minimum instream flow releases will be provided from May 16 through May 31:

- BN, AN, and W WYs 300 cfs
- D WYs 275 cfs
- C WYs 225 cfs

This increase in flow above that provided in the April 16-May 15 period tends to favor fall-run Chinook salmon over *O. mykiss* fry; however, increased rearing habitat provided by improvements to in-channel habitat complexity will improve *O. mykiss* fry rearing habitat, especially if preference to placing LWD is given to along the stream margins preferred by *O. mykiss* fry and juveniles, as described in Section 2.6.2.D below.

1.6.1.C Floodplain Rearing Pulse Flow

For floodplain pulse flows to be effective on the Tuolumne River, releases must be high enough to exceed the habitat otherwise available at lower in-channel flows (see Figure 9). Floodplain flows must also be of sufficient continuous duration to be effective as foraging opportunities so as not to require constant movement by juvenile Chinook salmon in response to frequent flow fluctuations. For the lower Tuolumne River, a flow of 2,750 cfs is projected to provide greater overall juvenile fall-run Chinook salmon carrying capacity compared to the continuous base flow described above. The preferred duration of the floodplain pulse flow is estimated to be 14 days or greater (Matella and Merenlender 2014), although shorter periods may be adequate as long as they are continuous and without large flow fluctuations. The floodplain rearing pulse flows were developed using the Flow West model and the work of the California Department of Fish and Wildlife (DFW), the Districts and SF.

To maximize the benefit of the floodplain rearing pulse flow, the start of such pulse will be timed to coincide with Chinook salmon rearing timing, which shall be determined by the Tuolumne River

[7] The upper thermal tolerance limit found in the study was reported as 25°C.

Partnership Advisory Committee (TRPAC), described in Section 1.6.2.D below, on an annual basis relying upon such information as date of egg deposition, date of emergence, water temperatures, visual observations, RST data and other relevant information.

Except in successive BN, D and C WYs, the spring floodplain pulse flow rates (inclusive of the minimum instream flow identified in Table A above) and durations proposed in the Tuolumne River VA are as follows:

- W and AN WYs — 2,750 cfs for a duration of 20 days
- BN WYs — 2,750 cfs for a duration of 18 days
- D WYs — 2,750 cfs for a duration of 14 days
- C WYs — 2,750 cfs for a duration of 9 days

Ramp rates associated with the floodplain pulse will be 300 cfs/hr for upramping and 200 cfs/hr for downramping. The volume of water contained in ramping is part of the floodplain pulse volume as is the base flow occurring at the time.[8]

The floodplain pulse flows also contain a "dry-year relief" plan specific to the floodplain pulse. For the floodplain pulse flows, dry-year relief occurs in sequences of D, C and BN WYs. Specifically, in a successive D or C WY, the floodplain pulse goes to zero for that year and any following successive D or C WY. In any BN WY occurring in a sequence of C and/or D WYs, the floodplain pulse flow will be 2,750 cfs for a duration of 14 days, instead of 18 days. Any BN WY occurring within a sequence of D and/or C WYs does not restart the D and/or C sequence. For example, in the WY sequence of C, D, BN, C, D, there would be no floodplain pulse in the first and second D and second C WYs in the sequence because a BN WY does not restart the dry-year relief sequence. In this example, there would be a floodplain pulse of 2,750 cfs for a duration of 14 days in the BN WY. Also, in a WY sequence of C, BN, D, there would be a floodplain pulse in the BN WY of 2,750 cfs for a duration of 14 days, but there would be no floodplain pulse in the D WY.

In a 3rd successive BN WY, the Districts, SF and CDFW shall meet and confer to see what if any water is available for a floodplain pulse. For example, in a sequence of W, BN, BN, BN WYs, the meet and confer would occur in the third BN WY.

For purposes of determining dry year relief, a sequence cannot start with a BN year (excluding sequential BN WYs as set-forth above). For example, in a WY sequence of BN, C and D, there would be a floodplain pulse of 2,750 cfs for a duration of 18 days in the BN WY, a floodplain pulse of 2,750 cfs for a duration of 9 days in the C WY, and then no floodplain pulse in the D WY.

All floodplain pulse flows are inclusive of the base flow. For example, if the base flow is 200 cfs, then the additional flow to achieve the floodplain pulse flow is 2,550 cfs, so as to have a total flow of 2,750 cfs.

In the event that the floodplain pulse and the spring outmigration pulse flow, described in Section 1.6.1.D below, overlap in whole or part, the floodplain pulse will be inclusive of the spring outmigration

[8] For example, the floodplain pulse volume in a Wet WY would be 99 TAF. For the floodplain pulse flow, the base flow occurring at the time is included as part of the floodplain pulse. The volume of 99 TAF would include the estimated ramping volume of about 2,000 AF if up-and down-ramping occurs from say 250 cfs to 2,750 cfs. Therefore the duration of the pulse at 2,750 cfs would be about 19 days and 14 hours.

pulse. For example, if the floodplain pulse is 2,750 cfs, and the overlapping spring outmigration pulse is 3,000 cfs, the total required flow for the period of overlap is 3,000 cfs.

1.6.1.D Spring Outmigration Pulse Flows

To encourage outmigration and increase survival, spring outmigration pulse flows will be provided which are carefully timed to coincide with the time periods when large numbers of fall-run Chinook salmon are of large parr or smolt size, circa 65 mm and above. Generally, the time period for release of spring outmigration pulse flows falls within the period of April 16 through May 31. The Tuolumne River VA includes the active monitoring of spawning timing and river temperatures, supplemented by snorkel surveys and/or seining, to calibrate degree days and juvenile size for the purpose of timing the spring outmigration pulse flows to coincide with the smoltification of large numbers of juveniles. Adaptive management principles will be applied to optimizing over time the timing, duration, and flow rate of the pulse flows as data is collected on the resulting outmigration survival as a ratio to the number of female spawners (e.g., exiting smolts per female spawner) as measured at the Districts' RSTs. The Districts' proposed Adaptive Management Plan for the spring outmigration pulse flow is described in Appendix E-1, Attachment F of the AFLA. The outmigration pulse flows are in addition to the base flows occurring at the time.

The spring outmigration pulse flow volumes are as follows:

- W and AN WYs 150 TAF
- BN WYs 100 TAF
- D WYs 75 TAF
- Successive D WYs 45 TAF
- First year C WY 35 TAF
- Successive C WYs 11 TAF

Consistent with the floodplain rearing pulse flow, the spring outmigration pulse flows include the provision for "dry-year relief". As shown above, in any successive occurrences of dry and/or critical water years, the spring outmigration pulse flows are reduced. Examples of this "dry-year relief" are enumerated below.

Example 1: If there were a sequence of six WYs of C-D-C-D-C-D, the second and third C and D WYs would have the reduced outmigration pulse flow volumes.

Example 2: If there were a sequence of four WYs of C-C-D-D, the second C and second D WYs would have reduced outmigration pulse flow volumes.

Example 3: If there were a sequence of five WYs of D-D-C-D-C, the second and third D and second C WYs would have reduced outmigration pulse flow volumes.

Example 4: If there were a sequence of six WYs of C-D-BN-C-D-C, the third C WY would have reduced outmigration pulse flow volumes.

Spring outmigration pulse flows are subject to upramping limit of 300 cfs/hr and downramping limit of no more than 200 cfs/hr. The volume of water in the ramping period is part of the pulse flow volume. That is, if flows are ramped from 300 cfs to an outmigration pulse of 3,000 cfs, the upramping would take approximately nine hours and use about 1,000 AF of water and the downramping back to 300 cfs would take about thirteen hours and use about 1,600 AF. If the WY was a BN WY, then the 100,000 AF pulse occurring at 3,000 cfs would be reduced to a volume of 97,400 AF.

1.6.2 Non-Flow Measures

The non-flow measures are also based on science developed on the Tuolumne River over several decades, including the most recent studies completed as part of the relicensing of the Don Pedro hydroelectric project. All referenced studies can be found at the Don Pedro relicensing website: www.donpedro-relicensing.com.

1.6.2.A Improve Spawning Gravel Quantity and Quality

The most recent studies of the spawning gravel resources present in the lower Tuolumne River demonstrate that the river downstream of the La Grange tailrace has sufficient spawning gravel now and for the foreseeable future to sustain a healthy and robust population of fall-run Chinook salmon and *O. mykiss* (AFLA W&AR-04, *Spawning Gravel in the Lower Tuolumne River*). The Spawning Gravel Study also estimated a loss from storage of approximately 8,000 tons of coarse sediment based on differencing 2005 and 2012 DTM data over the 7-mile reach covering the Dominant Spawning Reach of the lower Tuolumne River, extending from approximately River Mile (RM) 52 to RM 45. Distributed over the channel study area, the estimated lowering of the channel due to this loss is 13 mm, or less than half the average median grain size of the coarse channel bed (approximately 51 mm). Based on the findings of the AFLA W&AR-04 studies, the Tuolumne River VA includes the following specific measures to improve the spawning gravel resources of the lower Tuolumne River.

1.6.2.A-1 Augment Current Gravel Quantities through a Coarse Sediment Management Program

Approximately 75,000 tons of properly-sized gravel will be added between RM 52 and RM 39[9] over a ten-year period. Because spawning preferences of fall-run Chinook are more heavily weighted towards upstream habitats, the highest priority for initial gravel augmentation measures is in the vicinity of Old La Grange Bridge. The specific priority sites are the reaches containing Riffles A5 and A6, the Riffle A3/A4 complex, portions of Basso Pool, and portions of the Riffle A1/A2 complex.

Monitoring and adaptive management activities to identify potential future coarse sediment management actions include (1) repeating the Spawning Gravel study (AFLA W&AR-04) in Year 12 to inform additional measures and (2) conducting annual surveys of fall-run Chinook and *O. mykiss* spawning use of new gravel patches for five years following completion of each gravel augmentation project. Additional coarse sediment augmentation projects will be guided by the results of the updated Spawning Gravel study conducted in Year 12 and the annual surveys of spawning use.

1.6.2.A-2 Provide Gravel Mobilization Flows of 6,000 to 7,000 cfs

Flows released to the river in excess of required flows are referred to as "Spill". For purposes of gravel mobilization and movement/dispersal of fine bed material, this measure directs the Districts' Project

[9] Gravel augmentation projects are intended to primarily benefit fall-run Chinook salmon, as the Spawning Gravel Study demonstrates that sufficient suitable gravel currently exists to support the spawning of several hundred thousand *O. mykiss* (see W&AR-04, Table 5.5-1).

Operations staff to provide, during years when sufficient Spill is projected to occur, at least two days of flow measured at the USGS' La Grange gage of between 6,000 cfs and 7,000 cfs. Under the Tuolumne River VA, this is anticipated to occur at an average frequency of approximately once every three to four years. In years where the La Grange gage spring spill (March through June) is projected to exceed 100 TAF, the Districts would plan to release a flow of 6,500 cfs for two days within the spill period with downramping not to exceed 400 cfs/hr until a flow of 3,000 cfs is reached, then 300 cfs/hr after that.

In the event that the there is a Spill event that is insufficient to accommodate both this gravel mobilization flow and the SMP release described in Section 1.6.2.E below, the Districts will determine the best use of the available Spill in consultation with the TRPAC, described in Section 1.6.2.D below. It is expected that the TRPAC will develop protocols and recommend actions that will insure that the gravel mobilization flows will not conflict with, and will be consistent with and complimentary to, the purposes of the floodplain and outmigration pulse flows discussed in Sections 1.6.1.C and 1.6.1.D.

1.6.2.A-3 Gravel Cleaning

The Districts will conduct a five-year program of experimental gravel cleaning using a gravel ripper and pressure wash operated from a backhoe, or equivalent methodology, selected through coordination with resource agencies.[10] Each year of experimental cleaning will consist of two to three weeks of cleaning select gravel patches. The Districts will conduct *O. mykiss* spawning and redd surveys in areas planned for gravel cleaning prior to commencing any gravel cleaning in order to avoid any active spawning or redds. Subject to the findings of these surveys, the gravel cleaning may coincide with outmigration pulse flows (See Section 1.6.1.D, above) to benefit fall-run Chinook salmon smolt outmigration by providing increased turbidity to reduce predator sight feeding effectiveness. Gravel cleaning has the potential to expand availability of high quality gravel which would improve spawning success and egg-to-emergence survival for fall-run Chinook salmon.

1.6.2.A-4 Improve Existing Instream Physical Habitat and Habitat Complexity

Studies conducted during relicensing (AFLA W&AR-04; W&AR-08; W&AR-12; W&AR-19) and field data collected as part of fisheries studies and habitat restoration (see Table 3.5-8 of AFLA, Exhibit E) indicate the occurrence of large woody debris (LWD) is limited in the lower Tuolumne River (AFLA W&AR-12, pg 6-2). The same studies show that the woody debris captured in the Don Pedro Reservoir is too small to act as favorable LWD-induced habitat in the lower Tuolumne River (AFLA W&AR-12, pg 6-4). However, studies also indicate that *O. mykiss* rearing habitat, and to a lesser extent fall-run Chinook salmon habitat, can be improved by the introduction of properly-sized LWD material for the purpose of introducing greater instream structure and habitat complexity (AFLA W&AR-12).

Placement of properly-sized and designed LWD will provide favorable micro-habitats for *O. mykiss* and promote localized scour of fines to benefit fall-run Chinook salmon spawning. The Districts will fund LWD enhancements as part of the LTRHIP discussed in Section 1.6.2.D, below. In consultation with the TRPAC, funding will be provided to identify, collect, design and place LWD in select locations between RM 43 and RM 50, the preferred habitat reach of *O. mykiss*. Annual snorkeling surveys will be conducted to examine habitat use and localized substrate conditions before and after LWD placement. Preliminary locations have been identified near RMs 42.5, 47.5, and 48.8, requiring a total capital cost of

[10] It is anticipated that this coordination will be conducted by the TRPAC.

approximately $4 million. Design of LWD complexes will follow general guidelines presented in *Restoring Complexity: Design of Large Wood Structures and Off-Channel Habitats* (34th Annual Salmonid Restoration Conference; Fortuna, CA; April, 2016).

1.6.2.B. Predator Control and Suppression Plan

Lower Tuolumne River monitoring and relicensing studies have consistently demonstrated that predation of salmon juveniles by non-native black bass and striped bass has a significant impact on smolt production in the lower Tuolumne River. A long-term, robust and functional predator control and suppression plan is a high priority for the lower Tuolumne River. While population modeling results show that smolt survival on the lower Tuolumne River is moderately sensitive to flow rates, the same models demonstrate that, based on Tuolumne River site-specific data, smolt production is much more strongly correlated to predation levels (AFLA W&AR-05, W&AR-06, W&AR-07, and RST Reports). The Predator Control and Suppression Plan targets a reduction in annual predation rates of 10% below RM 25.5 and 20% above RM 25.5.

1.6.2.B-1 Construct a Fish Counting and Barrier Weir

The Districts will construct and operate a fish barrier and counting weir at approximately RM 25.5. The barrier weir will prohibit the movement of striped bass from upstream habitats used by rearing juvenile fall-run Chinook salmon and *O. mykiss*, while simultaneously providing a location where striped bass will congregate, facilitating their isolation and removal.

The specific design and location of the barrier and counting weir will be determined in consultation with DFW, and may be constructed with permanent concrete abutments and necessary appurtenances. Potential design features may include inflatable rubber dams, flap-gate spillways, radial gates and types of adjustable weirs that will minimize impacts to resident fish movement, boating and other recreation.

Use of the predator barrier and counting weir will be part of annual predator suppression activities discussed in Section 1.6.2.B-2, below.

1.6.2.B-2 Predator control and suppression

The Districts shall conduct annual predator suppression activities identified in the Districts' AFLA including, but not limited to, removal and/or isolation methods such as electro-fishing, fyke netting, seining and other positive collection methods. DFW shall facilitate, license, permit, and participate in these annual predator suppression activities.

To insure that desired reduction in annual predation rates is achieved, the Districts and SF may seek changes to fishing regulations related to catchable size, bag limits, or length of season of any predator fish. Similarly, the Districts and SF may seek the approval necessary to allow for fishing derbies, a bounty program, and/or other activities that, in their view, are necessary to establish a robust, maximally effective predator suppression and control program, although DFW may not support such efforts.

1.6.2.C. Reduce Fall-run Chinook Redd Superimposition

Studies have demonstrated the occurrence of redd superimposition in the Tuolumne River's Dominant Salmon Spawning reach above approximately RM 47 (FISHBIO 2013). Over the long-term, reduction of adverse effects of superimposition will increase spawning success and egg-to-emergence survival. Studies have shown (AFLA W&AR-05) that rates of spawning superimposition are relatively high for fall-run Chinook in the lower Tuolumne River at higher escapement levels (e.g., >5,000 female spawners) due to a preference for spawning to occur above RM 47. The reasons for this preference are uncertain, but may be correlated with the high percentage of out-of-basin hatchery strays in the Tuolumne River escapement and their lack of site fidelity. Suitable spawning gravels in the lower Tuolumne River extend from RM 51.5 to approximately RM 30.

To reduce the superimposition that occurs when a newly arrived spawning female selects a spawning site on top of a previously used site, the Districts shall deploy a temporary barrier to encourage use of suitable habitats at locations further downstream. Deployment of the temporary barrier (e.g., picket barrier) will occur once the number of female spawners counted at the RM 25.5 counting facility reaches 4,000.

The precise location, timing and operational duration of the temporary weir will be determined in consultation with the TRPAC. Redd surveys will also be used to inform annual decisions regarding deployment.

1.6.2.D. Lower Tuolumne River Habitat Improvement Program

The Districts and SF will implement a long-term habitat improvement strategy by establishing the Lower Tuolumne River Habitat Improvement Program (LTRHIP), which will identify, design, construct and monitor floodplain and in-channel habitat improvements to benefit fall-run Chinook and *O. mykiss* juvenile rearing life stages. Individual projects will be located along the lower Tuolumne River and will be designed in coordination with the flow regimes identified in Section 1.6.1, above. Specific individual projects envisioned to be undertaken through the fund are likely to include floodplain restoration; floodplain lowering to foster floodplain access at lower flows; backwater slough connections to the mainstem; riparian vegetation enhancements using native species; in-channel habitat improvements through placement of LWD; and/or re-contouring of potential juvenile Chinook stranding areas.

The Districts and SF will establish a dedicated fund with a commitment to a total funding of $38,000,000 for capital costs and an additional annual increment not to exceed $1,000,000/yr for O&M, monitoring, and reporting associated with completed capital projects. Neither the capital contribution nor the annual funding shall be dependent upon money from third-parties. All capital and annual funding shall be provided by the Districts and SF.

Development of individual projects for funding consideration will occur through the creation of the TRPAC. TRPAC will consist of the USFWS, CDFW, CCSF, TID, and MID. Other resource agencies will be invited to actively participate. TRPAC will identify, conceptualize, and recommend site-specific projects for funding under the LTRHIP with a target cost per project to be less than $5 million. The project recommendation process would be based on the Spawning Habitat Integrated Rehabilitation Approach (SHIRA) process, or some other technically rigorous approach approved by the TRPAC members. A final project development process will be outlined in a Memorandum of Understanding describing the procedures and protocols of the TRPAC. As discussed in item 1.6.2.E below, the TRPAC will also be involved in recommending how predicted Spill events can be better managed to benefit native salmonids, while not jeopardizing dam safety. In all matters, the TRPAC will operate in an advisory capacity only, with final decision-making authority resting solely with the Districts and SF.

The total capital contribution to the LTRHIP will be $38 million, to be funded in increments of $9.5 million, the first of which will be contributed within six months. After the first contribution, subsequent contributions of $9.5 million shall be made within six months of the 6th, 9th, and 12th anniversaries.

1.6.2.E. Implement a Spill Management Plan

Flows released to the river in excess of required flows are referred to as "Spill". Modeling of the Tuolumne River VA flows, described in Section 1.6.2.A-2, above, predicts that total flows released to the lower Tuolumne River from the Don Pedro Reservoir in the February through June time frame will exceed the Tuolumne River VA required flows in 23 years of the 42-year period of record from 1971-2012 (i.e., 55% of the time). When projected to be available, reasonable efforts will be made to manage Spill in accordance with flow recommendations developed by the TRPAC. The implementation of any use of Spill to benefit fish is subject to, and at the complete discretion of, the Districts' operations staff, which is responsible for overall dam safety, flood control, and meeting operating rule curve constraints.

The primary goal of the Spill Management Plan (SMP) is to attempt to maximize the benefit of Spill events for fall-run Chinook salmon floodplain rearing through the control of Spill flow rates, timing, and duration as described below and further developed through the SMP. The initial governing metrics for the SMP are as follows:

Timing

The target months for management of available flow volumes in the SMP for additional floodplain rearing are March and April. The rationale for these target months is (a) by early March, reasonably reliable predictions of total runoff volume expected to occur, using the 90% exceedance probability, are available from Bulletin 120 prepared by the California Department of Water Resources (CDWR) and (b) studies of fall-run Chinook salmon on the Tuolumne River demonstrate that March and April are important months for in-river fall-run Chinook juvenile rearing (see AFLA W&AR-06) and Section 1.6.1.C above. There may be exceptions to these target months as recommended by the TRPAC; for example, in years when significant winter precipitation events might result in earlier Spill.

Duration of SMP Releases

The target minimum duration of a managed continuous Spill release to enhance floodplain rearing will be consistent with the duration of the floodplain pulse described in Section 1.6.1.C above. If there is Spill available, there may be opportunities to adaptively manage this duration based on recommendations of the TRPAC and subsequent relevant research.

Flow Targets

Section 1.6.1.C above describes the minimum flow for floodplain pulses. Flows in the range of 500 cfs to 1700 cfs have been shown to provide poorer fry and juvenile rearing habitat on the Tuolumne River than flows below and above this range (see Districts' AFLA, Exhibit E, Section 5.6), and thus if there is Spill available, this range should be avoided to the extent practicable except during recession flows. Flows will be adaptively shaped to the extent practicable to include recession rates recommended by the TRPAC.

Spring Outmigration Pulse Flow

If the forecasted Spill volume in March is less than 55,000 acre-feet, the managed Spill may be added to the spring outmigration pulse flow identified in the Section 1.6.1.D, above. Alternatively, based on a recommendation of the TRPAC, any Spill volume of less than 55 TAF may be used to improve in-channel rearing or temperature management consistent with flow targets mentioned above.

Fall Adult Migration Attraction Pulse Flow

In the event there is excess water available on September 1 of any year, as described below, the TRPAC may recommend release of such excess water as an adult fall-run Chinook salmon migration attraction flow, subject to the following:

- If on September 1 the Don Pedro Reservoir water surface elevation is above 801.9 feet,
- Any such water will be used before October 7.
- Use of the water will not, by itself, result in the Don Pedro Reservoir water surface elevation being less than 801.9 ft as of October 7.

Alternatively, if recommended by the TRPAC, Spill may be used for the purpose of temperature management.

Flow releases recommended by the TRPAC during the fall period for adult migration or temperature management may be coordinated with releases from other San Joaquin River tributaries to the extent possible to maximize potential benefits to salmonid populations throughout the San Joaquin River watershed.

Adaptive Management of Spills

Habitat conditions in the lower Tuolumne River are expected to change over time due to naturally occurring events, the implementation of the floodplain rearing pulse flow, or as a result of habitat improvement projects that will occur as part of the LTRHIP described above. Within six months of the 12th anniversary, the Districts will initiate the necessary studies to develop a report, including revised rearing habitat vs. flow relationship on the lower Tuolumne River, which shall reflect and document the changes that have occurred using the results of study AFLA W&AR-04 as baseline habitat conditions. This report will be provided as a draft to individual members of the TRPAC for a 60-day review prior to filing with FERC.

Changed habitat conditions, or any other data and information that has been developed through the LTRHIP and SMP, may be used to guide recommendations of the TRPAC.[11]

Reporting

The Districts will file with FERC by January 31 of the calendar year following the occurrence of a Spill a report describing the actual flows that occurred under the SMP, the final TRPAC recommendations for that year's Spill use, and any proposed changes to the SMP. A draft report for review and comment will be provided to the individual members of the TRPAC at least 60 days prior to the filing with FERC.

---

[11] It is expected that the TRPAC will develop protocols and recommend actions that will insure that the SMP does not conflict with, and is consistent with, the purposes of the floodplain rearing pulse flow.

1.6.2.F. Future Project Feasibility Studies

MID, TID and SF will, in good faith, engage in cooperative feasibility level studies for future projects and/or programs to provide additional instream flows in successive D and C WYs to improve the conditions of the fishery in the Tuolumne River. Initial feasibility level studies will be completed within 2 years from the date of execution of this VA by DFW. Initial feasibility level studies will be provided to DFW for review. Any determination to proceed will be subject to mutual agreements on allocation of benefits and costs. Examples include, but are not limited to:

A. Groundwater “Banking”

The Modesto and Turlock sub-basins are designated as high priority sub-basins by DWR and are subject to the provisions of the Sustainable Groundwater Management Act. TID is a member of the West Turlock Subbasin Groundwater Sustainability Agency (GSA) and MID is a member of the Stanislaus and Tuolumne Rivers GSA. The GSA’s have identified additional groundwater recharge as one of the mechanisms that will likely be included in their Groundwater Sustainability Plans.

In approximately 50% of WY types, the Tuolumne River yields water in excess of existing/future urban and agricultural demand. A portion of this spill water could be used to recharge the Modesto and/or Turlock ground water sub-basins in W and AN WYs in coordination with activities undertaken by the GSA. It is possible these efforts could be augmented to develop water for extraction, use and management by MID, TID and CCSF in coordination with DFW to augment Tuolumne River instream flows in C and D WYs.

The Districts and SF could make the predefined volume of water available at a location yet to be defined. A mutually agreeable financing structure will be developed that fairly and proportionally allocates responsibility for any and all costs associated with construction, environmental permitting, operation, maintenance, and design.

Example: In 2017, approximately 3.4 MAF of water was released at La Grange above the required instream flows. Consistent with SGMA and the physical limitations of the Modesto and/or Turlock groundwater sub-basins, a portion of this volume of water could have been diverted to spreading basins or directly injected into the groundwater aquifers within the Modesto and/or Turlock groundwater sub-basins and "banked" for later extraction and delivery to MID and/or TID’s irrigation conveyance system in exchange for releases to the Tuolumne river at La Grange in C and D WYs.

B. Spillway Modification

The New Don Pedro Dam has two spillways that are located approximately 1,500 feet west of the right abutment. The service spillway is a concrete ogee crest controlled by three radial gates, 45 feet wide by 30 feet high. The gated spillway crest is at elevation 800.0 and the top of gates is at elevation 830.0. The gates have a rated capacity of 172,500 cfs (approx. 57,500 cfs per gate) with all 3 gates fully open and the reservoir at elevation 850 feet. The 995-foot crest length ungated emergency spillway has a discharge capacity of 300,000 cfs at its current elevation of 830.0 feet. The peak outflow and stage at New Don Pedro Dam during the Probable Maximum Flood are currently estimated to be 525,600 cfs and elevation 852.0 feet, respectively.

A modest raise of the spillway gates and ogee crest of 4 to 8 feet would add additional storage available in wet years. A portion of this water could be provided in successive D and C WYs when no floodplain pulse occurs and outmigration pulse flows have been reduced as described in Section 1.6.1.D above. The amount of additional water that could be made available is unknown at this time.

C. Inter Basin Collaborations

There are a number of potential collaborations among and between the San Joaquin tributaries that could develop additional water supplies, some of which could be utilized to enhance fishery flows. There are also potential collaborative non flow measures (i.e. improved and augmented hatchery activities on the Merced River) that could benefit all of the tributaries.

1.6.3 Funding

Funding for Tuolumne River non-flow measures

The Districts and SF will provide all funding necessary to construct, operate and maintain all of the non-flow measures, including monitoring and reporting costs. Such funding shall not be dependent or contingent upon actions by third parties, such as future appropriations, grant approvals, or donations. Any third-party funding that is received will be added to, and not used as part of or to otherwise reduce, the funding commitment by Districts and SF.

1.6.4 Timing

Early Implementation

Within 45 days of affirmative commitment by the SWB to consider the Tuolumne VA as part of a future, comprehensive Bay-Delta Plan update consistent with ordering paragraph 7 of SWB Resolution No. 2018-0059, the Districts and SF shall (1) make all flows consistent with Section 1.6.1 for a period not to exceed 12 months, (2) begin the planning, permitting, environmental review and construction processes associated with the non-flow measures identified in Sections 1.6.2.A in an effort to begin construction within 12 months, (3) begin the planning, permitting, environmental review and construction processes associated with the restoration of Riffle 3A/B in conjunction with the Tuolumne River Conservancy, (4) begin the formation of and protocols for the TRPAC, and (5) work with the TRPAC to develop the protocols for, and if possible implement, the SMP.

Timing Following Adoption of Comprehensive Bay-Delta Plan Update

Upon adoption of a comprehensive Bay-Delta Plan update that includes water quality objectives and a plan of implementation consistent with the provisions of the Tuolumne River VA, the Districts and SF will immediately make all flows consistent with Section 1.6.1 and begin the planning, permitting, environmental review and construction processes associated with all non-flow measures identified in Section 1.6.2.

1.6.5 Expected Outcomes

The Tuolumne River VA is part of a comprehensive plan to improve water quality and habitat conditions for native fish in the lower Tuolumne River. The goals of the Tuolumne River VA are to maintain year-round flow releases below La Grange Diversion Dam, together with non-flow measures in the Tuolumne River watershed, sufficient to support all lifestages of native fish populations located in the lower Tuolumne River, and which reasonably contribute toward maintaining viable native migratory fish populations in the San Joaquin River watershed and Delta. Analyses performed by both the Districts and DFW show that these goals can be reached through performance of the Tuolumne River VA. Output from these analyses are presented below.

1.6.5.1. Improvement in Number of Successfully Out-migrating FRCS Smolts

During the FERC relicensing process, the Districts used empirically-derived scientific data to develop five (5) predictive models – the Tuolumne River operations model, the Don Pedro Reservoir Temperature model, the Lower River Temperature model, the Tuolumne River Fall-run Chinook Population model and the Tuolumne River *O. mykiss* population model. (See W& AR 02, 03, 06, 10 and 16). These models are integrated, such that the output of the operations model becomes the input to the reservoir temperature model, and the output of the reservoir model becomes the input to the lower river temperature model, and the output of the lower river temperature model becomes the input to the chinook and *O. mykiss* population models, respectively. These models provide projections of effects of changes in river conditions and project operations. The models are useful for comparing the expected effects of changes, but are not intended to be precise projections of future outcomes. [12]

The Tuolumne River Fall-run Chinook Population model described above was used to compare the expected outcomes of the Tuolumne River VA with those under the base case and expected under the SWB's SED. Through the combination of flow and non-flow measures, the Districts and SF expect to significantly improve the success of out-migrating FRCS smolts in the lower Tuolumne River. As shown in Figure 10, the Districts and SF expect the Tuolumne River VA to increase the number of FRCS smolts reaching the confluence with the San Joaquin River by 150% than under current conditions, and by more than 80% under the SWB's SED.

[12] The models were collaboratively developed, reviewed, shared with all relicensing participants, and training on the use of the models was provided. FERC relied on the models in its DEIS for the Don Pedro and La Grange hydroelectric projects. (see FERC's February 11, 2019 DEIS, Chapter 3).

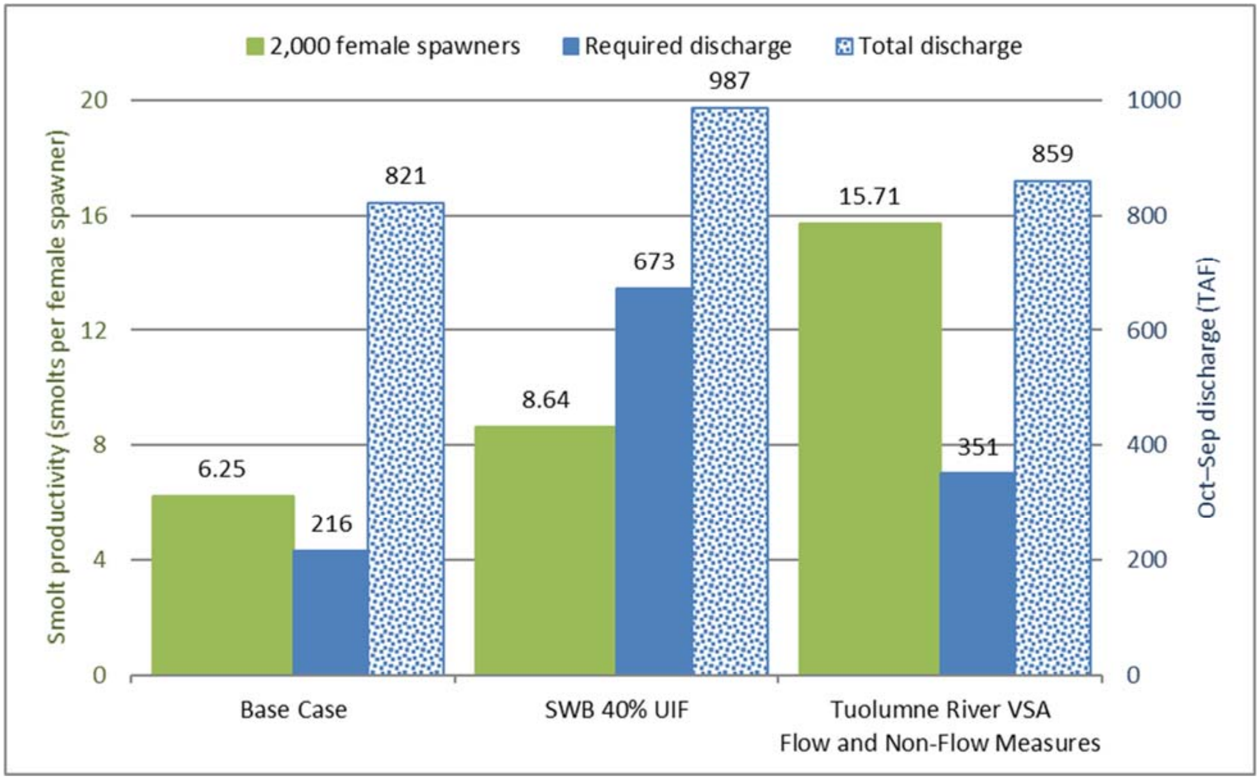


Figure 10. *Comparison of anticipated increase of FRCS smolts successfully reaching the confluence of the San Joaquin River. Required and total discharge measured at the La Grange gage.*

1.6.5.2. Improvement in Number of Young of Year O. mykiss

The Tuolumne River *O. mykiss* Population model described above was used to compare the expected outcomes of the Tuolumne River VA with those under the base case and expected under the SWB's SED. Through the combination of flow and non-flow measures, the Districts and SF expect to significantly improve the number of young-of-year *O. mykiss* in the lower Tuolumne River. As shown in Figure 11, the Districts and SF expect the Tuolumne River VA to increase the number of young-of-year *O. mykiss* by almost 60% than under current conditions, and by more than 95% than under the SWB's SED.[13]

[13] Modeling done by Districts and SF shows that the high June flows required by the SED are actually detrimental to *O. mykiss* fry rearing in the lower Tuolumne River.

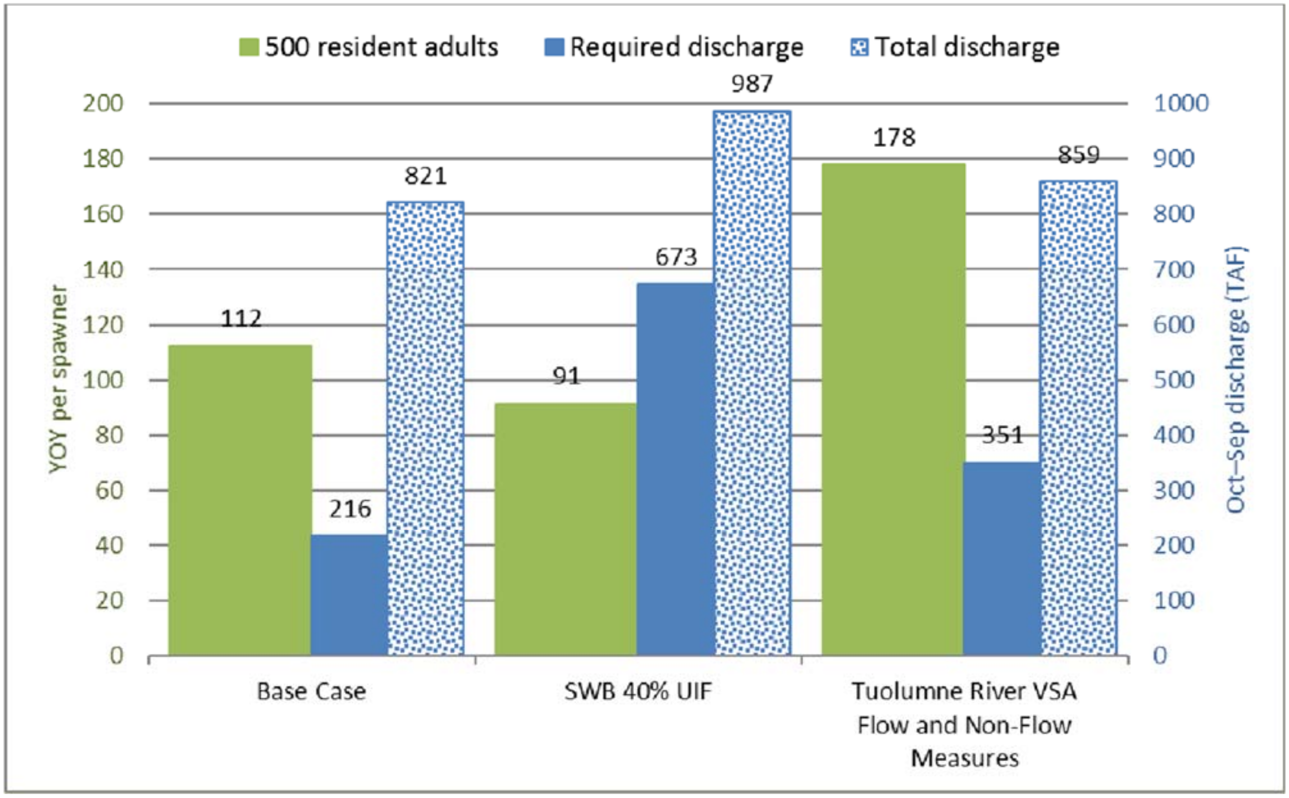
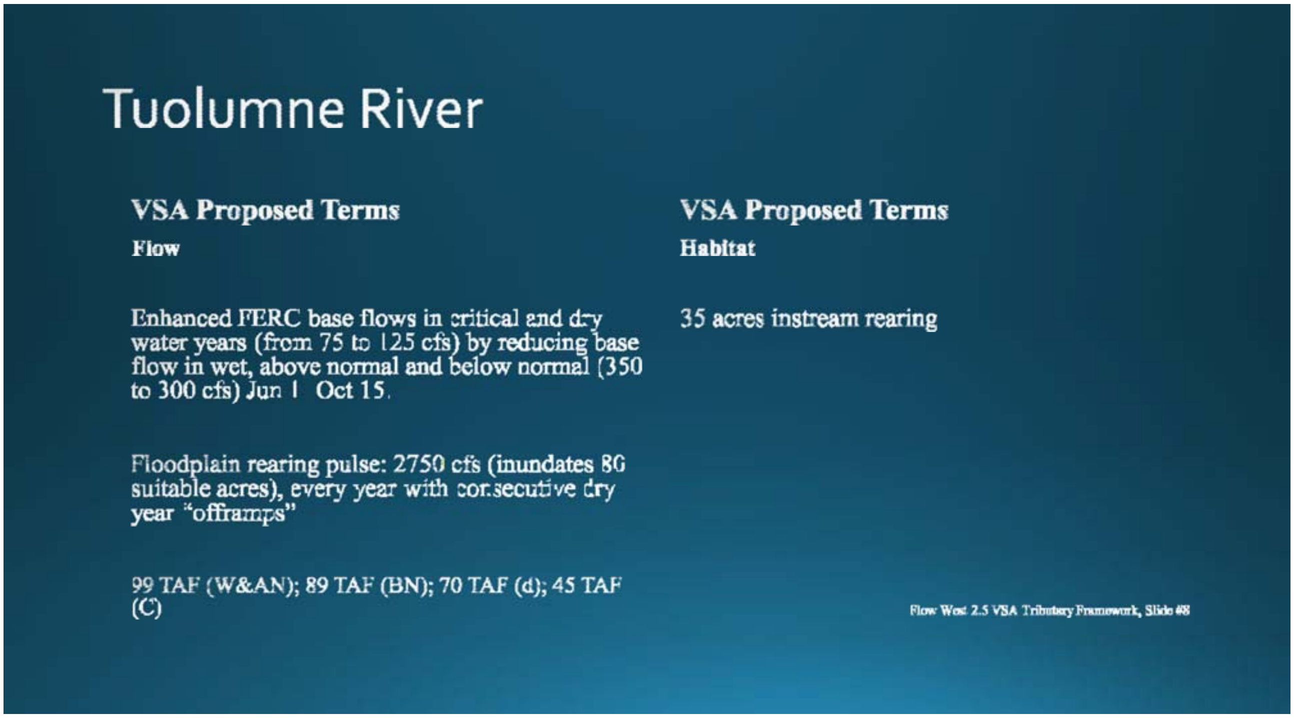


Figure 11. *Comparison of anticipated increase in YOY per spawner. Required and total discharge measured at the La Grange gage.*

1.6.5.3. Increase in Number of Suitable Acres of Rearing Habitat

Based upon the information developed and presented by Flow West on behalf of DFW and DWR, the Districts and SF expect the flows of the Tuolumne VA to generate at least 80 acres of suitable juvenile floodplain rearing habitat, and at least 35 acres of additional in-channel rearing habitat.



The expected quantity of suitable floodplain rearing habitat and in-channel rearing habitat under the Tuolumne VA exceeds that expected under the SWB's SED.

1.6.5.4. Improvement in Quantity and Quality of Rearing Habitat.

Via the specific floodplain rearing pulse flow identified in Section 1.6.1.C, the adaptively managed SMP identified in Section 1.6.2.E, and the collaboratively developed floodplain improvement and habitat complexity projects developed through the LTRHIP, the Districts and SF expect to significantly improve the quantity and quality of floodplain and in-channel habitat to benefit fall-run Chinook salmon and *O. mykiss* juvenile rearing life stages. There is no required improvement in quality or quantity of rearing habitat in the SWB's SED.

Appendix A7: San Joaquin River Settlement Downstream of the Merced River (Friant Division)

1.7 San Joaquin River Settlement Below Merced River (Friant Division)

1.7.1 Flow Measures

The Secretary of Interior, pursuant to section 1004(a)(4)(C) of the San Joaquin River Settlement Act (P.L. 111-11), proposes to manage San Joaquin River Restoration Flows (Restoration Flows) that are otherwise capable of being recaptured and recirculated for the benefit of Friant Division Contractors under the San Joaquin River Restoration Settlement (SJRRS) and San Joaquin River permits 11885, 11886, and 11887 and License 1986

In all years, except for those determined to be Critical-High or Critical-Low under the SJRRS, Reclamation proposes to reduce the recapture of Restoration Flows to the extent necessary to achieve a goal of total Delta outflows derived from any San Joaquin River flows released below Friant Dam of 50,000 acre-feet during the period of February and May (Delta Outflow Goal), subject to the following:

- Reclamation proposes to recapture, protect and manage Restoration Flows for the purpose of reducing or avoiding impacts to water deliveries to Friant Division long-term contractors caused by Restoration Flows except when, during the months of February through May, reducing recapture diversions as part of this agreement is necessary to satisfy the Delta Outflow Goal above.
- The maximum amount of reduced recapture in any month during the period of February through May would be up to 50% of the total recapturable Restoration Flows for such month.
- It is understood and allowed that in some years there would not be sufficient Restoration Flows to meet the Delta Outflow Goal. In such years, Reclamation would still reduce recapture of San Joaquin Restoration Flows by 50% of the existing flows, but the Delta Outflow Goal would not be satisfied, and Reclamation would not be required to take other actions or make other releases of water.
- Consistent with law, Reclamation would not reduce water supply to other CVP Contractors in order to achieve the Delta Outflow Goal.
- All flows released below the Friant Dam, including those flows released and/or bypassed by Friant Dam necessary to address flood conditions, would contribute towards satisfying the 50,000 acre-foot Delta Outflow Goal.

1.7.2 Non-Flow Measures

1.7.3 Funding

1.7.4 Timing

1.7.5 Expected Outcomes

Appendix A8: Sacramento-San Joaquin Delta

1.8 Sacramento-San Joaquin Delta

1.8.1 Flow Measures

Delta outflows will be augmented through the cumulative contributions of tributaries described above, plus a contribution from SWP and CVP of 300,000 acre-feet of water in Above Normal, Below Normal, and Dry water year types. Collectively, the majority of this water can be provided April through October of each year it is made available. Some water could be made available earlier in the year, and specific flows would be determined based on coordination through the governance program described below. Table 1 shows the cumulative water available for Delta outflow under this proposal.

Table 1. New Water Through VA [1]

WQCP Phase	Tributary	Season	Source	Application[2]	C	D	BN	AN	W
1	Tuolumne [3, 4]			Flow	45	70	89	99	99
1	Friant	February - March	Reduction in recapture under SJR Settlement Act	Flow		50	50	50	50
2	Sacramento	April and May[5]	Land fallowing	Block		100	100	100	
2	Feather	Spring or Summer [5]	Land fallowing	Block		50	50	50	
2	Yuba	Assume Spring likely [5]	Reservoir storage	Block		50	50	50	
2	American	Spring	Groundwater substitution	Hybrid	10	10			
2	American	Spring	Reservoir storage	Hybrid			10	10	
2	American	Spring	Reservoir storage and/or groundwatersubstitution	Hybrid		10			
2	American	Spring	Reservoir storage and/or groundwatersubstitution	Hybrid	20	20			
2	Mokelumne[4]	March - October	Reservoir storage	Flow				45	45
2	Mokelumne[4]	March - October	Reservoir storage	Flow			20		
2	Mokelumne[4]	March - October	Reservoir storage	Flow		10			
	Years 1-7	**New Water by Year Type (TAF)**			75	370	369	404	194
	Years 8+ of VSA implementation[6]	TBD	TBD	TBD		300	300	300	
	Total New Water by Year Type (TAF)				**75**	**670**	**669**	**704**	**194**

All Delta outflow will be used to test hypotheses developed through the science program included in this proposal. Tributary flow contributions to outflow will be made with consideration for in-stream flow needs, regulatory compliance (i.e., cold water pool), flood control, outflow scheduling for the entire water year, and its interaction with the total expected Delta outflow (other contributions made through this proposal and other hydrology). Outflow provided by the tributaries for contributions to outflow would be accounted for and would not be exported by the SWP or CVP. Outflow provided by the SWP and CVP will be at least 300,000 acre-feet above what is required by the existing water quality control plan. Delta outflow resulting from SWP and CVP export reductions may exceed 300,000 acre-feet if required to comply with Biological Opinions issued for operations of the SWP and CVP..

---

[1] Above existing conditions. See Section 1.3.5

[2] "Flow" represents an instream target, "Blocks" can be scheduled within constraints, and "Hybrid" represents a combination

[3] Subject to successive D/C year relief (BN year does not reset D/C year sequence, but would require floodplain pulse)

[4] Subject to further review of dynamic local modeling to validate totals

[5] Subject to coordination with DFW (Yuba) or fisheries agencies (Sacramento, Feather)

[6] Year Types TBD. This 300TAF of water would be made available consistent with the description in Addendum H to the December 12, 2018 Framework. Water made available through Proposition 1 storage projects will become available as projects become operational, without further demonstration of a science-based need under the VA.

Delta outflow in this proposal is meant to be variable to accomplish two purposes:

- The deliberate application of Delta outflow, combined with a monitoring and synthesis program (described below), to resolve long-standing uncertainties in the outflow needed to maintain viable fish populations and a stable Delta ecosystem.

- Include enough flexibility in the timing and amount of Delta outflow to allow for annual adjustments to test the hypotheses in consideration of outflows absent the flows provided through this proposal.

In addition to the 300,000 acre-feet and tributary contributions described above, an additional 300,000 acre-feet of water will be made available, subject to conditions below, through a combination of Prop 1 storage projects that generate environmental water; purchases of additional water through the Agreement Framework, other willing seller/buyer arrangements; future bond funding; and, if required, from SWP Contractors and South of Delta CVP Contractors. Environmental water provided through Prop 1 storage projects would be made available as these projects are constructed. If the science demonstrates a need, additional water to generate a total of 300,000 acre-feet will be made available in year eight of the term of this proposal or beyond. This water would also be used to test specific hypotheses for identified species or ecosystem needs, as agreed to through the new governance structure by a stakeholder group. The availability of this water provided by the SWP and CVP is contingent upon the restructuring of the Delta science and monitoring program.

1.8.2 Non-Flow Measures

Non-flow measures for the Delta will consist of restoration of over 5,455 acres of habitat, with additional habitat to be identified over time through scientific findings and analysis. This primarily includes tidal habitat restoration, floodplain restoration, enhancement of shaded riverine and riparian areas, channel bank margin habitat improvement, upland habitat restoration, reoperation of water infrastructure to improve water quality and hydrodynamics for fish species, increase in treatment of invasive aquatic weeds, food web productivity and augmentation projects, establishment of a research station in Rio Vista to facilitate improved and advanced aquatic research to support adaptive management, consolidation of water diversions and addition of fish screens at the consolidated diversion, and increased funding for game wardens to reduce illegal take of sensitive species.

1.8.3 Funding

Funding for Delta flow measures
Contributions made by the tributaries will be funded as described for each tributary above, including through the surcharge on CVP and SWP to generate the water purchase fund, and through contributions of public funding. The SWP and CVP will not be compensated for their contribution to outflow.

Funding for Delta non-flow measures
Non-flow measures in the Delta could be funded by a range of state funds, including but not limited to, the science fund generated from surcharges associated with the VAs, the Department of Water Resources, the Department of Fish and Wildlife, the Department of Boating and Waterways, Proposition 1, Proposition 84, Proposition 68, State or Federal water contractors, or other sources.

1.8.4 Timing

For flow measures, assuming it is a Dry, Below Normal, or Above Normal Water Year Type, 300 TAF would be contributed through export reductions immediately after the approval by the State Water Resources Control Board of this proposal. Additionally, tributary releases that result in Delta outflow and are part of this proposal, would not be exported though South-of-Delta facilities and would be allowed to continue to flow to the San Francisco Bay. This resulting Delta outflow would happen immediately upon release by the upstream tributaries.

For non-flow measures, many physical habitat restoration actions would happen within 1 to 5 years after adoption of this proposal by the Board. Actions that generate improvements in food web productivity would continue for the length of this proposal. Funding for game wardens, predation control and increased aquatic weed removal would occur immediately after adoption of this proposal by the Board. Other projects, such as Dos Rios and Chipps Island are anticipated to occur in years 2021 and beyond.

1.8.5 Expected Outcomes

Over 700 TAF of water will be committed to outflow as part of this proposal. The application of this water across seasons and water years would vary, and would be based on direction from the stakeholder group through the process described below. This flexibility will allow for real-time adjustments to hydrologic conditions (for example, to take advantage of pulse flows from storms), experimental flows to test ecological responses to landscape changes, and strategic use of flows to improve water quality. This also involves narrowly targeting flows to improve ecological conditions in specific areas, which increases the efficiency of the use of this water. Additionally, several projects are proposed to increase the land-water interaction in the Delta. Freshwater flows, tidal flows, and landscapes would be managed together to stimulate ecosystem processes and functions to improve habitat conditions for fish. This increased flexibility in the timing and magnitude of freshwater flows and linkages to landscape modifications will increase habitat benefits and take advantage of tidal energy. For example, flows in combination with structural habitat projects will be used to reverse declines in food resources for the Delta ecosystem, maximize high-quality habitat that favors native plants and animals, and manage nutrient pollution to reduce harmful algal blooms. Flow and non-flow habitat actions can also be influenced by existing and planned gates and barriers to further maximize the benefits of these resources. Clear hypotheses would be used to monitor, report and adjust both flow and non-flow actions to maximize the benefits of the water and funding made available to the Delta habitats. This approach has the best chance of improving our understanding of how to manage the Delta in the future.

Appendix A9: Putah Creek

1.9 Putah Crrek

Monticello Dam and Lake Berryessa, located on Putah Creek in Napa County, is the central component of the U.S. Bureau of Reclamation's (Reclamation) Solano Project and the primary source of agricultural and municipal water for Solano County. The Solano County Water Agency (SCWA) operates the Solano Project on behalf of Reclamation and in this role is responsible for streamflow releases to Lower Putah Creek, a 22-mile-long stream segment located between the Putah Diversion Dam, near the town of Winters, and the Yolo Bypass. During the 1990's the Putah Creek drainage was the subject of extensive litigation – the Putah Creek Water Cases – that cumulated in the Condition 12 Settlement Agreement among appropriative water right holders upstream of Lake Berryessa, and the Putah Creek Accord, which addressed instream flow requirements downstream of the Solano Project and ultimately transformed Lower Putah Creek into a perennial stream.

Prior to construction of the Solano Project in the late 1950's, much of Lower Putah Creek was typically dry in the summer and fall, and therefore, provided no surface runoff to the Yolo Bypass or the Sacramento River during those seasons. Since implementation of the Putah Creek Accord in 2000, Lower Putah Creek has been transformed into a perennial stream with significant ecological benefits to native resident fish populations, and more recently, anadromous salmonids, most notably fall run Chinook salmon.

In addition to the augmentation of streamflows, the Putah Creek Accord established a permanent funding commitment by SCWA for monitoring the condition of fish and wildlife, a permanent commitment by SCWA to fund a "Streamkeeper" position to oversee baseline monitoring and other programs associated with a variety of ongoing enhancement projects on Lower Putah Creek, and created a governance structure – Lower Putah Creek Coordinating Committee - to oversee the activities of the Streamkeeper. Through implementation of the Putah Creek Accord, Lower Putah Creek is now recognized as a model for the management of native fish populations in flow-regulated streams.

Although Lower Putah Creek has rarely - if ever - been identified by State or Federal resource agencies as a suitable candidate for restoration of anadromous fish populations in the Sacramento-San Joaquin drainage, implementation of the Putah Creek Accord has clearly demonstrated the potential for establishing a self-sustaining population of fall run Chinook salmon on Lower Putah Creek. Since 2015 and despite limited accessibility from the Yolo Bypass, large numbers of fall run Chinook salmon - annual numbers ranging from 200 to 1800 adults – have successfully spawned in Lower Putah Creek.

Nearly all if not all of the Chinook salmon observed to date are thought to be hatchery strays. Monitoring data obtained pursuant to the Putah Creek Accord indicate that adult salmon successfully spawn in Lower Putah Creek, but that the current availability of spawning habitat is limiting production. SCWA is funding genetic and fish tagging studies by U.C. Davis to assess whether or not the progeny of these spawning salmon ultimately return to Lower Putah Creek in sufficient numbers to establish a self-sustaining population. SCWA has also embarked on a "gravel bed scarification" project to enhance and expand available spawning habitats.

As a part of the Voluntary Settlement Agreement and in addition to the commitments made by SCWA pursuant to the 2000 Putah Creek Accord, SCWA will provide additional streamflows to facilitate salmonid fish passage, work with private and public landowners to provide an additional two miles of suitable salmonid spawning habitat, and expand and increase the duration of genetic and fish tagging studies to more fully address the question of self-sustaining fish populations. These efforts will be coordinated with and complement the ongoing "Lower Putah Creek Realignment Project" currently being implemented by the Department of Water Resources to restore ecological functions in the Yolo Bypass and to enhance fish passage from the Yolo Bypass to and from Lower Putah Creek, as well as Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project planned by the Department of Water Resources and U.S. Bureau of

Reclamation.

1.9.1 Flow Measures

In 2000, when the Putah Creek Accord was adopted, the prospect of a self-sustaining salmon population of any scale in Lower Putah Creek was considered questionable. Nevertheless, the following "supplemental" streamflow provisions were included in the Putah Creek Accord to potentially attract adult Chinook salmon and to provide limited spawning and rearing habitat:

1) "Pulse Flows" (for attraction) – 50 cfs for 5 days (between Nov. 15 and Dec 15)
2) "Ramp Down Flows" (following Pulse Flows) of 19 cfs through March 31
3) "Flushing Flows" (for downstream migrants) of 5 cfs from Apr. 1 through May 31

SCWA will augment the aforementioned streamflows as follows:

1) "Pulse Flows" – additional 2,500 acre-feet to be released between Nov. 1 and Dec. 15
2) "Ramp Down Flows" – additional 2,500 acre-feet to be released immediately following Pulse Flow releases and continuing through March 31.
3) "Flushing Flows" – additional 1,000 acre-feet to be released from Apr. 1 through May 31.

The timing and magnitude of the augmented streamflows will be determined in consultation with the Lower Putah Creek Coordinating Committee, the Department of Water Resources, and U.S. Bureau of Reclamation to optimize operation of the Lower Putah Creek Realignment Project and habitat management in the Yolo Bypass.

1.9.2 Non Flow Measures

SCWA will work with private and public landowners along Lower Putah Creek to expand available spawning habitats by an additional two miles through a combination of gravel scarification (loosening of cemented gravels) and construction of side channels within the existing Lower Putah Creek flood plain. In addition, SCWA will extend funding of the ongoing Chinook genetic/tagging study for five years (program set to expire at the conclusion of 2020).

1.9.3 Funding

The cost of all Flow Measures will be borne by SCWA. To the degree possible, SCWA will seek funding from private and public sources to finance Non-Flow Measures and in any event that private and/or public funding sources are insufficient, will self- fund any remaining amounts required to accomplish the Non-Flow Measures identified above.

1.9.4 Timing

SCWA is prepared to implement the Flow Measures and Non Flow Measures identified above immediately following adoption of the Voluntary Settlement Agreement.

1.9.5 Expected Outcomes

Together, the Flow Measures and Non Flow Measures identified above are expected to:

1) Enhance Chinook population by improving access to a quality/quantity of spawning habitats.

2) Complement and expand the benefits to be provided by the Lower Putah Creek Realignment Project (in addition to supplemental fish passage flows, provide an additional and reliable source of water for up to 430 acres of floodplain habitat and 90 acres of tidal freshwater habitat to be constructed as a part of the Lower Putah Creek Realignment Project)
3) Compliment benefits of Yolo Bypass Habitat Restoration and Fish Passage Project by providing additional spawning and rearing habitats accessible from the Yolo Bypass, and additional water to support habitat enhancement within the Yolo Bypass.
4) Determine whether a self-sustaining population of Chinook salmon has been established in Lower Putah Creek.

Appendix A10: Illustrative Scope and Magnitude of Non-flow Projects

1.10.1 Sacramento River Habitat Projects

Project	Identified In…	Description	Targeted Habitat	Benefits	Years	Timeline without VSA	Life Stage	Possible Funding Source(s)	Implementation Lead	Contingency	Planning/CEQA Status	Construction/Action Started?	Regulatory Requirement?
Spawning Habitat Keswick to Red Bluff Diversion Dam; Objective – Annually place 40,000 to 55,000 tons of gravel at the Keswick and/or Salt Creek injection site(s). Create at least three site-specific gravel restoration projects upstream of Bonnyview Bridge within 5 years.													
Salt Creek Gravel Injection	Upper Sac AFHRP	Improve substrate conditions for spawning salmonids at key riffles	up to 25,000 CY	Increase existing suitable spawning habitat area	Bi-Annually (1-10 years)	unknown	S	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Market Street	Upper Sac AFHRP	Improve substrate conditions for spawning salmonids at key riffles	up to 12,000 CY	Increase existing suitable spawning habitat area	Tri-Annually	unknown	S	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	N/A	Year by Year	No
Turtle Bay Island Side Channels and Gravel	Upper Sac AFHRP	Improve substrate conditions for spawning salmonids at key riffles and side channel	place and shape 25,000 CY	Increase existing suitable spawning habitat area	Tri-Annually	unknown	S,R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Keswick Dam Gravel Injection	Upper Sac AFHRP	Improve substrate conditions for spawning salmonids at key riffles	up to 25,000 CY	Increase existing suitable spawning habitat area	Annually (1-15 years)	Yes currently (but annual funds are not assured)	S	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	N/A	Year by Year	No
Rearing Habitat Keswick to Red Bluff Diversion Dam; Objective – Create a total of 40 to 60 acres of side channel habitat at no fewer than 10 sites in Shasta and Tehama County													
South Shea Levee	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Increase existing suitable spawning habitat area; improve of natural river morphology; increase floodplain habitat, riparian habitat, and instream cover	0-5 years	unknown	S,R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Shea Levee	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Increase existing suitable spawning habitat area; improve natural river morphology and connection to historic side channel habitat	0-5 years	unknown	S,R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Tobiasson Island - Side Channel/South Bank	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Increase existing suitable spawning habitat area; improve of natural river morphology; increase floodplain habitat, riparian habitat, and instream cover	0-5 years	unknown	S,R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Side Channel Habitat - Cypress Ave. Bridge Downstream	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	0-5 years	Potentially in 2019	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Shea Island Channel/Rearing	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	0-5 years	unknown	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Anderson River Park Channel/Rearing	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	0-5 years	Potentially in 2020 but need permits	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Kutras Lake Project	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	6-10 years	Potentially 2020	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Tobiasson Island Channel/Rearing	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	6-10 years	unknown	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Kapusta Island and River Right Bank Channel/Rearing	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	6-10 years	unknown	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Reading Island Channel/Rearing	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	6-10 years	Potentially in 2020 but need permits	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Rancho Briesgau Channel/Rearing	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	11-15 years	unknown	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
China Gardens Side Channel	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Increase existing suitable spawning habitat area; improve of natural river morphology; increase floodplain habitat, riparian habitat, and instream cover	11-15 years	unknown	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Rio Vista	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	11-15 years	unknown	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
East Sand Slough	Upper Sac AFHRP	Creation and improvement of side channel habitat	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	11-15 years	unknown	R	Upper Sac AFHRP, Bond, Science Fund	Potentially USBR, SRSC	No	No	No	No
Rearing Habitat Red Bluff Diversion Dam to Verona; Objective – Enhance ~ 2,000 acres of floodplain habitat in the Sutter Bypass within the term of the Voluntary Agreement. Provide fish passage and floodplain habitat at Tisdale Weir within 5 years and Colusa Weir within 10 - 15 years. Inventory historic oxbows and design fish passage and floodplain projects within 5 years and implement projects within 10 years.													
Off-Channel Rearing Habitat Restoration Projects - Side Channel/Oxbow/Floodplain on Lower Battle Creek (below Coleman Hatchery) on Lands Owned by BLM and CDFW	SRS	Study and Determine potential ox bow restoration sites	TBD	Improve natural river morphology, riparian habitat, instream cover, and habita complexity	6-10 years	No	R	Bond, DWR	SRSC, CDFW, BLM, USBR	No	No	No	No
Tisdale Weir and Bypass Multibenefit Project	SRS/SVSRP	Operable Weir	None, weir modification only but required to inundate Sutter bypass	Operable weir to allow for adult passage for upstream migration, and out-migrating juveniles to access Sutter Bypass	0-5 years	No	AM, R, M	Bond, DWR	SRS/SVSRP	No	No	No	No
Tisdale Bypass into Sutter Bypass		Improve the bypass property into suitable habitat	500 acres	Property already owned by CDFW and accessible, create habitat for outmigrating salmon	0-7 years	unknown	R, A	Bond, DWR, CDFW	SRSC/DWR/CDFW	No	No	No	No
Lower Colusa Basin Drain Floodplain		Flood lower basin lands through Knights Landing Outfall Gates (KLOG)	300 acres	Operations of KLOG to allow passage of outmigrating salmon onto floodplain	0-5 years	No	R	Bond, DWR	SRSC/SVSRP/DWR	No	No	No	No
Sutter Bypass Area Multibenefit Project	SRS	Increase Suitable Habitat	2000 acres	Increase suitable habitat for out-migrating juveniles to access Sutter Bypass	6-15 years	No	R, M	SRS	SRSC, CDFW, BLM, USBR	No	No	No	No
Setback Levee		Construct setback levee on existing Sac levees with willing landowners	200 acres	Additional rearing habitat connected with Sac River	10-15 years	No	R	Bond, CDFW, DWR	SRSC, DWR, Corp	No	No	No	No
Colusa Weir Multibenefit Improvements		Operable Weir	None, weir modification only but required to inundate Sutter bypass	Operable weir to allow for adult passage for upstream migration, and out-migrating juveniles to access Sutter Bypass	6-10 years	No	AM, R, M	Bond, DWR	SRS/SVSRP	No	No	No	No
Sutter Bypass Weir 1 - Rehabilitation of Weir Structure and Fish Ladder. Coupled with New Lower Butte/Sutter Bypass Water Management Plan	SRS	Operable Weir	None, weir modification to benefit migrating juveniles and adults	Operable weir to allow for adult passage for upstream migration, and out-migrating juveniles to access Sutter Bypass	0-5 years	No	AM	Bond, DWR	SRS/SVSRP	No	No	No	No

Sutter Bypass Weir 2 Multibenefit Project	SRS/SVSRP	Operable Weir	None, weir modification to benefit migrating juveniles and adults	Operable weir to allow for adult passage for upstream migration, and out-migrating juveniles to access Sutter Bypass	0-5 years	No	AM	Bond, DWR	SRS/SVSRP	No	No	No	No
Man Made Structures Keswick-Verona; Objective – Complete remaining high-priority fish screen projects. Reduce lighting to 3 lux or less at fish screens and bridges within 5 years. Incorporate ongoing redd dewatering coordination with Anderson Cottonwood Irrigation District into a Voluntary Agreement. Address fish passage issues at Weir 1 and Weir 2 within 5 years													
Reduced Lighting and Sacramento River Bridges	Upper Sac AFHRP	Perform study on bridges and lighting conditions and work with agencies to reduce lighting	TBD	Increase survival of migrating fish by reducing predation risks	0-5 years	No	M	Upper Sac AFHRP	SRS/SVSRP	No	No	No	No
Screen Meridian Farms Water Company	SRS/SVSRP	Install fish screen	N/A	Fish screen, benefits based on the Sac Valley fish screen program	0-5 years	No	M	AFRP	USBR, SRSC	No	No	No	No
Screen Natomas Mutual Water Company	SRS/SVSRP	Install fish screen	N/A	Fish screen, benefits based on the Sac Valley fish screen program	0-5 years	No	M	AFRP	USBR, SRSC	No	No	No	No
Anderson Cottonwood Irrigation District Dam Operations to Project Salmon Redds	SVSRP	Weir and bypass operations	TBD	Increase existing suitable spawning habitat area	0-5 years	No	I	AFRP	USBR, SRSC	No	No	No	No
Study, Design, and Implement Modifications to Known Redd Dewatering Locations	New	Perform study on redd locations and water elevations based on river stages	TBD	Increase existing suitable spawning habitat area	0-10 years (annual)	No	I	AFRP	USBR, SRSC, CDFW	No	No	No	No
Program for Identification of Predation Hot Spots. Adaptively Manage for the Reduction/Improvement of Predator Contract Points at Man-Made Structures Where Predator Interactions Have Been Observed	New	Perform Study	TBD	Study, currently occurring	0-2 years	Yes	M	AFRP, CDFW, SRSC, NCWA	CDFW	No	No	Yes	No
Study Route-Specific Survival at Key Diversion Facilitie and Implement Appropriate Devices that Reduce Route Selection Into Lower Survival Areas	New	Perform Study	TBD	Study	0-10 years; Annual plan within one year	No	M	AFRP	USBR, SRSC	No	No	No	No

1.10.2 Feather River Habitat Projects

Project	Identified In…	Description	Targeted Habitat	Benefits	Years	Timeline without VSA	Life Stage	Possible Funding Source(s)	Implmentation Lead	Contingency	Planning/CEQA Status	Construction/Action Started?	Regulatory Requirement?
Gravel augmentation	New	Improve substrate conditions for spawning salmonids at key riffles	25,000 cu. yd.	Increase existing suitable spawning habitat area	0-5 years	Unknown	S	DWR, Prop 1, CVPIA	DWR	None	None	No	No
Remove Sunset Pumps and associated rock dam	SRS	Remove barrier/entrainment risk for upstream salmonid and sturgeon passage	Over 25 miles upstream	Improve fish passage for salmon, steelhead, and sturgeon and allow for access to more habitat	0 – 5 years	Unknown	AM, M	Prop 1	SBFCA	None	None	No	No
Oroville Wildlife Flood Stage Reduction Project	CVFPP	Weir improvements and ecosystem restoration and Oroville Wildlife Area to allow floodplain access	100 – 600 acres	Improve natural river morphology; increase floodplain habitat, riparian habitat, and instream cover	1 – 3 years	1-3 years	R	DWR, Prop 1	SBFCA	None	Final CEQA April 2013	Construction started 8/1/2018	No
Nelson Slough Floodplain Restoration	FRRFMP	Provide optimal habitat for floodplain rearing and reduce stranding during high flow events	20 acres	Improve natural river morphology; increase floodplain habitat, riparian habitat, and instream cover	3 – 15 years	Unknown	R	DWR, Prop 1	DWR	None	None	No	No
Abbott Lake Re-Connection/Restoration	FRRFMP	Provide optimal habitat for floodplain rearing and reduce stranding during high flow events	440 acres	Improve natural river morphology; increase floodplain habitat, riparian habitat, and instream cover	3 – 15 years	Unknown	R	DWR, Prop 1	DWR	None	None	No	No
Star bend Setback Levee	CVFPP	Provide optimal habitat for floodplain rearing and reduce stranding during high flow events	50 acres	Improve natural river morphology; increase floodplain habitat, riparian habitat, and instream cover	3 – 15 years	Unknown	R	DWR, Prop 1	DWR	None	None	No	No
Feather River Setback Levee below Yuba River on River Left Floodplain	FRRFMP	Provide optimal habitat for floodplain rearing and reduce stranding during high flow events	1,100 acres	Improve natural river morphology; increase floodplain habitat, riparian habitat, and instream cover	3 – 15 years	Unknown	R	DWR, Prop 1	DWR	None	None	No	No
Identification of Predation Hot Spots and Adaptive Management for Predator Reduction	New	Improve rearing and migration conditions by reducing predation	Entire reach of river	Improve salmon and steelhead survival	0 – 15 years	Unknown	R, M	TBD	DWR/DFW	None	None	No	No

Project		Description	Targeted Habitat	Benefits	Years after FERC License	Timeline without VSA after FERC License	Life Stage	Possible Funding Source(s)	Implmentation Lead	Contingency	Planning/CEQA Status	Construction/Action Started?	Regulatory Requirement?
Habitat Improvement Plan (A101)	FERC SA	Develop and adaptive management plan to respond to restoration project feedback	n/a	Identifies actions under the AMP	2 years	3 years	All	DWR	DWR	FERC license	CEQA completed, 401 issued, NMFS BiOp obtained	No	Yes
Gravel Supplementation Improvement Program (A102)	FERC SA	File a gravel supplementation and improvement plan to respond to restoration project feedback	94,000m² (23.2 acres)	Increase existing suitable spawning habitat area	2 projects within 2 years; 5 within 5; 10 within 10	1 project within 5 years	S	DWR	DWR	FERC license	CEQA completed, 401 issued, NMFS BiOp obtained	No	Yes
Channel Improvement Program (A103)	FERC SA	Creation and improvement of side channel habitat	1.0 acre of improved habitat; 5 acres of new	Improve natural river morphology and riparian habitat	Develop plan within 2 years; 3 channels in 5; all channels within 7	Plan in 4 years; All channels within 10 years	S, R	DWR	DWR	FERC license	CEQA completed, 401 issued, NMFS BiOp obtained	No	Yes
Structural Habitat Program (A104)	FERC SA	Installation of large woody debris, boulders, etc. and filing a plan for implementation	100 pieces LWD and 25 boulders	Improve instream cover and habitat complexity	Submit plan within 1 year; implement within 2 years	Submit plan in 2 years, implement within 5 years	R	DWR	DWR	FERC license	CEQA completed, 401 issued, NMFS BiOp obtained	No	Yes
Fish Weir Program (A105)	FERC SA	Filing plans for weir installation, installation of monitoring and segregation weirs	67 acres (spring-run habitat after seg weir install)	Provide adult salmon with protected habitat	Install count weir within 1 year and segregation weir within 3	Plan filed in 8 years and weir installed after	AM, S	DWR	DWR	FERC license	CEQA completed, 401 issued, NMFS BiOp obtained	No	Yes
Riparian Floodplain Program (A106)	FERC SA	Filing of recommendations for riparian projects, physical completion of projects	1100 acres	Improve natural river morphology; increase floodplain habitat, riparian habitat, and instream cover	Screening level within 3 years; 1 project within 10; 2 projects within 15	Full implementation in 25 years	R	DWR	DWR	FERC license	CEQA completed, 401 issued, NMFS BiOp obtained	No	Yes
Hatchery Improvement Implementation (A107)	FERC SA	Implementation of temperature targets, filing a hatchery genetics management plan (HGMP), data collection – minimize straying	no increase in habitat, HGMP will significantly improve genetic fitness of SR over time	Provide biologically-based propagation management strategies that ensure the conservation and recovery of salmon and steelhead populations	Target hatchery temperatures and data collection immediately; HGMP within 1 year	HGMP within 2 years	AM, S	DWR	DWR	FERC license	CEQA completed, 401 issued, NMFS BiOp obtained	No	Yes

1.10.3 Yuba River Habitat Projects

Project[1]	Identified In…	Description	Targeted Habitat (acres)	Benefits	Years	Timeline without VSA	Life Stage	Possible Funding Source(s)	Implmentation Lead	Contingency	Planning/CEQA Status	Construction/Action Started?	Regulatory Requirement?
Barton's Bar	New	Create a new side channel by terraforming, and add riparian plantings stabilized with bioengineering features (e.g., boulders, engineered log jams [ELJs] and large woody material [LWM]) to improve channel complexity and habitat diversity.	2	Increase juvenile rearing habitat availability, increase channel complexity and habitat diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increaing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Big Ravine	New	Create a permanent off-channel backwater area by terraforming/lowering. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.	4	Increase juvenile rearing habitat availability, increase habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increaing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Upper Gilt Edge Bar	New	Use terraforming/lowering to increase side channel inundation frequency and duration, enhance stability of existing side channel inlet to protect against high flows, and add riparian plantings stabilized with bioengineering features.	5	Increase juvenile rearing habitat availability, improve habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increaing riparian habitat	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Long Bar Pond	New	Use terraforming/lowering to re-connect areas of suitable off-channel rearing habitat (pond) with the lower Yuba River, and lower areas of high terrace to create additional shallow, slow velocity off-channel rearing habitat. Add riparian plantings stabilized with bioengineerng features to improve channel complexity and diversity.	11	Increase juvenile rearing habitat availability, increase habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increaing riparian habitat	10-15 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Bar B Pond	New	Use terraforming/lowering to improve the inlet connection between suitable off-channel rearing habitat and the lower Yuba River, and lower areas to create additional shallow, slow-velocity rearing habitat. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.	4	Increase juvenile rearing habitat availability, improve habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increaing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
BVID Diversion	New	Add riparian plantings stabilized with bioengineering features to improve habitat productivity, complexity and diversity.	8	Increase juvenile rearing habitat availability, enhance productivity by increaing riparian habitat, and provide instream object cover and overhanging escape cover.	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Pond Upstream of Daguerre Point Dam	New	Use terraforming to stabilize the inlet connections between off-channel slackwater areas and the lower Yuba River to create more permanent shallow, slow-velocity rearing habitat. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.	3	Increase juvenile rearing habitat availability, improve habitat complexity and diversity, provide instream object cover and overhanging escape cover; enhance productivity by increaing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
YWA Diversion	New	Add riparian plantings stabilized with bioengineering features to improve habitat productivity, complexity and diversity.	1	Increase juvenile rearing habitat availability, enhance productivity by increaing riparian habitat, and provide instream object cover and overhanging escape cover.	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Walnut Pond	New	Use terraforming/lowering to create a permanent off-channel backwater habitat with suitable water depths and flow velocities for juvenile Chinook salmon and steelhead rearing. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.	5	Increase juvenile rearing habitat availability, improve habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increaing riparian habitat	6-10 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Recology Pond	New	Use terraforming/lowering to create: (1) a permanent off-channel backwater habitat with suitable water depths and flow velocities for juvenile Chinook salmon and steelhead rearing; and (2) a side channel from the lower Yuba River to the newly constructed floodplain area. Add riparian plantings stabilized with bioengineering features to improve habitat complexity and diversity.	31	Increase juvenile rearing habitat availability, increase habitat complexity and diversity, provide instream object cover and overhanging escape cover; enhance productivity by increaing riparian habitat	10-15 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
Island Stabilization Upstream of Daguerre Point Dam	New	Use terraforming to create anabranching channels to provide shallow, slow-water juvenile rearing habitat. Add riparian plantings stabilized with bioengeering features to improve channel complexity and diversity.	2	Increase juvenile rearing habitat availability, increase habitat complexity and diversity, provide hydraulic roughness elements, instream object cover and overhanging escape cover; enhance productivity by increaing riparian habitat	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No
First Island	New	Preserve two high value areas that provide very good spawning and rearing habitat by stabilizing the existing channel configuration to protect against high flow channel modifications.	14	Protection of spawning and rearing habitat from high flow modifications	0-5 years	Unknown	R, S	YWA, bond, science fund[2]	YCWA	None	None	No	No
Pilot Studies (e.g., Waterway 13, flooded farm fields to increase fish growth)	New	Study potential design options to permanently eliminate an existing stranding/isolation hazard at Waterway 13; test use of flooded farm fields to produce larger anadromous salmonids	10	Protection of fish species from stranding, improvement of juvenile rearing habitat and food production	0-5 years	Unknown	R	YWA, bond, science fund[2]	YCWA	None	None	No	No

Notes

[1] These are preliminary projects that are going through additional screening for river geomorphology, land ownership, constructability including access and greatest benefit cost. Replacement projects will be identified if the listed projects are reduced in size or eliminated.

[2] Some of these projects may be constructed by USACE funding if the Yuba River Ecosystem Study is authorized by Congress, funds appropriated by Congress and the authorized study contains these projects. If the USACE projects go forward it would not likely be until after year 5 and the USACE would construct the project with a 35% local cost share.

1.10.4 American River Habitat Projects

Habitat Projects Presented as Part of Voluntary Agreement Framework

(All projects listed may have been identified in multiple lists/documents, this spreadsheet is intended only for illustrative purposes)

Tributary/Location	Project	Identified In...	Timeline with VA*	Funded without VA?	Life Stage Supported	Benefit	Possible Funding Source(s)	Implmentation Lead	Contingency	Planning/CEQA Status	Construction/Action Started?	Regulatory Requirement?
American	Paradise Beach	Spawning projects: CVPIA, Rearing projects: New	6-8 years	No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Howe Ave.	Spawning projects: CVPIA, Rearing projects: New		No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Howe to Watt	Spawning projects: CVPIA, Rearing projects: New	6-8 years	No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	William Pond Outlet	Spawning projects: CVPIA, Rearing projects: New		No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	River Bend	Spawning projects: CVPIA, Rearing projects: New		No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Upper River Bend	Spawning projects: CVPIA, Rearing projects: New	1-3 years	No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Ancil Hoffman	Spawning projects: CVPIA, Rearing projects: New	4-6 years	No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Sacramento Bar - North	Spawning projects: CVPIA, Rearing projects: New	4-6 years	No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	El Manto	Spawning projects: CVPIA, Rearing projects: New	4-6 years	No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Sacramento Bar - South	Spawning projects: CVPIA, Rearing projects: New	4-6 years	No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Sunrise	Spawning projects: CVPIA, Rearing projects: New	1-3 years	No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Upper Sunrise	Spawning projects: CVPIA, Rearing projects: New	1-3 years	No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Lower Sailor Bar	Spawning projects: CVPIA, Rearing projects: New		No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Upper Sailor Bar	Spawning projects: CVPIA, Rearing projects: New		No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No
	Nimbus Spawning	Spawning projects: CVPIA, Rearing projects: New		No	S and/or R	Increase existing suitable spawning habitat area; improve natural river morphology; increase floodplain habitat, riparian habitat and instream cover and habitat complexity	CVPIA, Prop. 1, Prop. 68, Science and Habitat Fund, local cost share	Sacramento Area Water Forum	None	Reconnaissance level assessment complete	No	No

1.10.5 Mokelumne River Habitat Projects

Project	Identified In…	Description	Targeted Habitat	Benefits	Years	Timeline without VSA	Life Stage	Possible Funding Source(s)	Implementation Lead	Contingency	Planning/CEQA Status	Construction/Action started?	Regulatory Requirement?
Creation of Floodplain Habitat	AFRP Final Restoration Plan	Design and build floodplain habitat to maximize rearing capacity in a 2 o 3 year recurrence cycle	50 acres	improve instream growth and improve survival to tidal influence	Years 1-15	Unknown	R	Federal, State, Stakeholders	EBMUD	EBMUD	None	No	No
Identification of Predation Hot Spots & Predator Management	CVPIA SIT Priority	Identify Predator/Prey hotspots and develop active management strategies to address impacts	migratory corridor	improve survival of juveniles past predator hot spots	Years 1-15	Unknown	R,M	Federal, State, Stakeholders	EBMUD	EBMUD	None	No	No
Screen High Priority Diversions	AFRP Final Restoration Plan	Prioritize riparian pumps for screening based on timing of operation and size of fish passing. Screen highest priority pumps	5-10 priority screens based on landowner participation	increase survival past diversions and reduce predator induced losses and entrainment losses	1 project annually	Unknown	R, M	Federal, State, Stakeholders	EBMUD	EBMUD	None	No	No
Marking and Tagging Hatchery Production	HSRG	100% mark, 25% tag hatchery production and related necessary infrastructure to support action identified in the Ca HSRG recommendations	no increase in habitat, target is improving Hatchery/Natural proportion	improve ability to manage natural and hatchery populations to maximize natural production	Ongoing over span of agreement	Unknown	all life stages	CDFW, Stakeholders	CDFW	None	None	No	No
Hatchery and Genetics Management Plan	HSRG	Complete Fall Run HGMP and Steelhead HGMP for Mokelumne River	no increase in habitat, target is improving Hatchery/Natural proportion	provide the regulatory context and approvals to better manage natural populations and hatchery populations to meet both goals	5 years	Unknown	all life stages	CDFW, Stakeholders	CDFW	None	None	No	Yes
Hatchery Improvement Program	HSRG	Capital infrastructure to support increased steelhead population size, and rearing space for fall run chinook to support new actions	no increase in habitat, target is improving Hatchery/Natural proportion	improve ability to manage natural and hatchery populations to maximize natural production	5 years	Unknown	all life stages	CDFW, Stakeholders	EBMUD	EBMUD	None	No	No
Optimized Release Strategy	new	Alternative means to release a portion of hatchery and naturally produced juveniles through the Delta to improve survival. Natural fish in dry/critically dry years only	no increase in habitat, target is improving juvenile survival and reduce adult stray rates	Improve through Delta survival and reduce straying to better manage hatchery and natural populations	Years 1-15	Unknown	M	CDFW, Stakeholders	EBMUD	EBMUD	None	No	No
Gravel Enhancement Maintenance	AFRP charter	Provide maintenance gravel annually to existing restored 1 mile reach on the Lower Mokelumne River	1 river mile	maintain ecosystem function in the spawning reach	Years 1-15	Unknown	S,I	Federal, State, Stakeholders	EBMUD	EBMUD	Yes	Yes	No
Gravel Augmentation Program	AFRP charter	Identify and Implement new spawning habitat restoration Projects	4 projects TBD, total acreage unknown	Improve spawning opportunities by increasing total suitable spawning area. Reduce superimposition, increase incubation survival	Years 1-15	Unknown	S,I	Federal, State, Stakeholders	EBMUD	EBMUD	None	No	No
Fish community Assessment	JSA- WQRMP	Monitor relationships between fish assemblages and physical and biological parameters to facilitate adaptive management of flow and non-flow actions.	no increase in habitat, target is ecosystem function evaluation	manage the river as an ecosystem. Compile data on native, non-native and predator locations to inform instream management decisions	Years 1-15	Unknown	ecosystem function	EBMUD	EBMUD	EBMUD	None	No	No
Steelhead Population Assessment	JSA- WQRMP	research and management actions that increase anadromy, minimize risk of inbreeding depression, increase freshwater and through-Delta survival, improve adult returns to the hatchery and improve monitoring in freshwater, and the estuary	no increase in habitat, target is steelhead population management	Better manage Federally Threatened CV steelhead in the Mokelumne River. Compile data to inform instream management, hatchery management of the natural and hatchery populations	Years 1-15	Unknown	all life stages	CDFW, Stakeholders	EBMUD	EBMUD	None	No	No

1.10.6 Sacramento-San Joaquin Delta Habitat Projects

Project	Identified In…	Description	Targeted Habitat	Benefits	Years	Timeline without VSA	Life Stage	Possible Funding Source(s)	Implmentation Lead	Contingency	Planning/CEQA Status	Construction/Action Started?	Regulatory Requirement?
North Delta Arc Ecorestore Acres	EcoRestore	Restore 4,500+ acres of tidal wetland, floodplain, shaded riverine/riparian, channel bank, and upland habitats. Implement modifications and/or reoperations o existing water infrastructure to improve water quality and hydrodynamics for native fish species. These acres/projects are above and beyond existing Ecorestor acres/projects.	Locations: Deep Water Ship Channel, Yolo Bypass, Cache Slough Complex, Miner/Georgia/Sutter Sloughs, West Delta, Lower Sacramento River, Suisun Marsh and Bay.	Increase and improve suitable Delta Smelt, Longfin Smelt, sturgeon, and salmonid spawning and rearing habitat, and help improve/increase food availability. Similar benefits to other native aquatic and terrestria species.	1-5 years for some projects, up-to 15 yrs for others.	5+ yrs for some potential projects. Closely linked to available resources/funding, which may be limited or wholly unavailable without VSA	Multiple aquatic species atmultiple life stages	DWR, CDFW, SWP, Reclamation, federal water contractors, Prop 1, Prop 84, Prop 68	Largely DWR and CDFW	None	Concepts identified, no overarching CEQA coverage.	No	No
Complete Tidal and Channel Margin Restoration on Sacramento River, Steamboat Slough, and Sutter Slough	CWF	Restored habitat would be located and designed to benefit listed aquatic species, including winter- and spring-run Chinook Salmon, steelhead, green sturgeonas well as Delta and Longfin Smelt	Approximately 155 acres of tidal marsh, and 4.3 miles of channel margin habitat on Sacramento River, Steamboat Slough, and Sutter Slough. This would be done in coordination with 1,830 acres of tidal restoration for Delta and Longfin Smelt.	Increase and improve suitable salmon rearing and holding habitat	1-5 years	1-7 years	Multiple aquatic species atmultiple life stages	DWR, USBR, State and Federal WaterContractors	DWR, DCA	None	Identified at a programatic level inCWF EIR/S	No - Planning phase	Yes
Chipps Island Tidal Restoration	DFW	Tidal habitat restoration for the 2008 USFWS BiOp and 2009 CDFW ITP	800 acres	Food web support and suitable rearing habitat for Delta smelt, longfin smelt, and salmon	Beginning 2021	Beginning 2021	Multiple aquatic species atmultiple life stages	SWP	DWR	Pending real estate acquisition process	Early stages of project design and modeling. Have not started CEQA	No	Yes
Increased Aquatic Weed Removal	DSRS	Increased treatment of aquatic weeds to improve Delta Smelt habitat quality	500 acres	Increase and improve suitable Delta smelt and salmon rearing habitat, including predation reduction/through-Delta survival	Ongoing over span of agreement	2017-2019	Multiple aquatic species atmultiple life stages	DWR, DBW, CDFW	DWR	None	Herbicide treatments for this action are covered by DBW's existing permits	Yes	No
Predator Hot Spot Removal	New	Identify and eliminate/modify known predator hot spots (areas where predatory fis are know to congregate and where they are known to have higher per capita consumption of juvenile salmonids). Remove select predatory fish from known locations within the Delta to improve survival of out-migrating juvenile salmonids.	Salvage release sites, (migratory corridors), locations of dense and invasive SAV/FAV, head of old river, Clifton Court Forebay (radial gates), sunken vessels, etc. Other select locations in Sacramento River, Cache Slough Complex, and Miner/Georgia/Sutter Sloughs.	Improve out-migrating juvenile salmon through-Delta survival, potential benefits to Delta Smelt and Longfin Smelt.	Ongoing over span of agreement	Linked to available resources and funding, which may be limited or wholly unavailable without VSA's.	Multiple aquatic species atmultiple life stages	DWR, CDFW, SWP, Reclamation, federal water contractors.	CDFW, DWR, Reclamation	None	Concepts identified, no overarching CEQA coverage.	Some ongoing studies.	No
North Delta Food Subsidies	DSRS	Augmented flows through the Yolo Bypass to deliver plankton to downstream areas inhabited by Delta Smelt	North Delta	Improve and increase suitable Delta smelt, longfin smelt, and salmon rearing habitat	Ongoing over span of agreement	Unknown	Multiple aquatic species atmultiple life stages	DWR	DWR/CDFW	Action will not be conducted in extreme high flow and drought years	None	Yes	No
Suisun Marsh Food Subsidies	DSRS	Reoperation of the Suisun Marsh Salinity Control Gates: Improve habitat conditions for Delta Smelt by increasing habitat connectivity and food web interactions in the Suisun Marsh and parts of Suisun Bay. Roaring River Distribution System Food Production: Installation of a drain gate to drain food rich water from the system into Grizzly Bay to augment food supplies. Coordinated managed wetlands drains to promote food export from managed wetlands to adjacent tidal sloughs and bays	Suisun Marsh sloughs, channels, and Grizzly Bay	Increase and Improve suitable Delta smelt, longfin smelt, and salmon rearing habitat	Ongoing	Ongoing	Multiple aquatic species atmultiple life stages	DWR, General Funds, SWP, Reclamation	DWR	None	Initial pilot studies in progress/ No CEQA required/ addendum to BiOps in progress for 2019	Modified gate operations occurred in 2018 and will occur in 2019. A new drain was installed in 2018 and food web studies to begin June 2019. All managed wetlands surveyed for draining capabilities in 2018: data and action in progress.	No
Construct Rio Vista Estuarine Research Station (RVERS)	DSRS	Establishment of a research station in a central Bay-Delta location to facilitate improved aquatic research and monitoring in support of adaptive management	Entire Delta (research area)	Provide cohesive inter-agency science programs and serve as an information repository to support decision-making	1-5 years	25 year lease-to-own agreement (construction start date unknown)	Multiple aquatic species atmultiple life stages	DWR, SWP, USBR	DWR	Lack of federal funding might prevent action from occurring	Completed EIR/EIS, Biological Opinion, Delta Plan Covered Action.	No	No
Consolidate and Screen Intakes at Cache Slough		Consolidate existing agricultural and other water diversions within the Cache Slough Complex into new or modified existing diversions with fish screens. Ensure diverted water gets to its intended area of use, while reducing fish entrainment.	Cache Slough Complex	Reduce Delta Smelt and Longfin Smelt entrainment	1-5 years	Unknown	Multiple aquatic species atmultiple life stages	Unknown	CDFW	Lack of funding might prevent action from occurring (currently no clear funding nexus)	None	No	No
Funding for Game Wardens for Enforcement/Boats in Delta	New	Reduce illegal take of sensitive species, including Chinook Salmon, Steelhead, an Green Sturgeon - this would increase funding significantly beyond existing base levels identified in the 1986 Delta Fish Agreement	Sacramento-San Joaquin Delta, Norther Sacramento Valley, Southern San Joaquin Valley	Reduce poaching of sturgeon and salmon	Ongoing over span of agreement	Existing base funding since 1993 would continue without any proposed increases	Multiple aquatic species atmultiple life stages	DWR	DWR/CDFW	None	None	Yes	Yes

1.10.7 Tuolumne River Habitat Projects

Native Fish Protection and Enhancement Measures (non-flow) in the Tuolumne River included in the Voluntary Agreement (VA)[1]

KEY to Highlighting: Green = Multi Species; Blue = Geomorphology; Red = Steelhead/rainbow trout; Salmon = Chinook salmon

Project and Location	Description	Life Stage	Benefits	Timeline with VA	Timeline Without VA	Funding Source	Estimated Capital Cost	Estimated Monitoring and O&M Cost[2]
Riffle A2 Rehabilitation RM 50.6/50.7	Add appropriately sized gravel to improve substrate conditions for spawning and incubation	Spawning and incubation	Increased spawning opportunity and improved egg-to-emergence survival	2 years	8 to 10 years	TID, MID, CCSF	$0.6 million	$0.3 million
Riffle A3 Rehabilitation RM 50.4 to 50.6	Add appropriately sized gravel to improve substrate conditions for spawning and incubation	Spawning and incubation	Increased spawning opportunity and improved egg-to-emergence survival	2 years	8 to 10 years	TID, MID, CCSF	$0.8 million	$0.3 million
Riffles 3A and 3B RM 49.2 to 49.6	Add appropriately sized gravel; restore banks to appropriate floodplain elevation and function; remove invasive hardwood species; restore native riparian vegetation	Spawning, incubation and juvenile rearing	Improved egg-to-emergence survival and expanded floodplain rearing habitat	2.5 years	Not undertaken	TID, MID, CCSF	$3.2 million	$0.2 million

[1] Preliminary estimated cost in 2017 dollars.

[2] Estimated cost for monitoring, operation, and maintenance over the term of the Voluntary Agreement (VA).

Gravel Cleaning RM 45-49	Clean select gravel patches to expand availability of high quality gravel to improve spawning and incubation	Spawning and incubation	Improved spawning habitat quality and egg-to-emergence survival	3 years	7 years	TID, MID, CCSF	$1.2 million	$2.85 million
Lower Tuolumne River Habitat Improvement Program RMs 5 to 48	$38M capital fund shall be used for a variety of improvement and restoration projects to be developed in conjunction with the TRPAC (below). Examples of likely projects include floodplain lowering, floodplain connectivity, riparian plantings, in-channel placement of LWD	Juvenile rearing, smolt outmigration	Expanded floodplain rearing; expanded in-channel rearing; and improved smolt outmigration survival	1 year	7 years	TID, MID, CCSF	$38 million	$15 million

Tuolumne Partnership Advisory Committee	Collaborative body to provide recommendations on specific LHTRIP projects, adaptive projects, adaptive management, spill management and other restoration activities in the lower Tuolumne River. Will consist of MID, TID, CCSF, DFW, US FWS and others	Enhancement and protection of all in-river life stages.	Coordinated implementation and development of habitat and flow improvements on the river; cooperative adaptive management program	1 year	7 years	TID, MID, CCSF	$0.1 million	$2.9 million
Riffle A5 RM 51.2	Construct alternative riffle/pool morphology	Over-summering *O. mykiss* juvenile and adults	Improved juvenile rearing; improved foraging; improved spawning habitat	3 years	8 to 11 years	TID, MID, CCSF	$1.5 million	$0.2 million
Riffle A6 RM 51.0	Construct alternative riffle/pool morphology	Over-summering *O. mykiss* juvenile and adults	Improved juvenile rearing; improved foraging; improved spawning habitat	3 years	8 to 11 years	TID, MID, CCSF	$1.8 million	$0.3 million
Basso Pool RM 47.0 to 47.3	Construct medial bar; riffle pool-tail morphology[3]	Over-summering *O. mykiss* juvenile and adults	Improved juvenile rearing; improved foraging; improved spawning habitat	3 years	8 to 11 years	TID, MID, CCSF	$2.2 million	$0.3 million

[3] The total amount of new, appropriately-sized gravel to be added as a result of the specific projects identified herein is approximately 75,000 tons.

	LWD enhancement RMs 42.5, 47.3, 48.8[4]	Improve instream habitat complexity through targeted addition of LWD to the lower Tuolumne River	*O. mykiss* Juvenile rearing	Improved juvenile rearing and increased in-channel rearing area	2.5 years	8 to 10 years	TID, MID, CCSF	$3.7	$0.3 million
	Increase in-river flow to RM 26 and add additional points of diversion at RM 26 as a multi-purpose measure	Construct 2 infiltration galleries to be operated from June through mid-October, enabling an increase of flow between LGDD and the IGs to benefit *O. mykiss*	*O. mykiss* Juvenile rearing and over-summering adults.	Expand optimal temperatures for *O. mykiss* juvenile rearing and adult habitat	4 years	11 years	TID, MID, CCSF	$13.0 million	$8.1 million
	Gravel mobilization flows	Improve stream geomorphology by mobilizing gravel and redistribution of fines. When a Spill is expected to occur, provide 2 days of flow between 6-7,000 cfs	Stream geomorphology	Resorting gravels and removal of embedded fines; improve river functions	1 year	6 years	TID, MID, CCSF	N/A	$1.0 million

[4] Part of LTRHIP described above.

	Riffle A3/4 RM 51.5; Gravel Augmentation	Spawning gravel size and distribution integrated with Project flow regime	Stream geomorphology	Resorting gravels and improved gravel size for Chinook spawning	3 years	8 to 11 years	TID, MID, CCSF	$0.6	$0.2
	Fish counting and barrier weir RM 25.5	Improve rearing and migration conditions upstream of the weir by preventing access by striped bass and other predators	Fry and juvenile rearing; smolt outmigration	Reduce predation on fry and juvenile fall-run Chinook salmon	3 years	10 years	TID, MID, CCSF	$12 million	$7.3 million
	Predator control and suppression	Improve rearing and migration conditions by reducing predation	Fry and juvenile rearing; smolt outmigration	Reduce predation on fry and juvenile fall-run Chinook salmon	2 years	9 years	TID, MID, CCSF	$0.2 million	$1.9 million
	Reduce redd super-imposition RMs 47-52	Construct a seasonal weir when upstream gravel patches are at capacity to encourage use of suitable habitats at downstream locations	Spawning and incubation	Improve over-all fall-run Chinook spawning success by reducing redd superimposition	2 years	9 years	TID, MID, CCSF	$4.2 million	$1.1 million

	Spill managem ent plan RM 52- RM 0	Maximize the benefits of Spill events by managing rates, timing, and duration to benefit floodplain rearing, in-channel rearing, or temperature management	Juvenile rearing and smolt outmigration		1 year	7 years	TID, MID, CCSF	$0.7 million	$2.3 million
	TOTALS							**83.8 million**	**44.5**