Appendix G1

Voluntary Agreement Proposal

Draft Strategic Plan for the Proposed Agreements to Support Healthy Rivers and Landscapes

Prepared by:

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California Environmental Protection Agency
California Department of Water Resources
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Contra Costa Water District
East Bay Municipal Utility District
Friant Water Authority
Garden Highway Mutual Water Company
Glenn-Colusa Irrigation District
Kern County Water Agency
Metropolitan Water District of Southern California
Modesto Irrigation District
Regional Water Authority
River Garden Farms
San Francisco Public Utilities Commission
San Luis and Delta-Mendota Water Authority
Solano County Water Agency
State Water Contractors
Sutter Mutual Water Company
Tehama-Colusa Canal Authority
Turlock Irrigation District
Western Canal Water District
Westlands Water District
Yuba Water Agency

September 2023

Draft Strategic Plan for the Proposed Agreements to Support Healthy Rivers and Landscapes

Updated: September 9, 2023

Preface

Document Purpose

This document is a preliminary draft of the Strategic Plan which, in final form, will be content for Exhibit F to the Global Voluntary Agreement (VA). The VA Parties provide this draft to the State Water Board for information, as they prepare their Staff Report to update the Bay-Delta Plan. This Strategic Plan provides an overview of the proposed VA Program as well as additional details on the Flow and Non-flow Measures included in the March 29, 2022, Memorandum of Understanding to advance the Term Sheet for the Voluntary Agreements Program, including amendments (Appendix A). Appendix B and Appendix C provide a description of the Draft Governance Program and Draft Science Plan for the Voluntary Agreements Program. The primary purposes of VA governance and science activities are to maximize benefits of the Flow and Non-flow Measures for the narrative objectives and to provide accountability and transparency of the VA Program to regulatory agencies and the public.

Definitions

Applicable Law means: state or federal law, including a Constitution, statute, regulation, court decision, precedential adjudicative decision, or common law, that applies to obligations or activities of Parties contemplated by this Agreement.

Bay-Delta Plan means: Water Quality Control Plan for the San Francisco Bay/Sacramento/San Joaquin Delta Estuary (2018, as amended [date of Final Action]).

Bay-Delta Watershed means: the area extending nearly 500 miles from the Cascade Range in the north to the Tehachapi Mountains in the south, and is bounded by the Sierra Mountain Range to the east and the Coast Range to the west that drains through the Sacramento River, the San Joaquin River, and their tributaries through the Delta to the Pacific Ocean through the Golden Gate Strait.

California Native American Tribe means: a federally recognized California Native American tribe or a non-federally recognized California Native American tribe that is on the contact list maintained by the Native American Heritage Commission.

CDFW means: the California Department of Fish and Wildlife.

CDWR means: the California Department of Water Resources.

Central Valley Project or CVP means: the project authorized by 50 Stat. 850 (1937) and subsequent statutes, and operated by the U.S. Department of the Interior Bureau of Reclamation, for water supply, protection, restoration, and enhancement of fish and wildlife, power, flood control and other purposes.

Contributed Funds means: funds paid by Parties and deposited by the Systemwide Funding Entity in either the Structural Science and Habitat Fund or the Revolving Water Transfer Fund.

Delta means: the Sacramento-San Joaquin Delta (including Suisun Marsh) as defined in Water Code Sec. 85058.

Flow Measures means: VA flows as described in Appendix 1 of the March 29, 2022, Term Sheet and all associated amendments.

Enforcement Agreements means: the agreements signed by non-federal Parties pursuant to Government Code section 11415.60, or with respect to federal Parties, a Government Code section 11415.60 agreement to implement any VA-related modifications to water rights held by a federal entity and a memorandum of understanding to implement other federal VA commitments, and approved by the State

Water Board, to provide in part regulatory authority for Flow Measures and Non-flow Measures in the VA Program.

Final Action means: final action by the State Water Board to amend the Bay-Delta Plan.

Global Agreement means: the Global Agreement establishing the overall structure for the VA Program, and specifically providing the systemwide terms for the Science, Funding, and Governance Programs.

Governance Entities means: all institutional arrangements identified for the implementation of the VA.

Governance Program means: the governance procedures that the Parties will follow to implement the VA Program. A description of the Governance Program is provided in Appendix B to the Draft Strategic Plan.

Implementing Agreements means: the agreements to implement Flow and Non-flow Measures, specific to a Tributary or the Delta.

Implementing Entities means: Parties that sign an Implementing Agreement, and other entities specified therein, that have responsibilities to implement measures stated in the agreement.

Memorandum of Understanding or MOU means the "Memorandum of Understanding Advancing a Term Sheet for The Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan, and Other Related Actions," dated March 29, 2022.

Narrative Viability Objective means: a new water quality objective that the Parties support in the Bay-Delta Plan, as stated below:

> "Maintain water quality conditions, including flow conditions in and from tributaries and into the Delta, together with other measures in the watershed, sufficient to support and maintain the natural production of viable native fish populations. Conditions and measures that reasonably contribute toward maintaining viable native fish populations include, but may not be limited to, (1) flows that support native fish species, including the relative magnitude, duration, timing, temperature, and spatial extent of flows, and (2) conditions within water bodies that enhance spawning, rearing, growth, and migration in order to contribute to improved viability. Indicators of viability include population abundance, spatial extent, distribution, structure, genetic and life history diversity, and productivity.* Flows provided to meet this objective will be managed in a manner to avoid causing significant adverse impacts to fish and wildlife beneficial uses at other times of the year.
>
> * The actions the State Water Board and other agencies expect to take to implement this objective are described in section [insert number] of this Plan's Program of Implementation."

Non-flow Measures means: habitat restoration measures and other non-flow measures as described in Appendix 2 of the March 29, 2022, Term Sheet and all associated amendments and other measures (e.g., funding for science).

Participants means: Representatives from VA Parties, California Native American tribes, non-governmental organizations, and other interested parties that are appointed consistent with the procedures in the Systemwide Governance Committee Charter and that together participate in the Governance Program.

Parties means: signatories to the MOU and amendments.

Program of Implementation means: the program of measures, schedule, and monitoring necessary to achieve the water quality objectives in the Bay-Delta Plan, as adopted pursuant to Water Code sections 13241 and 13242.

Public Water Agencies or water purveyors means: VA Parties that are water suppliers and distributors for agricultural, municipal, industrial, hydropower, recreational and environmental use.

Responsible Parties means: the Parties who are Implementing Entities and sign an Enforcement Agreement.

Revolving Water Transfer Fund means: an account created by the SWF Entity to compensate Parties for flow contributions pursuant to the applicable Implementing Agreements.

Science Program means: the procedures and other requirements that the Parties will use to evaluate the effects of the VA Program. The Science Plan is Appendix C to the Draft Strategic Plan.

State Water Board means: the State Water Resources Control Board.

State Water Project or SWP means: the project authorized by California Water Code sections 11000 et seq., and operated by CDWR, for water supply, power, flood control and other purposes.

Strategic Plan means: this document or the plan developed, maintained, and updated by the Systemwide Governance Committee to describe the schedule and other details of implementation of the VA measures.

Structural Science and Habitat Fund or SSHF means a fund created by the SWF Entity to support science and habitat programs within the VA Program in accordance with this Global Agreement and the applicable Implementing Agreements.

Substitute Environmental Document or SED means: the substitute environmental document that analyzes the effects of implementing the VA Program, as well as other issues as necessary for the update to the Bay-Delta Plan, in compliance with the California Environmental Quality Act. The SED is part of the State Water Board’s Staff Report for the updated Bay-Delta Plan.

Supported Amendments means: amendments to the Bay-Delta Plan, including Table 3 and Program of Implementation, that incorporate the VA Program. The Parties sign the Global Agreement following the State Water Board’s Final Action on the Supported Amendments.

System Operator means: the organizations that control their respective water operations.

Systemwide means: same scale as the Bay-Delta Watershed.

Systemwide Funding Entity or SWF Entity means: the funding entity established pursuant to Section 11. The Systemwide Funding Entity may be either an already existing entity or a new entity formed by one or more Parties with the written consent of the other Parties.

Systemwide Measures means: the Flow and Non-flow Measures that are not tightly constrained, and therefore can be deployed for the greatest overall benefit as assessed at the scale of the Bay-Delta Watershed by the Systemwide Governance Committee. Note that as of May 2023, Systemwide Measures have not yet been identified and this is expected to be a next step in the Summer and Fall of 2023.

Term Sheet means: the “Term Sheet for The Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan, and Other Related Actions” (March 29, 2022) and associated amendments.

Tributary/Delta Measures means: the Flow and Non-flow Measures that can be implemented by the VA Party that committed the measures as long as that implementation is consistent with the Enforcement Agreements.

USBR means: the United States Bureau of Reclamation.

VA Program means the measures, rights and obligations stated in the Global Agreement and:

A. Supported Amendments to Bay-Delta Plan (Exhibit A);

B. Implementing Agreements (Exhibit B.1 – B.X);

C. Enforcement Agreements (Exhibit C.1 – C.X);

D. Governance Program (Exhibit D);

E. Science Plan (Exhibit E);

F. Strategic Plan (Exhibit F); and

G. Funding Plan (Exhibit G).

Voluntary Agreements or VAs means: the Global Agreement, the Implementing Agreements, and the Enforcement Agreements.

Year means: time starting on the Effective Date of the Global Agreement. Year 0 begins on that date.

Draft Strategic Plan for the Proposed Agreements to Support Healthy Rivers and Landscapes

1 Overview

The proposed Voluntary Agreements Program (VA Program) will be a comprehensive, multi-year effort that brings together dozens of water agencies with the state and federal governments to pool resources and provide targeted river flows and expanded habitat in the Sacramento and San Joaquin River watersheds and Bay Delta. The VA Program, if approved by the State Water Resources Control Board (State Water Board) as an implementation pathway for an updated Bay-Delta Plan, could help meet requirements to protect beneficial uses in the Sacramento and San Joaquin watersheds.

Building on the Term Sheet to the March 29, 2022, Memorandum of Understanding (MOU) and amendments (Appendix A), this Draft Strategic Plan ("Plan") was produced by the Parties to the MOU[1] to provide additional detail on the proposed VA Program. The Parties that signed the MOU and amendments are "VA Parties" for the purpose of this Plan. Section 1 of this Plan provides background and an overview of the proposed VA Program. Sections 2 and 3 provide details on the Flow Measures and Non-flow Measures that are proposed for inclusion in the VA Program. Appendices to this Plan provide additional details on proposed governance, science and funding activities within the VA Program.

This draft Plan (inclusive of appendices) was produced for the purposes of informing the State Water Board's public review process on the updating of the Bay-Delta Plan. The VA Parties may update this Plan as necessary following the public review process, including to address comments received. The VA Parties will then request that the State Water Board approve this Plan as an element of the Program of Implementation.

Current MOU Signatories

State And Federal Agencies
California Natural Resources Agency
California Environmental Protection Agency
California Department of Water Resources
California Department of Fish and Wildlife
US Bureau of Reclamation

Upper Sacramento River
Garden Highway Mutual Water Company
Glenn-Colusa Irrigation District
River Garden Farms
Sutter Mutual Water Company

Feather River
Western Canal Water District

Yuba River
Yuba Water Agency

American River
Regional Water Authority

Mokelumne River
East Bay Municipal Utility District

Tuolumne River
San Francisco Public Utilities Commission
Modesto Irrigation District
Turlock Irrigation District

San Joaquin (Friant)
Friant Water Authority

Putah Creek
Solano County Water Agency

State and Federal Contractors
Metropolitan Water District of Southern California
State Water Contractors
Westlands Water District
Kern County Water Agency
San Luis and Delta-Mendota Water Authority
Tehama-Colusa Canal Authority
Contra Costa Water District

1.1 Background

The State Water Board and the nine regional water quality control boards administer the Porter-Cologne Water Quality Control Act (Wat. Code, § 13000 et seq.) (Porter-Cologne Act) to achieve an effective water quality control

[1] Current signatories are indicated in the accompanying text box. Additional parties may sign the MOU in the future.

program for the state and are responsible for the regulation of activities and factors that may affect the quality of the waters of the state. The State Water Board is authorized to adopt a water quality control plan in accordance with the provisions of Water Code sections 13240 through 13244, insofar as they are applicable (Wat. Code, § 13170). The State Water Board has adopted a Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). It first adopted the plan in 1978, amending it in 1995, 2006, and 2018. In 2008, it initiated its periodic review and began proceedings to update the current Bay-Delta Plan. The Bay-Delta Plan designates beneficial uses of the waters of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta watershed), establishes water quality objectives for the protection of those beneficial uses, and establishes a program of implementation to implement those objectives.

In May 2017, then-Governor Edmund G. Brown, Jr. issued "Principles for Voluntary Agreements" stating in relevant part: "The goal is to negotiate durable and enforceable Voluntary Agreements that will be approved by applicable regulatory agencies, will represent the program of implementation for the water quality objectives for the lower San Joaquin and Sacramento Rivers and Delta, will forego an adjudicatory proceeding related to water rights, and will resolve disputes among the parties regarding water management in the Sacramento-San Joaquin-Bay-Delta Watershed." Interested parties, including state and federal agencies, municipal and agricultural water suppliers, and others undertook extensive efforts beginning in 2017 to negotiate VAs. On December 12, 2018, the Directors of California Department of Fish and Wildlife (CDFW) and California Department of Water Resources (CDWR) appeared before the State Water Board and presented the results of the negotiation process to date. Specifically, the Directors presented a "Framework Proposal for Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan" (Framework Proposal). On December 12, 2018, the State Water Board adopted Resolution No. 2018-0059 to update the 2006 Bay-Delta Plan. First, it amended the water quality objectives for the protection of fish and wildlife beneficial uses in the Lower San Joaquin River and its three eastside tributaries (the Stanislaus, Tuolumne, and Merced Rivers), and agricultural beneficial uses in the southern Delta. It also amended the program of implementation for those objectives. It approved and adopted the Substitute Environmental Document (SED) for the Lower San Joaquin River. Ordering paragraph 7 of Resolution No. 2018-0059 states:

> "The State Water Board directs staff to provide appropriate technical and regulatory information to assist the California Natural Resources Agency in completing a Delta watershed-wide agreement, including potential flow and non-flow measures for the Tuolumne River, and associated analyses no later than March 1, 2019. State Water Board staff shall incorporate the Delta watershed-wide agreement, including potential amendments to implement agreements related to the Tuolumne River, as an alternative for a future, comprehensive Bay-Delta Plan update that addresses the reasonable protection of beneficial uses across the Delta watershed, with the goal that comprehensive amendments to the Bay-Delta Plan across the Delta watershed may be presented to the State Water Board for consideration as early as possible after December 1, 2019."

In January 2019, Governor Gavin Newsom confirmed his intention to complete the efforts to reach VAs, providing commentary on February 4, 2020 that "California must get past differences on water. Voluntary agreements are the path forward." On March 1, 2019, the Directors of CDFW and CDWR entered into a "Planning Agreement Proposing Project Description and Procedures for the Finalization of the Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan" (Planning Agreement). Over the course of 2019, the State, Reclamation, water agencies, and NGOs met to develop the Voluntary Agreement framework. A large plenary group consisting of representatives from several state and federal agencies, water agencies and NGOs was formed along with three primary subgroups: legal, governance and science, and assets (measures). Each group developed materials for a 15-year framework, which was then presented in February 2020 to the plenary as a complete framework. The State and Reclamation then continued conversations with water agencies through March 2022 to build upon the 2020 framework to include additional detail and secure additional assets (funding and water). Based on this updated framework, the VA Parties signed a Memorandum of Understanding to advance the "Term Sheet for the Voluntary Agreements Program to Update and Implement the Bay-Delta Water Quality Control Plan" (Term Sheet to the MOU; Appendix A).

1.2 Narrative Objectives

The Parties are committed to providing Flow and Non-flow Measures in the VA Program, that together with other measures in the Bay-Delta Plan, are necessary to implement water quality objectives in the Bay-Delta Plan related to the protection of native fishes. These objectives are: (1) the existing narrative objective that provides for water quality conditions, together with other measures in the watershed, sufficient to achieve a doubling of natural production of chinook salmon from the average production of 1967-1991, consistent with the provisions of State and federal law (Narrative Salmon Objective); and (2) a new narrative objective to achieve the viability of native fish populations (Narrative Viability Objective).

The Parties propose that the State Water Board adopt the following Narrative Viability Objective for the Bay-Delta Watershed, including the Lower San Joaquin River:

> "Maintain water quality conditions, including flow conditions in and from tributaries and into the Delta, together with other measures in the watershed, sufficient to support and maintain the natural production of viable native fish populations. Conditions and measures that reasonably contribute toward maintaining viable native fish populations include, but may not be limited to, (1) flows that support native fish species, including the relative magnitude, duration, timing, temperature, and spatial extent of flows, and (2) conditions within water bodies that enhance spawning, rearing, growth, and migration in order to contribute to improved viability. Indicators of viability include population abundance, spatial extent, distribution, structure, genetic and life history diversity, and productivity.* Flows provided to meet this objective shall be managed in a manner to avoid causing significant adverse impacts to fish and wildlife beneficial uses at other times of the year.
>
> * The actions the State Water Board and other agencies expect to take to implement this objective are described in section [insert number] of this Plan's Program of Implementation."

1.3 Proposed VA Program

In the Bay-Delta watershed, a comprehensive approach to managing and integrating habitat, flow, landscape, and other factors is required to protect native fish and wildlife species, while concurrently protecting water supply reliability, consistent with the legal requirement of providing reasonable protection for all beneficial uses. The Bay-Delta Plan requires flow measures, and while recommending other actions, the Bay-Delta Plan's program of implementation generally does not include actions that the State Water Board will take directly to address other non-flow measures to protect fish and wildlife, including physical habitat restoration of channels, wetlands and floodplains. The Parties seek to take a comprehensive approach to integrate flow and non-flow measures, including habitat restoration and landscape reactivation, subject to ongoing adaptive management based on a science program. This Plan, together with the appendices, describes a VA Program to effect this comprehensive approach. Flow and Non-flow Measures will be subject to regulatory oversight mechanisms as described in Section 1.4.

The Parties request that the Program of Implementation in the updated Bay-Delta Plan include the VA Program as a pathway to implement the Narrative Salmon Objective and proposed Narrative Viability Objective, on a finding that the VA pathway, in conjunction with other measures in the Bay-Delta Plan, will provide reasonable protection of the associated beneficial uses as documented in the Substitute Environmental Document (SED).

Flow Measures

Commitments by participating water agencies will generate hundreds of thousands of acre-feet of water dedicated for environmental purposes that will be adaptively managed to benefit native fish populations and habitats and protected for Delta outflow. The amount of this environmental water varies depending on how dry or wet a year becomes, with up to 825,000 acre-feet in some years above flows resulting from the 2019 Biological Opinions and State Water Board Decision 1641.

The proposed Flow Measures for the VA Program can be flexibly managed based on timing and season to increase instream flows and Delta outflows and test biological hypotheses, consistent with regulatory requirements. The proposal focuses the deployment of Flow Measures in the Spring (March through May). Consistent with the State Water Board's Scientific Basis Report (SWRCB 2017), Flow Measures provided during March through May, are hypothesized to help to restore more natural flow patterns during a biologically important time period in an effort to improve conditions for native aquatic species.

Section 2 provides details on the proposed Flow Measures, including water quantities by water source and water year type, seasonal timing, and a narrative description of flow accounting.

Non-flow Measures

Through the VA Program, significant, coordinated investments will be made to improve fish and wildlife habitat conditions throughout the watershed. The agreements encompass more than 45,000 acres of instream habitat, new spawning and rearing habitat, floodplain habitat and fish food production. Section 3 provides more detail on the expected commitments of habitat restoration activities and other Non-flow Measures by geographic area, including their expected implementation timing and an overview of habitat accounting protocols.

Governance, Science and Adaptive Management

The primary purposes of VA governance and science activities are to maximize benefits of the Flow and Non-flow Measures for the narrative objectives and to provide accountability and transparency of the VA Program to regulatory agencies and the public. The Parties will coordinate efforts, engage other interested participants and report on activities at both a systemwide (Bay-Delta watershed) and local scale through the governance structures and processes described in Appendix B. One of these governance structures, the Systemwide Governance Committee, is in the initial stages of forming for the purposes of preparing for the implementation of the VA Program.

A VA Science Committee has also been established to coordinate science activities and recommend an adaptive management framework to assess outcomes of VA Flow and Non-flow Measures. A Draft Science Plan developed by the VA Science Committee is provided in Appendix C. The draft Science Plan describes the metrics that will be used to evaluate the benefits of Flow and Non-flow Measures towards the narrative objectives and to inform adaptive management.

Funding

Over $2.9 billion of funding commitments have been identified to support the VA Program. Funding to support the VA Program will be generated from multiple sources over the term of the agreement, including from DWR, Reclamation and other federal agencies, public water agencies, bond and other state funding, and other sources. Funding will support the acquisition of water and support science and habitat projects. For additional details on the expected revenues to support the VA Program, see Appendix 3 of the Term Sheet.

1.4 Regulatory Oversight

The VA Program is anticipated to have multiple mechanisms of regulatory oversight. Three key mechanisms described in the Term Sheet to the MOU are:

(1) **Government Code Section 11415.60 Agreements (or 'Enforcement Agreements')** that will state the specific obligations of those VA Parties responsible for implementation, along with related regulatory enforcement mechanisms, each to be signed by VA Parties and the State Water Board (see Section 2.2C of the Term Sheet).

(2) **Annual and Triennial Reports** that will be produced at the local and systemwide (Bay-Delta Watershed) scale for submittal to the State Water Board (see Section 9.4 of the Term Sheet for more detail).

(3) **The initiation of a process by the State Water Board at Year 6 of the VA Program** to evaluate and determine the implementation pathway for VA Parties after Year 8 (see Section 7.1 of the Term Sheet for more detail).

The Draft Governance Description (Appendix B) also includes additional information on proposed State Water Board oversight. The Draft Governance Description is expected to be further developed in coordination with State Water Board staff to ensure consistency with the above described Enforcement Agreements and State Water Board regulatory requirements.

1.5 VA Program Timeline

Figure 1 provides an overview of key activities and anticipated timeline with respect to the VA Program. In 2023 and 2024, VA Parties are working to develop necessary legal agreements and provide information to the State Water Board for regulatory review purposes. Early implementation of habitat projects is also ongoing and described further in Section 3. As defined in the Term Sheet, the VAs would become effective on the date the Enforcement Agreements are executed. The VAs would then remain in effect for a term of 8 years after the Effective Date, with the possibility of extension.

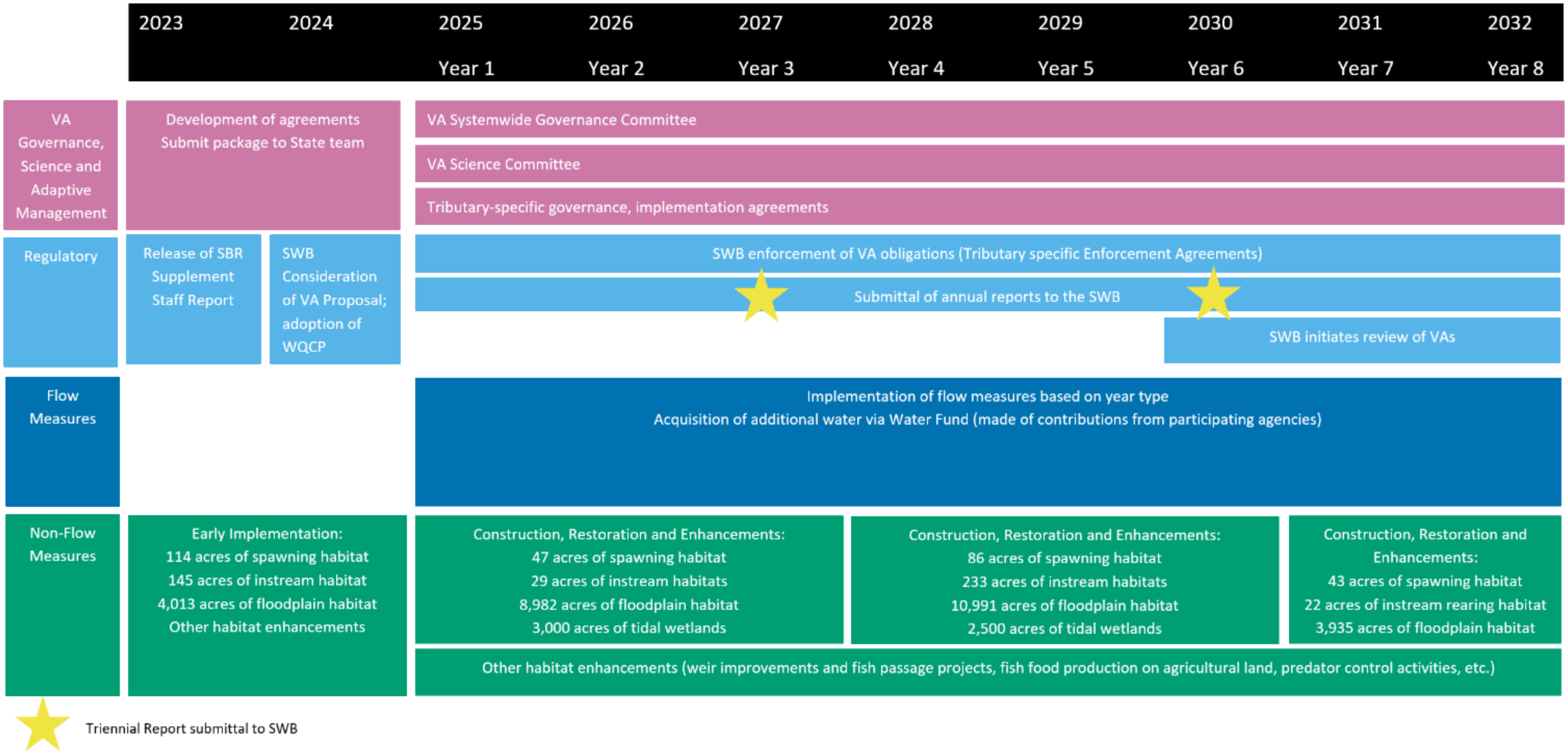

Figure 1: VA Program – Key Activities and Timeline

2 Flow Measures Description

This section provides details on the proposed Flow Measures for the VA Program including water quantities by water source and water year type (Section 2.1.1), a default plan and flexibility bracket for the seasonal timing of Flow Measures (Section 2.1.2), the flexibility of Flow Measures for systemwide coordination (Section 2.1.3), a narrative description of flow accounting (Section 2.1.4), and additional details for each water source, including decision-making processes for the deployment of Flow Measures that are subject to Implementing Agreements, Enforcement Agreements and applicable regulatory requirements (Sections 2.2 to 2.12).

2.1 Overview of Flow Measures

2.1.1 Water Quantities by Water Source and Water Year Type

Table 1 describes the water quantities of the Flow Measures by water source and water year type. These Flow Measures will be additive to the Delta outflows required by Revised Water Rights Decision 1641 (Revised D-1641) and resulting from the 2019 Biological Opinions, although the 2019 Biological Opinions may be modified, including to resolve litigation concerning those opinions (Term Sheet, Section 4.1). Flow Measures described as “Water Purchase Program” or other water purchases will be obtained through a free-market program for single-year transfers, subject to applicable law (Term Sheet, Section 5.1). Flow contributions from all water sources will not impact water supplies for wildlife refuges nor impact health and safety water supplies. Additional details on Flow Measures are provided in Appendix 1 to the Term Sheet and associated amendments.

Table 1: New Contributions to Tributary Flow and Delta Outflows in Thousand Acre Feet by Sacramento River Index[1,2,3] (Adapted from Term Sheet, Appendix 1 and associated amendments)

Source Category	Specific Source	C (15%)[4]	D (22%)	BN (17%)	AN (14%)	W (32%)
San Joaquin River Basin	*Minimum Placeholder Contributions (Stanislaus and Merced)[5]*	*11*	*83*	*101*	*85*	*0*
San Joaquin River Basin	*San Joaquin Basin Portion of Gap[5]*	-	*11*	*2*	*10*	-
San Joaquin River Basin	Tuolumne[15]	37	62	78	27	0
Friant	-	0	50	50	50	0
Sacramento River Basin[6]	Sacramento[7]	2	102	100	100	0
Sacramento River Basin[6]	Feather	0	60	60	60	0
Sacramento River Basin[6]	Yuba	0	60	60	60	0
Sacramento River Basin[6]	American[8]	30	40	10	10	0
Sacramento River Basin[6]	Mokelumne[13]	0	5	5	7	0
Sacramento River Basin[6]	Putah[9]	7	6	6	6	0
CVP/SWP Export Reduction[10]	-	0	125	125	175	0
PWA Water Purchase Program	Fixed Price	3	63.5	84.5	99.5	27
PWA Water Purchase Program	Market Price[11, 14]	0	50	60	83	0
Permanent State Water Purchases[12]	-	65	108	9	52	123
Year 1 New Outflow Above Baseline (Low Target)	-	***155***	***825.5***	***750.5***	***824.5***	***150***

Footnotes to Table 1:

[1] This table reflects status of negotiations as of the date of this Framework. Prior "global gap" to meet adequacy are now reflected as Permanent State Water Purchases.

[2] Outflows additive to baseline and will be provided January through June. A portion of the VAs' flows can be flexibly shaped to other times of year to test biological hypotheses while reasonably protecting beneficial uses. Such shaping will be subject to VAs' governance program. Flows made available through reservoir reoperations will be subject to accounting procedures described in term sheet and all flows will be verified as a contribution above baseline using these accounting procedures.

[3] An assessment based on the accounting procedures to be developed pursuant to Term Sheet section 8.3 will be conducted prior to year 8 of VA to determine if the flows in this table have materialized on average above baseline by water year type. The VA parties acknowledge that, if this analysis does not demonstrate that flows have materialized as shown in this table, then the VAs will be subject to Term Sheet provisions of Section 7.4(B)(ii) or (iii).

[4] C year off-ramps subject to negotiation, but flows in this table must reflect average C year contributions over the term of the VA.

[5] As of the date of this document, discussions with these water sources are still ongoing. Table shows minimum placeholder contribution for the SJR tributaries (Stanislaus and Merced) equivalent to what would have been provided under the VA. Additional flows above minimum placeholder values will be required in certain year types to satisfy current water quality objectives.

[6] The new flow contributions from the Sacramento River Basin identified in this table, plus new flow contributions resulting from the below-referenced PWA Water Purchase Program, Permanent State Water Purchases, and PWA Fixed Price Water Purchase Program line items in Table 1, are not intended to result in idling more than 35,000 acres of rice land in the Sacramento River Basin.

[7] 2 TAF in Critical and Dry years is subject to ongoing discussions. VA parties agree that the Sacramento River flow contribution of 100 TAF will be provided during the January through June period, except when it is recommended through the VA governance process that shifting the timing of a portion of this contribution would be in the best interest of the fishery. Recommendations by the VA governance group require approval from the following agencies: National Marine Fisheries Service, California Department of Fish and Wildlife, and the State Water Board.

[8] Contingent on funding groundwater substitution infrastructure to be completed by a subsequent year. These flows are included in the Year 1 subtotal. 30 TAF of groundwater provided in 3 out of 8 D or C years; 10 TAF of upstream reservoir storage provided in 3 out of 8 AN or BN years; and an additional 10 TAF in D years provided from one or a combination of sources.

[9] Consistent with the safe yield of the Putah Creek Accord (2000).

[10] If, in any year, this level of Exporter contribution would reduce supplies that would otherwise be provided to Exporters to protect M&I Public Health and Safety, then the Exporter contribution will be reduced to avoid reduction of M&I Public Health and Safety water, consistent with operations contemplated in D-1641 and the biological opinions for the coordinated operations of the CVP and SWP to protect health and safety water supplies.

[11] The VA's governance program will be used to determine the use of available funding to provide additional outflow in AN, BN, or W years. If DWR is called upon to provide the water by foregoing SWP exports, such call will be handled through a separate agreement between DWR and its contractors.

[12] State to permanently acquire 65TAF of water in all water year types to contribute to meeting the flow targets specified in this table. After applying this 65TAF in all water years a gap of 43TAF will persist in D years and a gap of 58TAF will persist in W years; however, there will be a surplus of 56TAF in BN years and a surplus of 13TAF in AN years. D and W year gaps to filled by redistributing a portion of the PWA water purchase contribution from BN and AN years, and through additional State water purchases in W years.

[13] EBMUD will operate to the tributary flows proposed in Section 2.7.3 or Appendix A5 of the Memorandum of Understanding dated March 1, 2019 ("Mokelumne River Proposal" or "2019 MRP"). Modeled flows in the 2019 MRP were above the existing requirements in EBMUD's D-1641/Joint Settlement Agreement (JSA) year types. EBMUD will present modeling, consistent with the VA flow accounting procedures, to demonstrate average long-term contribution of new flows from the Mokelumne, and if a shortfall is determined relative to the flows stated in modified Table 1 above for a given Sacramento River index year type EBMUD will commit to funding the purchase of any remaining volume difference when that Sacramento year type occurs during the 8-year term of the agreement. The VA Parties will endeavor to achieve fair and equitable pricing for all VA water purchases.

[14] EBMUD commits to coordinating and prioritizing possible water purchases from the Mokelumne River system to the extent feasible and practical and acceptable to EBMUD. And, consistent with footnote 11 of Appendix 1 Flow Tables, Table 1a: The VA's governance program will be used to determine the use of available funding to provide additional outflow in AN, BN, or W years. If DWR is called upon to provide the water by foregoing SWP exports, such call will be handled through a separate agreement between DWR and its contractors.

[15] As measured at the Modesto flow gauge. Modeling done by the State predicts that with implementation of the Tuolumne VA that Tuolumne River flows as measured at the Modesto gauge, on average by water year type, will exceed the average January-June flows in the base case (flow resulting under current conditions with the 1995 FERC Settlement Agreement in effect). The modeling projects the following resultant flows at Modesto gauge that will be protected as Delta outflows.

2.1.2 Default Plan and Flexibility Bracket

A Default Plan and a Flexibility Bracket for VA Flow Measures is provided in Table 2 to Table 5. The Default Plan defines a long-run average timing for VA Flow Measures by water source and water year type which is based on hydrology and operations analysis and/or modeling of the deployment of VA Flow Measures.

The Flexibility Bracket is defined for each water source and is inclusive of:

- Flexibility for VA governance entities to time the VA Flow Measure for the benefit of native fish and to test hypotheses in consideration of hydrological opportunities;
- Flexibility for implementing organizations (operators) to work within operational and hydrological constraints and to ensure that VA Flow Measures are additive contributions.

In any given year within the 8-year VA Program, VA Flow Measures will be deployed within the Flexibility Bracket.

The Default Plan and Flexibility Bracket focus the deployment of VA Flow Measures in the Spring (March through May). Consistent with the State Water Board's Scientific Basis Report (SWRCB 2017), VA Flow Measures provided during March through May are hypothesized to help to restore more natural flow patterns during a biologically important time period in an effort to improve conditions for native aquatic species.

Table 2: Default Plan and Flexibility Bracket for VA Flow Measures in Above Normal water year. Bolded numbers represent the Default Plan and numbers in parentheses represent the Flexibility Bracket for any given year. Values are a proportion of the total flow contribution as stated in Table 1 (Appendix 1 of the MOU and all associated amendments). The summary row was calculated by multiplying each water source's water quantity contributions for the VA by the Default Plan proportion.

Source	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Friant	**0%**	**0%**	**0%**	**0%**	**5%** (0-5%)	**20%** (15-30%)	**40%** (35-70%)	**35%** (0-35%)	**0%**	**0%**	**0%**	**0%**
Sacramento	**0%**	**0%**	**0%**	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**50%** (0-100%)	**50%** (0-100%)	**0%** (0-25%)	**0%**	**0%**	**0%**
Feather	**0%**	**0%**	**0%**	**0%**	**0%**	**75%** (50-90%)	**25%** (10-50%)	**0%**	**0%**	**0%**	**0%**	**0%**
Yuba (YWA)	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)	**0%**	**0%**	**0%**
American	**0%**	**0%**	**0%**	**0%**	**0%**	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)	**0%**	**0%**	**0%**	**0%**
Mokelumne – N & Above[1]	**13%** (10-30%)	**0%**	**0%**	**0%**	**0%**	**8%**[2]	**43%**[2]	**36%**[2]	**0%**	**0%**	**0%**	**0%**
Tuolumne	**0%**	**0%**	**0%**	**0%**	**0%**	**63%**[3]	**18%**[3]	**19%**[3]	**0%** (0-40%)	**0%**	**0%**	**0%**
Putah	**0%**	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-84%)	**16.7%** (0-74%)	**8.3%** (0-54%)	**8.3%** (0-57%)	**0%**	**0%**	**0%**	**0%**
CVP/SWP Export Reduction	**0%**	**0%**	**0%**	**0%**	**0%**	**0%** (0-30%)	**50%** (30-70%)	**50%** (30-70%)	**0%** (0-30%)	**0%**	**0%**	**0%**
PWA Water Purchase Program	**0%**	**0%**	**0%**	**0%**	**0%**	**0%** (0-40%)	**50%**[4]	**50%**[4]	**0%** (0-40%)	**0%**	**0%**	**0%**
Permanent State Water Purchases	**0%**	**0%**	**0%**	**0%**	**0%** (0-40%)	**33.3%**[5]	**33.3%**[5]	**33.3%**[5]	**0%** (0-40%)	**0%**	**0%**	**0%**
Summary	**<1%**	**<1%**	**<1%**	**<1%**	**<1%**	**13%**	**44%**	**41%**	**0%**	**0%**	**0%**	**0%**

[1] Mokelumne year type determined as described in Section 2.7 based on D-1641 thresholds of projected unimpaired runoff. VA flow releases subject to offramp to protect cold water pool, described in Table 13, fn. 1.

[2] Flexibility Bracket for the March to May period is 70-90%.

[3] Flexibility Bracket for the March to May period is 60-100%.

[4] Flexibility Bracket for the April to May period is 60-100%.

[5] Flexibility Bracket for the March to May period is 60-100%.

Table 3: Default Plan and Flexibility Bracket for VA Flow Measures in Below Normal water year. Bolded numbers represent the Default Plan and numbers in parentheses represent the Flexibility Bracket for any given year. Values are a proportion of the total flow contribution as stated in Table 1 (Appendix 1 of the MOU and all associated amendments). The summary row was calculated by multiplying each water source's water quantity contributions for the VA by the Default Plan proportion.

Source	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Friant	**0%**	**0%**	**0%**	**0%**	**5%** (0-5%)	**20%** (15-30%)	**40%** (35-70%)	**35%** (0-35%)	**0%**	**0%**	**0%**	**0%**
Sacramento	**5%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-50%)	**10%** (0-25%)	**15%** (0-25%)	**20%** (0-25%)	**20%** (0-25%)	**20%** (0-25%)	**10%** (0-25%)
Feather	**0%**	**0%**	**0%**	**0%**	**0%**	**75%** (50-90%)	**25%** (10-50%)	**0%**	**0%**	**0%**	**0%**	**0%**
Yuba (YWA)	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)	**0%**	**0%**	**0%**
American	**0%**	**0%**	**0%**	**0%**	**0%**	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)	**0%**	**0%**	**0%**	**0%**
Mokelumne[1]	**26%** (10-30%)	**0%**	**0%**	**0%**	**0%**	**17%[2]**	**32%[2]**	**25%[2]**	**0%**	**0%**	**0%**	**0%**
Tuolumne[3]	**0%**	**0%**	**0%**	**0%**	**0%**	**77%[4]**	**11%[4]**	**12%[4]**	**0%** (0-40%)	**0%**	**0%**	**0%**
Putah	**0%**	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-84%)	**16.7%** (0-74%)	**8.3%** (0-54%)	**8.3%** (0-57%)	**0%**	**0%**	**0%**	**0%**
CVP/SWP Export Reduction	**0%**	**0%**	**0%**	**0%**	**0%**	**33.3%** (20-80%)	**33.3%** (20-80%)	**33.3%** (0-50%)	**0%**	**0%**	**0%**	**0%**
PWA Water Purchase Program	**0%**	**0%**	**0%**	**0%**	**0%**	**0%** (0-40%)	**50%[5]**	**50%[5]**	**0%** (0-40%)	**0%**	**0%**	**0%**
Permanent State Water Purchases	**0%**	**0%**	**0%**	**0%**	**0%** (0-40%)	**33.3%[4]**	**33.3%[4]**	**33.3%[4]**	**0%** (0-40%)	**0%**	**0%**	**0%**
Summary	**1%**	**<1%**	**<1%**	**<1%**	**1%**	**26%**	**32%**	**29%**	**3%**	**3%**	**3%**	**2%**

[1] Mokelumne year type determined as described in Section 2.7 based on D-1641 thresholds of projected unimpaired runoff. VA flow releases subject to offramp to protect cold water pool, described in Table 13, fn. 1.

[2] Flexibility Bracket for the March to May period is 70-90%.

[3] See Table 16 for Default Plan in off-ramp conditions.

[4] Flexibility Bracket for the March to May period is 60-100%.

[5] Flexibility Bracket for the April to May period is 60-100%.

Table 4: Default Plan and Flexibility Bracket for VA Flow Measures in a Dry water year. Bolded numbers represent the Default Plan and numbers in parentheses represent the Flexibility Bracket for any given year. Values are a proportion of the total flow contribution as stated in Table 1 (Appendix 1 of the MOU and all associated amendments). The summary row was calculated by multiplying each water source's water quantity contributions for the VA by the Default Plan proportion.

Source	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Friant	**0%**	**0%**	**0%**	**0%**	**0%**	**40%** (40-75%)	**30%** (25-30%)	**30%** (0-30%)	**0%**	**0%**	**0%**	**0%**
Sacramento	**5%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-50%)	**10%** (0-25%)	**15%** (0-25%)	**20%** (0-25%)	**20%** (0-25%)	**20%** (0-25%)	**10%** (0-25%)
Feather	**0%**	**0%**	**0%**	**0%**	**0%**	**33.3%** (20-40%)	**33.3%** (20-40%)	**33.3%** (20-40%)	**0%**	**0%**	**0%**	**0%**
Yuba	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)	**0%**	**0%**	**0%**
American	**0%**	**0%**	**0%**	**0%**	**0%**	**33.3%** (20-40%)	**33.3%** (20-40%)	**33.3%** (20-40%)	**0%**	**0%**	**0%**	**0%**
Mokelumne[1]	**25%** (10-30%)	**0%**	**0%**	**0%**	**0%**	**15%[2]**	**34%[2]**	**26%[2]**	**0%**	**0%**	**0%**	**0%**
Tuolumne[3]	**0%**	**0%**	**0%**	**2%**	**1%**	**60%[4]**	**19%[4]**	**16%[4]**	**2%** (2-37%)	**0%**	**0%**	**0%**
Putah	**0%**	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-84%)	**16.7%** (0-74%)	**8.3%** (0-54%)	**8.3%** (0-57%)	**0%**	**0%**	**0%**	**0%**
CVP/SWP Export Reduction	**0%**	**0%**	**0%**	**0%**	**0%**	**33.3%** (20-80%)	**33.3%** (20-80%)	**33.3%** (0-50%)	**0%**	**0%**	**0%**	**0%**
PWA Water Purchase Program	**0%**	**0%**	**0%**	**0%**	**0%**	**0%** (0-40%)	**50%[5]**	**50%[5]**	**0%** (0-40%)	**0%**	**0%**	**0%**
Permanent State Water Purchases	**0%**	**0%**	**0%**	**0%**	**0%** (0-40%)	**33.3%[6]**	**33.3%[6]**	**33.3%[6]**	**0%** (0-40%)	**0%**	**0%**	**0%**
Summary	**1%**	**<1%**	**<1%**	**<1%**	**<1%**	**23%**	**32%**	**33%**	**3%**	**3%**	**3%**	**1%**

[1] Mokelumne year type determined as described in Section 2.7 based on D-1641 thresholds of projected unimpaired runoff. VA flow releases subject to offramp to protect cold water pool, described in Table 13, fn. 1.

[2] Flexibility Bracket for the March to May period is 70-90%.

[3] See Table 16 for Default Plan in off-ramp conditions.

[4] Flexibility Bracket for the March to May period is 60-95%.

[5] Flexibility Bracket for the April to May period is 60-100%.

[6] Flexibility Bracket for the March to May period is 60-100%.

Table 5: Default Plan and Flexibility Bracket for VA Flow Measures in a Critical water year. Bolded numbers represent the Default Plan and numbers in parentheses represent the Flexibility Bracket for any given year. Values are a proportion of the total flow contribution as stated in Table 1 (Appendix 1 of the MOU and all associated amendments). Note that not all water sources are making contributions to VA Flow Measures in critical years – see Table 1 for details. The summary row was calculated by multiplying each water source's water quantity contributions for the VA by the Default Plan proportion.

Source	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Sacramento	**5%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-50%)	**10%** (0-25%)	**15%** (0-25%)	**20%** (0-25%)	**20%** (0-25%)	**20%** (0-25%)	**10%** (0-25%)
American	**0%**	**0%**	**0%**	**0%**	**0%**	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)	**0%**	**0%**	**0%**	**0%**
Tuolumne[1]	**0%**	**0%**	**0%**	**2%**	**2%**	**68%**[2]	**14%**[2]	**9%**[2]	**5%** (5-36%)	**0%**	**0%**	**0%**
Putah	**0%**	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-84%)	**16.7%** (0-74%)	**8.3%** (0-54%)	**8.3%** (0-57%)	**0%**	**0%**	**0%**	**0%**
PWA Water Purchase Program	**0%**	**0%**	**0%**	**0%**	**0%**	**0%** (0-40%)	**50%**[3]	**50%**[3]	**0%** (0-40%)	**0%**	**0%**	**0%**
Permanent State Water Purchases	**0%**	**0%**	**0%**	**0%**	**0%** (0-40%)	**33.3%**[4]	**33.3%**[4]	**33.3%**[4]	**0%** (0-40%)	**0%**	**0%**	**0%**
Summary	**<1%**	**1%**	**1%**	**1%**	**1%**	**44%**	**31%**	**19%**	**2%**	**<1%**	**<1%**	**<1%**

[1] See Table 16 for Default Plan in off-ramp conditions.
[2] Flexibility Bracket for the March to May period is 60-91%.
[3] Flexibility Bracket for the April to May period is 60-100%.
[4] Flexibility Bracket for the March to May period is 60-100%.

2.1.3 Systemwide Planning and Decision Making for VA Flow Measures

The Draft VA Governance Program (Appendix B to the Strategic Plan) describes the VA governance entities that will be engaged in planning and decision making related to Flow Measures, including a Systemwide Governance Committee and Tributary/Delta Governance Entities. Some Flow Measures are more flexible than others in terms of the degree to which their timing can be shaped by decisions or recommendations from the Systemwide Governance Committee. Note that Responsible Parties reserve final decision-making authority over the deployment of Flow Measures (subject to Implementing Agreements, Enforcement Agreements and applicable regulatory requirements). Table 6 summarizes which water sources have Flow Measures that may be possible to shape given a recommendation from the Systemwide Governance Committee. Sections 2.2 to 2.12 describe the governance and decision-making processes related to each water source.

Table 6: Summary of whether the Systemwide Governance Committee can make recommendations or decisions with respect to the VA Flow Measures for each water source.

Water Source	Can the Systemwide Governance Committee make recommendations or decisions with respect to the Flow Measures for this water source?
Friant	The flow is managed by a Restoration Administrator to achieve a specific Restoration Goal. It is uncertain if this Restoration Administrator can consider recommendations from the Systemwide Governance Committee.
Sacramento	Yes (recommendations), but there are many other regulations, constraints and considerations for this water source which will limit ability to implement recommendations.
Feather	Yes (recommendations), 50 TAF is under direct control of SWP and DWR can flexibly allocate that quantity of water over the March to May period based on recommendations from local system biologists and the VA Systemwide Governance Committee.
Yuba	Yes (recommendations) - The Yuba Water contribution can be flexibly allocated across April through June, including in response to recommendations from the Systemwide Governance Committee, at the discretion of Yuba Water and consistent with the Yuba River Development Project's regulatory and operational constraints.
American	Yes (recommendations) - the Systemwide Governance Committee can make recommendations within the March through May Flexibility Bracket. American River-specific tributary governance will consider the recommendations after assessing river conditions and integration of flows with the Modified Flow Management Standard.
Mokelumne	Yes (recommendations) – the Mokelumne governance entity for the VA is the Partnership established by a Joint Settlement Agreement. The Partnership will consider any recommendations from the Systemwide Governance Committee.
Tuolumne	Yes (recommendations) - The Tuolumne River Parties will consider recommendations from the Systemwide Governance Committee.
Putah	Yes (recommendations) – The flow to Lower Putah Creek is managed by the Solano County Water Agency. Monthly minimum and current seasonal pulse flow releases are governed by the Putah Creek Accord. The Systemwide Governance Committee can make recommendations within the Flexibility Brackets from November to May

Water Source	Can the Systemwide Governance Committee make recommendations or decisions with respect to the Flow Measures for this water source?
	subject to real-time conditions, and within the operational and systematic limitations discussed in Section 2.9 that are beyond the Agency's control.
CVP/SWP Export Reduction	Yes (recommendations) – The Systemwide Governance Committee may make recommendations to the Reclamation and DWR, however there is limited flexibility in the timing for this water source given the constraints that need to be met to ensure this is additional water.
PWA Water Purchase Program	Yes (decisions) – the Systemwide Governance Committee will make decisions related to timing of use and exercise of flexibility of the water made available by each water purchase within the program. These decisions will need to be made in coordination with the entities that are making the water available.
Permanent State Water Purchases	Yes (decisions) – the Systemwide Governance Committee will make decisions related to timing of use and exercise of flexibility of the water made available by each water purchase within the program. These decisions will need to be made in coordination with the State and will depend upon any constraints in how the water is being made available.

2.1.4 Flow Accounting

VA Flow Measures accounting involves confirming that the actions VA parties commit to take have in fact occurred. To assess this, evaluations may include evaluating the additional instream tributary flows, reservoir reoperations, and reductions in CVP/SWP Exports. Separately, the VA program will need to assess Delta inflows and outflows resulting from the combined VA Flow Measures, which may require actions from the State Water Board to protect flows made available. This section provides a narrative description of the flow accounting method describing how each VA water source contributes additional instream tributary flow or a reduction in CVP/SWP Exports.

This narrative description is the first step toward developing quantitative flow accounting methods that address VA accounting. The next step is to develop quantitative flow accounting methods to assess whether commitments for VA Flow Measures have been met and to evaluate how the combined VA Flow Measures contribute to both Delta inflow and outflow. Measuring the total additional contribution of VA Flow Measures to Delta inflow and outflow will require a modeling and monitoring approach. This integrated approach will consider the direct measurement of the additional flow contributions from tributaries, Delta operations, and water purchases, with the real-time hydrology conditions that occur within any particular year, and include other additional evaluation methods as appropriate (e.g., verification of fallowing actions). In coordination with the State Water Board, the VA Parties, Department of Water Resources, and US Bureau of Reclamation will develop accounting procedures to ensure that flows provided under the VAs are additional contributions, which are intended to result in increased Delta inflows and outflows. These procedures will be incorporated into the Implementation Agreements as appropriate, and will be subject to approval by the State Water Board.

The narrative description of flow accounting in Table 7 includes the following:

- Column 1: the source of water for the VA Flow Measure.
- Column 2: A description of the immediate action(s) taken to provide additional instream flows, which include (a) reservoir releases of flows in excess of what would otherwise be released, and (b) pumping and diversion rates below what would have otherwise been allowed.

- Column 3: The additional action(s) that are taken to make water available, such as through reducing consumptive uses or through reservoir releases or reductions in pumping/diversion. Water-source specific details are included in Table 7, but general definitions of these actions follow:
    - Fallowing: land is left unplanted (idled) that would have otherwise been planted, which avoids the need for irrigation from either groundwater or diversions from surface water. Surface water that would have typically been used to irrigate fallowed fields is released from upstream reservoirs to be protected as additional instream flows.
    - Groundwater substitution: forgoing the diversion of surface water supplies for consumptive use (irrigation, M&I) and instead relying on groundwater supplies (in compliance with applicable SGMA Basin Plans). Surface water that would have otherwise been used for consumptive use is released from upstream reservoirs to be protected as additional instream flows.
    - Reservoir reoperation: modifying the current/existing operations of upstream reservoirs to release additional instream flows during the January-June period that would be protected from other downstream diversions consistent with water right priorities.
    - Forgone exports: water that would otherwise be planned and allowed to be exported (consistent with other regulatory requirements and agreements) remains instream and protected from other downstream diversions.
- Column 4: a description of the reference operation and other conditions that Flow Measures are additive to, and against which the Flow Measures will be measured to demonstrate that they are in fact additional flows.
- Column 5: a description of the conceptual measurement approaches, including the station where flows are measured for each water source.

The descriptions in Table 7 rest on the following assumptions:

- The State Water Board, working together with the VA Parties, will use its legal authorities to protect all flows generated by the actions described in Table 7 against diversions for other purposes for the term of the Vas consistent with water right priorities.
- To ensure flows can be protected without redirecting impacts to other water users, the State Water Board will need to implement a mechanism to protect those flows consistent with water right priorities and in some cases, commitments or other agreements between water users resolving any impacts may be necessary and are not shown in the tabulations.

Table 7: Narrative description of VA flow accounting for each water source (quantitative flow accounting approach is under development)

Water Source	Immediate action(s) taken to provide additional instream flows	Additional action(s) taken to make water contributions available	Flow Measures will be additive to flows resulting from…	Conceptual Measurement Approaches
Sacramento River	Reclamation releases additional water into Sacramento River from Shasta Reservoir, which is paid back in arrears, in real time, or ahead of time based on the timing of the action	Fallowing & groundwater substitution, which results in reduced diversions based on a crop irrigation/ evapotranspiration schedule	Current Biological Opinions (2019) (which includes D-1641)	VA flows measured as increase in release measured at Keswick and would exclude those flows needed to meet Delta requirements. VA contribution measured using fallowing and groundwater substitution verification would follow the approach described in the Transfer White Paper, though future work will resolve differences between VA accounting and White Paper idling ET rates and groundwater substitution depletion factors.
Yuba River (YWA)	Yuba Water Agency releases additional water into Yuba River from New Bullards Bar Reservoir during Spring	Reservoir reoperation	Operations to comply with Yuba Accord required flows and end of September target storage in New Bullards Bar Reservoir	VA flows and contribution measured as an increase in Yuba flows measured at Marysville gauge, and end of September storage used to verify seasonal contribution.

Water Source	Immediate action(s) taken to provide additional instream flows	Additional action(s) taken to make water contributions available	Flow Measures will be additive to flows resulting from…	Conceptual Measurement Approaches
Feather River	DWR releases additional water into Feather River from Lake Oroville during Spring following with payback timing	• Fallowing & groundwater substitution through reduced diversions • Upstream Reservoir reoperation	Operative in-stream flow and Delta requirements (i.e., requirements in effect at the time of the operation)	VA deployment measured as increase in release at Oroville complex and would exclude those flows needed to meet Delta requirements. VA contribution measured using fallowing and groundwater substitution verification would preliminarily follow the Water Transfers White Paper framework. For reservoir reoperation, VA contribution measured at Ponderosa Dam where verification would preliminarily follow the approach described in the Water Transfer White Paper.
American River	Reclamation releases additional water into the Lower American River from Folsom Lake during Spring	Upstream reservoir reoperation	Operative in-stream flow and Delta requirements by Reclamation (i.e., requirements in effect at the time of the operation)	VA flows measured as increase in release at Folsom Reservoir outlets and would exclude those flows needed to meet Delta requirements.
	Reclamation releases additional water into the Lower American River from Folsom Lake during Spring	Groundwater substitution (using groundwater diversions instead of surface diversions, with accounting for groundwater/surface interaction)	Operative in-stream flow and Delta requirements by Reclamation (i.e., requirements in effect at the time of the operation)	VA flows measured as increase in release at Folsom Reservoir outlets and would exclude those flows needed to meet Delta requirements.

Water Source	Immediate action(s) taken to provide additional instream flows	Additional action(s) taken to make water contributions available	Flow Measures will be additive to flows resulting from…	Conceptual Measurement Approaches
Mokelumne River **See Section 2.7 for more detail.**	Operation of Camanche Dam to increase minimum releases into the Mokelumne River above existing minimum release requirements, by the volume equal to the VA target flow requirements (10/20/45 TAF in "Dry," "Below Normal" (BN), and "Normal and Above" (AN) years, as described in Section 2.7.3).	Contribute funding towards the purchase of water if modeled additional inflow to the Delta from the Mokelumne River is less than the minimum VA target flow commitment based on Sacramento River Index (Dry: 5 TAF; BN: 5 TAF; AN: 7 TAF).	Operation of Camanche Dam to meet existing minimum release requirements, including JSA, D-1641, and prior obligations.	VA flows measured as increased minimum volume of releases from Camanche Dam above releases needed to meet existing minimum instream requirements.
Putah Creek (SCWA)	SCWA releases additional water into Putah Creek from Lake Solano based on VA target flow requests.	Reservoir reoperation	Operations to comply with Putah Creek Accord	VA flows measured at the Putah Diversion Dam as flows above minimum instream requirements.
Delta Operations (SWP/CVP Forgone Exports)	Reduction in export of unstored flows during the spring	Forgone Exports at CVP & SWP facilities	Operative regulatory requirements (i.e., requirements in effect at the time of the operation) in the Delta	VA flows measured as a reduction in diversion at Jones Pumping Plant and Clifton Court Forebay.

Water Source	Immediate action(s) taken to provide additional instream flows	Additional action(s) taken to make water contributions available	Flow Measures will be additive to flows resulting from…	Conceptual Measurement Approaches
Tuolumne River	Operation of Don Pedro Reservoir to meet an increased in-stream flow requirement at the La Grange gauge. The VA in-stream flow schedule and pulse flow volumes are greater than the current in-stream flow schedule and pulse flow volumes (1995 FERC Settlement Agreement) by the volumes shown in the VA MOU (top row of table in Tuolumne section, labeled "Tuolumne River downstream of La Grange Dam").	Operation of Don Pedro Reservoir to make increased in-stream flow releases consistent with the Tuolumne VA.	Operation of Don Pedro Reservoir to meet the in-stream flow requirements at the La Grange gauge included in the 1995 FERC Settlement Agreement for the Don Pedro Project. This operation will be estimated so that it incorporates the hydrology experienced during the implementation of the Tuolumne VA and reflects operational decisions that would have been made while operating to the 1995 FERC Settlement Agreement.	Tuolumne VA compliance will be determined by confirming that the Tuolumne VA flow obligations are met at the La Grange gauge, accounting for diversion at the Infiltration Galleries (if any). Flow will be measured at the La Grange gauge and compared to an estimate of flow that would have occurred at the La Grange gauge if Don Pedro Reservoir were operated to meet the in-stream flow requirements of the 1995 FERC Settlement Agreement. This comparison will account for diversion at the Infiltration Galleries (if any).
Friant	Continued implementation of the San Joaquin River Restoration Program	Forgone recapture	San Joaquin River flows without releases from Friant Dam	Flows from Friant Dam as measured at downstream recapture locations

Water Source	Immediate action(s) taken to provide additional instream flows	Additional action(s) taken to make water contributions available	Flow Measures will be additive to flows resulting from…	Conceptual Measurement Approaches
Water Purchases	Varies based upon method of actions taken to make water available (primarily includes additional reservoir releases, and/or diversion reductions)	Through export/diversion reductions or upstream contributions (e.g., fallowing, reservoir reoperations, etc.)	Operative regulatory requirements (i.e., requirements in effect at the time of the operation)	For upstream releases, fallowing, or ground water substitution, VA contribution measured based on methods that follow the Transfer White Paper. For export reductions, see Delta Operations.

2.2 Friant Flow Measures

2.2.1 Default Plan and Flexibility Bracket

Table 8 presents the Default Plan and Flexibility Bracket for VA Flow Measures from the Friant water source. Note that the Default Plan may need further refinement based on additional modeling. The Default Plan presented here is based on cursory post-processing of DWR's CalSim 3 results to account for one iteration of potential San Joaquin River Restoration Flows, accounting for flexibilities provided to the Restoration Administrator.

Table 8: Timing of VA Flow Measures from the Friant water source. Bolded numbers represent the Default Plan for VA Flow Measures and numbers in parentheses represent the Flexibility Bracket for any given year. Friant does not have VA Flow Measures in wet and critical water years.

Water Year	Feb	Mar	Apr	May
Above Normal and Below Normal	**5%** (0-5%)	**20%** (15-30%)	**40%** (35-70%)	**35%** (0-35%)
Dry	**0%**	**40%** (40-75%)	**30%** (25-30%)	**30%** (0-30%)

The Default Plan for Friant's VA Flow Measures assumes that in all years, except for those determined to be Wet, Critical-High, and Critical-Low under the Stipulation of Settlement in NRDC, et al. v. Kirk Rodgers, et al. (San Joaquin River Restoration Settlement [Settlement]), that Reclamation will reduce the recapture of Restoration Flows 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 through May (Delta Outflow Goal). 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. All flows released below 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. It is understood and allowed that in some years there would not be sufficient Restoration Flows to meet the Delta Outflow Goal, and Reclamation would not be required to take other actions or make other releases of water.

2.2.2 Governance and decision-making for Friant VA Flow Measures

On the Friant, the Restoration Flow Guidelines describe the process to quantify, release, and monitor Restoration Flows to comply with the Settlement. The Unimpaired Runoff on the San Joaquin River at Friant Dam over the course of the Water Year (October through September) sets the allocation of water volume available to the Restoration Administrator and the default Restoration Flow releases for each Restoration Year (March through February). When Reclamation sets the Initial Restoration Allocation, the issuance will be accompanied by a Default Flow Schedule. The Default Flow Schedule is derived from the Settlement Exhibit B Base Flow Hydrographs adjusted for the precise Unimpaired Runoff. Default Flow Schedules prepared by Reclamation provide an initial daily distribution of the annual Restoration Allocation and a starting point for the Restoration Administrator to develop a specific flow schedule. An approved Restoration Administrator's Restoration Flow Schedule Recommendation supersedes any Default Flow Schedule for the purposes of scheduling and releasing Restoration Flows.

Reclamation will discuss forecasts and operations with the Restoration Administrator before issuance of a Restoration Allocation and Default Flow Schedule. Reclamation will indicate the likely allocation for planning purposes, whether a new allocation is warranted, discuss the forecasts being used to generate the allocation, discuss Unreleased Restoration Flow management, discuss channel conveyance capacity constraints, and provide updates to flow operations and flow accounting.

Restoration Administrator

The Restoration Administrator (RA) is an individual selected by the non-Federal Settling Parties to help administer and implement the Restoration Goal of the Settlement, including annual and seasonal development of Restoration Flow Recommendations. The Restoration Administrator makes recommendations to the Secretary concerning the manner in which the hydrographs shall be implemented and when the Buffer Flows are needed to help in meeting the Restoration Goal. The Restoration Administrator's general duties are set forth in Paragraphs 9 and Paragraphs 11 through 19 of the Settlement.

The Technical Advisory Committee (TAC) contains six members selected by the Friant Water Authority and the Natural Resources Defense Council that advise the Restoration Administrator regarding technical topic areas outlined in the Settlement Exhibit D, including information needed to inform Flow Recommendations. There are two State of California members of the TAC (DWR and DFW) and three Federal agency liaisons (Reclamation, NMFS, USFWS) to the RA and TAC to ensure coordination and information-sharing with the Implementing Agencies.

Restoration Flow Schedule

The Restoration Administrator will provide an initial flow recommendation to Reclamation by January 31 of each year following the receipt of Reclamation's initial Restoration Allocation and Default Flow Schedule. When Reclamation provides a subsequently updated allocation, the Restoration Administrator will provide an updated recommendation. In addition, the Restoration Administrator may submit a new Restoration Flow Schedule or revise an existing schedule at any time or Reclamation may request an updated recommendation to help manage operational issues or rapidly changing hydrologic conditions.

Reclamation will release the Restoration Flow Schedule at Friant Dam or otherwise make releases from Friant Dam to meet the Restoration Administrator's flow targets at Gravelly Ford, Friant Dam, or other specified locations. It is recognized that fluctuations in Holding Contract demand in Reach 1, and any channel losses for Restoration Flows, may necessitate that Reclamation adjust releases at Friant Dam in order to meet the recommended flow targets at Gravelly Ford and other specified locations. Reclamation will also coordinate with San Joaquin River facility operators downstream of Gravelly Ford to meet the Restoration Administrator's recommended flow targets at downstream locations.

Flexible Flow Provisions

The Settlement outlines specific flexibilities that are always available to the Restoration Administrator, including ability to:

- Flexibly schedule Restoration Flows within the Spring Flexible Flow Period and Fall Flexible Flow Period, so long as the total volume of flows during that period of the year is not changed. The volume of flows depicted in the Exhibit B Base Flow Hydrograph during the Spring Period (March 1– April 30) and Fall Period (October 1–November 30) may be shifted up to four weeks earlier or later. This includes shifting Spring Flows into the winter of the proceeding Restoration Year. Flushing Flows also fall within this flexibility. These Flexible Flow Periods are depicted in figure below.
- Schedule Buffer Flows needed to meet the Restoration Goal based on daily flow rates or within the flexible provisions.
- Release Riparian Recruitment Flows to promote the establishment of riparian vegetation at appropriate elevations in the channel.

The Settlement outlines additional flexibilities that are only available to the Restoration Administrator with a determination of no increase in water delivery reduction to Friant Division Long–term Contractors as compared to the hydrographs and provisions of Settlement Exhibit B. These include:

- Shifts within the summer or winter flow accounts pursuant to Exhibit B 4(d). The volume within the summer or winter flow period remains the same, but the distribution of that volume across the flow period is different on a monthly or daily basis as compared to the Default Flow Schedule. This is referred to as "shifting flows".
- Transfers between flow accounts pursuant to Exhibit B 4(d). This is referred to as "transferring flows."

Given all the uncertainties described above in the Restoration Flow Schedule compared to the Default Flow Schedule, the Flexibility Bracket in Table 8 represents the potential range of when Restoration Flows would be anticipated to contribute to the Delta.

2.3 Sacramento Flow Measures

2.3.1 Default Plan and Flexibility Bracket

Table 9 presents the Default Plan and Flexibility Bracket for VA Flow Measures from the Sacramento water source.

Table 9: Timing of VA Flow Measures from the Sacramento water source. Bolded numbers represent the Default Plan for VA Flow Measures and numbers in parentheses represent the Flexibility Bracket for any given year. Sacramento does not have VA Flow Measures in wet water years.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Above Normal[1]	**0%**	**0%**	**0%**	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**50%** (0-100%)	**50%** (0-100%)	**0%** (0-25%)	**0%**	**0%**	**0%**
Below Normal, Dry and Critical[2]	**5%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-25%)	**0%** (0-50%)	**10%** (0-25%)	**15%** (0-25%)	**20%** (0-25%)	**20%** (0-25%)	**20%** (0-25%)	**10%** (0-25%)

[1] VA parties agree that the Sacramento River flow contribution of 100 TAF will be provided during the January through June period, except when it is recommended through the VA governance process that shifting the timing of a portion of this contribution would be in the best interest of the fishery. Recommendations by the VA governance process require approval from at least 2 of the following agencies: National Marine Fisheries Service, California Department of Fish and Wildlife, and the State Water Board. A process will need to be developed which describes this decision-making process for each of the three agencies as well as a summary of why one of the agencies chose not to approve the action.

[2] Assumes an April-October fallowing pattern. For November – February, assumes water from the action year would be held in storage to be used in the fall or into the winter, assuming Reclamation approves the extension of the VA water into the next water year and operations. For March, assumes a dry year pulse in March.

The Sacramento River Settlement Contractors (SRSC), water right holders on the Sacramento River that precede the Central Valley Project who also have a Settlement Contract with the Bureau of Reclamation, will contribute 100,000 acre-feet in Dry, Below Normal, and Above Normal years through annual land fallowing and up to 20% groundwater substitution pumping. This water would be available to the system under a land idling monthly allocation from April through October as shown in Table 9.

During initial VA discussions with DWR and CDFW, State representatives requested that SRSC make supply available in a Spring Pulse focused in April-May to benefit delta outflow and in river spring run salmon outmigration. As the SWRCB developed its Phase II UIF, subsequent to the VA conversations, it directed flows be made available from January through June. The Default Plan shown in Table 9 is to focus supply in April and May for Above Normal water years. In Below Normal and Dry water years, it is anticipated that supply will be spread between the months of April to October to provide benefits in the season that provides the most benefits for fish (as explained more below).

2.3.2 Governance and decision-making for Sacramento VA Flow Measures

Water provided by the SRSC will require the reoperation of Shasta Reservoir, which is owned and operated by the Bureau of Reclamation. This reoperation will involve the following actions and order:

1. A water year designation needs to be determined, if Dry, Below Normal, or Above Normal, the SRSC would implement actions to make water available, or would take actions to reduce demand by 100,000 AF.
2. VA governance entities (Sacramento River Governance and Systemwide Governance Committee) would decide on a recommended Spring Action based on the framework in the Strategic Plan. An evaluation of Shasta Cold Water Pool would be completed to ensure any spring action would not impact Winter Run salmon cold water temperature requirements that align with the applicable Biological Opinions and State Water Board water right requirements.
3. Recommendations by the VA governance entities require approval from at least 2 of the following agencies: National Marine Fisheries Service, California Department of Fish and Wildlife, and the State Water Board.
4. If a spring pulse is not possible (for example, because of winter-run salmon cold water temperature requirements) or needed, the VA governance entities would discuss other options for the block of water made available subject to Reclamation approval, which could include:
    a. Making the water available instream per the fallowing schedule
    b. Holding the water in storage in Shasta Reservoir until the fall to help meet fall flow and temperature requirements for fall-run salmon
    c. Carrying the water over into the next water year for a spring action while ensuring decision making is clear and accounting is done through an approved methodology (subject to any additional necessary regulatory approvals still under development).

For the options listed above, if any option falls outside of the Flexibility Bracket as defined in Table 9, the VA Parties providing Flow Measures for the Sacramento water source would seek prior approval from the State Water Board to make these adjustments.

For science informing governance, the Sacramento River Science Partnership can be used to develop a science and monitoring plan to inform the Strategic Plan and decision making.

Currently, the Sacramento River Temperature Task Group (SRTTG) provides feedback to Reclamation as it relates to Shasta cold water pool operations and winter-run salmon actions. Since the Sacramento River VA actions are more extensive and multi-species, a new governance structure will need to be formed from the VA parties focused on Sacramento River mainstem operations, actions, projects, and monitoring. The role and participants of the SRTTG may need to be adjusted to meet the VA, Biological Opinion and Temperature Management Planning processes.

2.4 Feather Flow Measures

2.4.1 Default Plan and Flexibility Bracket

Table 10 presents the Default Plan and Flexibility Bracket for VA Flow Measures from the Feather River.

Table 10. Timing of VA Flow Measures from the Feather water source. Bolded numbers represent the Default Plan for VA Flow Measures and numbers in parentheses represent the Flexibility Bracket for any given year. The Feather River does not have VA Flow Measures in wet and critical water years.

Water Year	Mar	Apr	May
Above Normal and Below Normal	**75%** (50-90%)	**25%** (10-50%)	**0%**
Dry	**33.3%** (20-40%)	**33.3%** (20-40%)	**33.3%** (20-40%)

The Feather will contribute 60,000 acre-feet in Dry, Below Normal, and Above Normal years between March and May, depending on water year type and with the monthly breakdown shown in Table 10. A pulse flow for two to three weeks in March and/or April will likely increase survival of emigrating juvenile salmonids by providing increased cover from predators, reduced pathogen transmission, faster migration speed, and increased rearing habitat. Specifically:

- By March/April, most juveniles will be rearing lower in the Feather River or in the Delta. Targeting March allows juveniles rearing or migrating at any location in the watershed (upper Feather River or Delta) the opportunity to benefit from increased flows.
- A March/April pulse flow is late enough to benefit nearly all recently emerged juvenile salmonids (spring-run and fall-run) while not waiting too long in their life cycle to provide the expected survival benefit (i.e., smaller, actively moving juveniles are most vulnerable).
- A March/April pulse could also correspond well with natural runoff events in the lower Feather River (e.g., Yuba River or Bear River) or the lower Sacramento River, heightening the potential value of an action due to increased turbidity or flow.
- In March/April, the first half of juvenile spring-run are released from the Feather River Fish Hatchery, so improved survival of this group would be expected.
- By stimulating or accelerating movement in March/April juveniles may emigrate through the lower Feather River before Striped Bass (*Morone saxatilis)* enter the system in large numbers, reducing the effect of predation.
- March/April is a key time for pathogen transmission in the lower Feather River. Utilizing a pulse flow would dilute pathogens and speed migration through pathogen dense portions of the river.
- Depending on timing of adult migration, a March/April pulse could improve adult passage over Sunset Pumps.

Dry year types would see a shift in focus to maintaining suitable habitat conditions and emigration period conditions by increasing flows over several weeks. Specifically:

- In dry years having the flexibility between March, April, and May to distribute water over several weeks or months (when flows are predicted to be lowest) to maintain basic habitat conditions (rearing habitat, ideal temperatures, etc.) could be critical for juvenile salmonid survival as they emigrate and rear in the lower Feather River.

- Maintaining slightly higher flows over Sunset Pumps would facilitate upstream passage of spring-run Chinook adults into the upper Feather River where conditions are most suitable.
- Even small increases spread out over many days between March and April would likely benefit both releases of juvenile spring-run Chinook from the Feather River Fish Hatchery (into the lower Feather River) by providing better rearing habitat, faster migration speeds, and reduced pathogen transmission.
- A March/April increase could also correspond well with natural runoff events in the lower Feather River (e.g., Yuba River or Bear River) or the lower Sacramento River, heightening the potential value of an action due to increased turbidity or flow.

2.4.2 Governance and decision-making for Feather VA Flow Measures

50,000 acre-feet of the total contribution of 60,000 is under the direct control of the SWP. As such, DWR is in the position to flexibly allocate that quantity of water over the March to May period, based on recommendations from local system biologists and the VA Systemwide Governance Committee.

2.5 Yuba Flow Measures

2.5.1 Default Plan and Flexibility Bracket

Table 11 presents the Default Plan and Flexibility Bracket for VA Flow Measures from the Yuba water source.

Table 11: Timing of VA Flow Measures from the Yuba water source. Bolded numbers represent the Default Plan for VA Flow Measures and numbers in parentheses represent the Flexibility Bracket for any given year. Yuba does not have VA Flow Measures in wet and critical water years.

Water Year	Apr	May	Jun
Above Normal and Below Normal	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)
Dry	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)

Yuba Water Agency's contribution, through measures described in Yuba Water's Implementing Agreement, will provide up to 50,000 acre-feet per year during Above Normal, Below Normal and Dry water years, as measured at the Marysville Gage. These flows will be available April through June.

2.5.2 Governance and decision-making for Yuba VA Flow Measures

The Yuba Water contribution can be flexibly allocated across April through June, including in response to recommendations from the Systemwide Governance Committee, at the discretion of Yuba Water and consistent with the Yuba River Development Project's regulatory and operational constraints.

When planning releases of the Yuba Water VA contribution, Yuba Water Agency will seek input from the Department of Fish and Wildlife on local and Delta conditions. The Yuba Water VA contribution will then be managed using the Yuba Accord's existing framework for coordination of operations with the Department of Water Resources and the Bureau of Reclamation.

In some years the flexibility shown in the table may be available (i.e., 33-66% in April, 33-66% in May, and 0-33% in June), while in other years the flexibility may be significantly limited by the Yuba River Development Project's regulatory and operational constraints.

2.6 American Flow Measures

2.6.1 Default Plan and Flexibility Bracket

Table 12 presents the Default Plan and Flexibility Bracket for VA Flow Measures from the American water source.

Table 12: Timing of VA Flow Measures from the American water source. Bolded numbers represent the Default Plan for VA Flow Measures and numbers in parentheses represent the Flexibility Bracket for any given year. The American does not have VA Flow Measures in wet years.

Water Year	Mar	Apr	May
Above Normal and Below Normal	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)
Dry	**33.3%** (20-40%)	**33.3%** (20-40%)	**33.3%** (20-40%)
Critical	**50%** (33-66%)	**50%** (33-66%)	**0%** (0-33%)

The Default Plan for the American water source is to deploy water in March through May in three out of eight years of the VA in above normal, below normal, dry, and critical years. In critical years, a concentrated pulse is biologically beneficial for juvenile outmigration, focusing on the months of March and April. For dry years, spreading VA contributions evenly over the months of March, April, and May are the most biologically beneficial. For above normal and below normal years, spreading VA contributions through the months of March and April are preferable. Reclamation would make these flows available from Folsom Reservoir and water providers in the American River region would back these flows up later in the year either through groundwater substitution above the Folsom outlets or downstream, or through releases from upstream storage. Flow pulses for the VA would potentially compliment flows made consistent with the Modified Flow Management Standard (MFMS), which provides protections for redd dewatering via a minimum release requirement. Additionally, VA flows could compliment the MFMS's spring pulse flows from March 15 to April 15 to help provide an emigration cue before lower flow conditions and thermal warming later in the spring.

The Default Plan and Flexibility Bracket provided here are consistent with science gathered on the American River and knowledge of suitable flow for outmigrating fish.

In dry and critical years, there may be advantages to fish in shifting the deployment of VA Flow Measures from Spring to other seasons, such as:

- Hold water in Folsom for cold water pool formation and maintenance and deploy water in fall for adult migration; or,
- Hold water in Folsom through the following winter for temperature control. Keeping water in the reservoir over the winter will build a larger pool of cold water for the spring and following summer, particularly if there are consecutive dry years.

Any deployment of VA Flow Measures outside of the Flexibility Bracket defined in Table 12 would be subject to State Water Board approval and would be considered on a case-by-case basis in coordination with the Operations Review Group (ORG, membership provided below) and in consideration of flows made through the MFMS. Deployment of VA Flow Measures outside of the Flexibility Bracket is applicable for groundwater substitution.

2.6.2 Governance and decision-making for American VA Flow Measures

Any releases of VA contributions from the American River would require the reoperation of Folsom Reservoir, which is owned and operated by the Bureau of Reclamation. The American River VA Parties, the Sacramento Water Forum, and Reclamation, through the ORG, will convene by February 1 of each year to review potential operational scenarios and water year types for the water year. An evaluation will occur, and a determination will be made whether releases will be made for VA contributions and whether the current year provides appropriate conditions to release water from Folsom Reservoir for the American River's flow contributions from upstream surface storage and/or groundwater substitution.

Reclamation would begin releasing VA contributions from Folsom as early as March 1 of a designated VA outflow year according to the schedule provided below, with replenishment[2] to occur after reservoir releases. For the Default Plan, Reclamation would release flows on the following schedule:

- **In Above Normal, Below Normal years:** 5 TAF released in March and 5 TAF released in April. These releases will be replenished from upstream storage.
- **In Dry years:** 10 TAF released in March, 10 TAF released in April, and 10 TAF in May. These releases will be replenished from groundwater substitution.
- **In Dry years:** An additional 3.3 TAF released in March, 3.3 TAF released in April, and 3.3 TAF in May. These releases will be replenished from upstream storage, groundwater substitution, or a combination of sources. If a D year is predicted by the ORG, a determination of the source of replenishment water will be determined by February 28 of the VA outflow year.
- **In Critical years:** 15 TAF released in March and 15 TAF released in April. These releases will be replenished from groundwater substitution.

The American River will also continue to be managed according to the MFMS, which is reflected in the 2019 Biological Opinions, and through a Memorandum of Understanding between the Sacramento Water Forum and Reclamation. The MFMS and VA for the American River will be treated as complimentary actions and will require local watershed-specific governance, with ongoing systemwide governance coordination.

2.7 Mokelumne Flow Measures

2.7.1 Default Plan and Flexibility Bracket

The Default Plan and Flexibility Bracket for VA Flow Measures from the Mokelumne water source are presented in Table 13 and Table 14, respectively. The numbers in Table 13 and Table 14 represent percent of the annual block of flow released from Camanche Dam in a given month or season. The Default Plan values are based on modeling completed for the Mokelumne River proposal and they are not operating criteria. Actual operations will be determined by the tributary governance in conformance with the seasonal Flexibility Bracket.

Mokelumne VA flow assets are available in three Water Year types ("Dry", "Below Normal", and "Normal and Above"). These Water Year types are specific to the Mokelumne River and have been used since the 1990s to make minimum flow release decisions on the tributary. For purposes of implementing the VA flow requirement, the tributary governance body will determine the Water Year type in the manner set forth in Section 2.7.2 below. In years when there is a year-type mismatch between the Sacramento River

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[2] Replenishment is the water made available by American River Parties, either through upstream surface storage releases or groundwater substitution, to fill the VA volumes released by Reclamation out of Folsom Reservoir.

Index and the Mokelumne-specific year type, the Mokelumne-specific year type is controlling for Mokelumne VA flow assets.

Table 13: Default Plan for timing of VA Flow Measures from the Mokelumne water source[1]. Year types are based on Mokelumne-specific index. Mokelumne does not have VA Flow Measures in water years designated "Critically Dry" under the Mokelumne-specific index.

Mokelumne-specific Water Year Type	Oct	Mar	Apr	May
Normal & Above	**13%**	**8%**	**43%**	**36%**
Below Normal	**26%**	**17%**	**32%**	**25%**
Dry	**25%**	**15%**	**34%**	**26%**

[1] 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.

Table 14. Flexibility Bracket for VA Flow Measures from the Mokelumne water source. Year types are based on Mokelumne-specific index. Mokelumne does not have VA Flow Measures in water years designated "Critically Dry" under the Mokelumne-specific index.

Mokelumne-specific Water Year Type	Oct	Mar to May
Normal & Above	10-30%	70-90%
Below Normal	10-30%	70-90%
Dry	10-30%	70-90%

The Mokelumne proposal for VA Flow Measures was developed to provide biologically beneficial flow regimes below Camanche Dam based on ambient conditions and when those flows are most beneficial to Mokelumne River fisheries. The proposal contains an offramp (Table 13, footnote 1) which applies when combined Pardee and Camanche storage is projected to be below a certain threshold. The purpose of the offramp is to minimize water temperature impacts and preserve cold water resources and achieve downstream temperatures to support the doubling goal of salmonid populations. The proposal provides no assurances that any flow will be released in any one month, but it assures the entirety of the obligated block flow (except in off ramp years) will be released during the designated water year. The Mokelumne River Proposal anticipates 70-90% of full annual volume released in the March-May period and 10-30% in October as reflected by the Flexibility Brackets stated in Table 14.

2.7.2 Governance and decision-making for Mokelumne VA Flow Measures

Tributary governance decisions which concern pre-existing flow obligations on the Mokelumne River are made by the Partnership established by the Lower Mokelumne River Joint Settlement Agreement (JSA). The Partnership will also provide tributary governance with respect to Mokelumne VA flow release obligations. The Partnership's VA-related governance obligations will include (1) making a Mokelumne VA year type determination in the manner described in this section, which will govern Mokelumne River VA flow obligations for each given water year, and (2) making decisions regarding the timing of Mokelumne River flow assets based on considerations described below and consistent with VA agreements.

Mokelumne VA Year Type Determination

For many years, Mokelumne River governance has been based on a tributary-specific year-type index developed for the JSA and incorporated into it. Attachment 1 of the JSA defines four year types: “Normal & Above”, “Below Normal”, “Dry”, and “Critically Dry”. The JSA imposes minimum release obligations in each year type. The year-types are determined based on Mokelumne-specific indicators as stated in JSA Attachment 1. Therefore, in any given year, the Mokelumne year-type may differ from the “equivalent” year-type of other year-typing systems like the Sacramento River Index. In general, for purposes of the JSA, year types are determined by a combination of projected storage and projected runoff indicators. The State Water Board incorporated the Mokelumne JSA year-type index and its associated thresholds into D-1641 (p.175). The year-type methodology described in those documents will continue to be used for the purpose of determining the JSA’s applicable flow obligations.

To determine the applicable VA flow obligations, the Mokelumne VA proposes to employ a slightly modified version of the year-type methodology described in the JSA and D-1641. The modified JSA year types and their application to determining the VA release requirement at a given time *w*ill be fully described in the Mokelumne River Implementation Agreement. In general, for VA purposes, Mokelumne year-type would be determined based on projected unimpaired runoff using the runoff thresholds specified in the JSA and D-1641, without regard to projected storage, as shown in Table 15.

Table 15: Mokelumne VA Year Types and Thresholds

Mokelumne VA Year Type	Normal & Above	Below Normal	Dry
Unimpaired runoff	890 TAF or More	889 TAF to 500 TAF	499 TAF to 300 TAF

In order to protect cold water pool, EBMUD will not be obligated to release water above existing release requirements 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, but in those circumstances the JSA/D-1641 required flows would continue to be provided. The Partnership would make an initial Mokelumne VA year-type determination each year before March based on available runoff projections. Following the release of DWR Bulletin 120, which typically occurs in April, the Partnership would update the Mokelumne River year-type designation based on the Bulletin’s unimpaired runoff projection, and that final designation would govern Mokelumne VA release obligations through October.

Flow Asset Decision-making

To meet the potential desire to release flows in March, the JSA Partnership Coordinating Committee (PCC) has a proposed schedule of decision making as follows:

- By mid-February each year, the JSA PCC will design and develop a daily flow schedule for the Spring Block flow to apply in the months of March through May based on EBMUD’s most recent median projection of Mokelumne Watershed unimpaired runoff for the Water Year.
- By mid-June each year, the JSA PCC will design and develop a daily flow schedule for the Fall Block flow to apply in September and October based on EBMUD’s most recent median projection of Mokelumne Watershed unimpaired runoff for the Water Year.
- The block flow will be distributed on a daily schedule, subject to ramping rates in place and approved by the JSA PCC. It is anticipated that contingency plans may also be included with the flow schedule, subject to periodic adjustments in median projections, to provide guidance on revising and/or adapting the schedule based on a change in conditions.

- If flood control releases on a given day are greater than the daily schedule of proposed VA releases provided by the JSA PCC, then no additional VA release is required on that day, as the portion of the flood releases that is equivalent to the proposed VA release will be credited as meeting the VA release obligation.
- Controlled releases are capped at 2,000 cubic feet per second (CFS) to protect downstream landowners.

Each year's flexibility will be based on real-time conditions, and decision making by the local tributary governance for the Mokelumne River (the Partnership) established by the Joint Settlement Agreement within the following boundary guidelines:

- The flow proposal is for up to 90% of committed Camanche Release flows to occur in the March-May period.
- The remaining flow after establishing releases in the March-May period to occur in October, not to exceed 30% of the annual releases.
- The Partnership considers a number of parameters annually to determine the correct distribution of flows to allow for optimizing fisheries benefit. Those parameters include, but are not limited to:
    - Delta entry timing of adult chinook for timing of fall attraction pulses,
    - Coordination with Reclamation on Delta Cross Channel operations to improve attraction pulse effectiveness;
    - Redd emergence timing so that floodplain benefits will be available for when most juvenile salmonids are able to use them;
    - Water year type (the dry year contribution is not intended to fill floodplains to beneficial growth criteria and so spring water would be used to encourage juvenile outmigration or introduce food into the main channel– likely in May); and
    - Ambient air and water temperatures (not attracting adults upstream when temperatures are limiting or not inundating floodplain when water temperatures are too low to produce good growth inducing opportunities).

Due to these variable parameters, March will generally get very little if any of the spring flows based on ambient and river water temperatures not supporting floodplain growth opportunities and may only see floodplain inundation in warmer climatological years where growth would be supported. In dry years, spring flow may only be in May to implement an outmigration peak pulse to move fish out of the system before temperatures become critical, or to provide instream food delivery. The fall flows will be released in October, based on salmon migration timing, Delta Cross Channel coordination, and ambient conditions.

The Partnership will review and consider any requests from the Systemwide Governance Committee but retain final decision-making authority on Mokelumne VA flow asset release schedules.

2.7.3 Additional Details on Flow Accounting for Mokelumne VA Flow Measures

The Mokelumne River VA flow assets are a volume of minimum Mokelumne flows to be released by EBMUD from Camanche Dam in excess of the volume of water that EBMUD is presently obligated to release from Camanche Dam to meet existing release requirements. Existing release requirements are comprised of (1) releases needed to satisfy demands of senior downstream water users and (2) releases required to meet instream flow requirements imposed by the *1998* Lower Mokelumne River Joint

Settlement Agreement (JSA).[3] The State Water Board incorporated the minimum release requirements of the JSA into D-1641 and thereby also into EBMUD's applicable water rights.

EBMUD would operate to provide VA releases from Camanche Dam, above existing minimum release flow requirements, of 10 thousand acre-feet (TAF), 20 TAF, and 45 TAF in "Dry," "Below Normal" (BN), and "Normal and Above" (AN) modified Joint Settlement Agreement (JSA) year types, respectively. The VA flow assets will be provided in two ways: (1) reservoir reoperation as needed to ensure a sufficient volume of releases above existing release requirements are provided to meet the VA obligation on the schedule required by the VA, and (2) if and to the extent necessary, also from forgoing diversions to storage or direct diversion EBMUD could otherwise lawfully make under its water rights.

EBMUD will work with DWR to refine modeling used to develop the modeled average long-term contributions of VA flows as inflow to the Delta from the Mokelumne River based on Sacramento River Index year type. If the modeling indicates the long-term average contribution will not meet an agreed quantity in any of three Sacramento River Index year types (specifically: Dry: 5 TAF; BN: 5 TAF; AN: 7 TAF), then EBMUD would contribute funding towards the purchase of the remaining volume difference when that Sacramento River Index year type occurs during the 8-year term of the agreement at an agreed price (or pricing method) to be specified in the VA. EBMUD could also receive credit toward backstop payments in years where modeled long term averages result in flows greater than zero during critical Sacramento River Index year types, or result in flows greater than 5 TAF in dry Sacramento River Index year types.

The Mokelumne River Governance Program will consider deployment requests made by the Systemwide Governance Committee and, when feasible, accommodate reasonable requests within real-time systematic constraints or emergency conditions. EBMUD will account aggregate VA flow contributions on a water year basis; any VA water that is not used during each water year will not carry-over to the following year.

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[3] These two components of existing release requirements are not necessarily additive in all circumstances. Under certain circumstances, a given amount of flow may properly be accounted for as simultaneously satisfying JSA minimum instream flow requirements and the rights of downstream water users.

2.8 Tuolumne Flow Measures

2.8.1 Default Plan and Flexibility Bracket

The Default Plan and Flexibility Bracket for VA Flow Measures from the Tuolumne water source are presented in Table 16 and Table 17, respectively.

Table 16: Default Plan for timing of VA Flow Measures from the Tuolumne water source. VA flows are new and additive flows.

Water Year	Jan	Feb	Mar	Apr	May	Jun
Wet	**0%**	**0%**	**63%**	**18%**	**19%**	**0%**
Above Normal	**0%**	**0%**	**63%**	**18%**	**19%**	**0%**
Below Normal	**0%**	**0%**	**77%**	**11%**	**12%**	**0%**
Below Normal with off-ramp	**0%**	**0%**	**70%**	**14%**	**16%**	**0%**
Dry	**2%**	**1%**	**60%**	**19%**	**16%**	**2%**
Dry with off-ramp	**5%**	**5%**	**35%**	**28%**	**20%**	**7%**
Critical	**2%**	**2%**	**68%**	**14%**	**9%**	**5%**
Critical with off-ramp	**7%**	**7%**	**63%**	**2%**	**0%**	**21%**

Table 17. Flexibility Bracket for timing of VA Flow Measures from the Tuolumne water source. VA flows are new and additive flows.

Water Year	Jan	Feb	Mar to May	Jun
Wet	**0%**	**0%**	**60% to 100%**	**0% to 40%**
Above Normal	**0%**	**0%**	**60% to 100%**	**0% to 40%**
Below Normal	**0%**	**0%**	**60% to 100%**	**0% to 40%**
Below Normal with off-ramp	**0%**	**0%**	**60% to 100%**	**0% to 40%**
Dry	**2%**	**1%**	**60% to 95%**	**2% to 37%**
Dry with off-ramp	**5%**	**5%**	**60% to 83%**	**7% to 30%**
Critical	**2%**	**2%**	**60% to 91%**	**5% to 36%**
Critical with off-ramp	**7%**	**7%**	**60% to 65%**	**21% to 26%**

Timing of VA flow measures from the Tuolumne River

The Tuolumne River VA instream flow requirement includes base flows that are set according to water year type and calendar date, and it also includes two pulse volumes for which the timing is somewhat variable within the March-June period. The tables above only pertain to the additive volume committed to in the Tuolumne VA. These additive flows are above current FERC 1995 requirements which include minimum daily flows in all months in all water year types. In the default schedule presented here, it is assumed that one pulse volume is released in March, and the second is released in April and May. In the flexibility ranges presented here in brackets, it is assumed that the March pulse volume can be released in any month from March through June, and it is also assumed that the April-May pulse volume could be released entirely in April, entirely in May, or could be released across both April and May. However, at least 60% of the additive flow will be released March through May. The biological basis for the flow flexibility is provided below.

Biological rationale: pulse flows and flexibility

There are two pulse flow volumes included in the Tuolumne VA: (1) floodplain inundation pulse, and (2) spring outmigration pulse.

1. Floodplain pulse
    - To maximize the benefit of the floodplain rearing pulse flow, each year's pulse will be timed with Chinook salmon rearing timing, which shall be determined via monitoring. Default timing will be March, but year-to-year decisions on timing will be determined 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.

2. Spring outmigration pulse
    - 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.

2.8.2 Governance and decision-making for Tuolumne VA Flow Measures

The Tuolumne River Parties (Modesto Irrigation District, Turlock Irrigation District, and San Francisco Public Utilities Commission) may flexibly allocate the flow contribution across January through June as provided by the Flexibility Brackets in the table above, including in response to recommendations from the Systemwide Governance Committee, real-time conditions on the Lower Tuolumne River, and consistent with regulatory and operational constraints. Additionally, the Tuolumne River Parties may allocate some or all of the flexible volumes of water outside of the January through June period as recommended by the Systemwide Governance Committee and approved by the State Water Board subject to real-time conditions on the Lower Tuolumne River and consistent with regulatory and operational constraints.

2.9 Putah Flow Measures

2.9.1 Default Plan and Flexibility Bracket

Table 18 presents the Default Plan and Flexibility Bracket for VA Flow Measures from the Putah water source.

Table 18: Timing of VA Flow Measures from the Putah water source. Bolded numbers represent the Default Plan for VA Flow Measures and numbers in parentheses represent the Flexibility Bracket for any given year. Putah does not have VA Flow Measures in wet water years.

Water Year	Nov	Dec	Jan	Feb	Mar	Apr	May
Above Normal, Below Normal	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-84%)	**16.7%** (0-74%)	**8.3%** (0-54%)	**8.3%** (0-57%)

Water Year	Nov	Dec	Jan	Feb	Mar	Apr	May
Dry & Critical	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-75%)	**16.7%** (0-84%)	**16.7%** (0-74%)	**8.3%** (0-54%)	**8.3%** (0-57%)

Hydrology

The Putah Creek watershed has a unique hydrology compared to most other Sacramento valley streams. Lake Berryessa is purely a rainfall fed reservoir, snow melt is negligible. The watershed lies under a corridor that channels frequent atmospheric river events over it, these conditions commonly occur in most years even when most of the state is experiencing "dry" conditions. Over the last decade, dry conditions have become more prevalent during the late fall/early winters (NOV-JAN) period. The late winter/early spring (JAN-MAR) is typically the most productive run-off period.

Operations

Monticello Dam (MD) impounds Putah Creek to form Lake Berryessa. Lake Berryessa does not have active flood management responsibilities or capabilities and only two relatively small controlled release point, a hollow jets valve and power house. The maximum controlled flow release from MD is less than 1,000 cfs. The Lake has a "Glory Hole" spillway that passively manages the lake level to prevent overtopping the MD. Regulated water released from the MD is re-impounded at the Putah Diversion Dam (PDD), a low-head check dam located 7 miles downstream to form Lake Solano, a small shallow regulating pool to check-up the water elevation for diversion to the Putah South Canal. This 7-mile reach is known as the Inter-dam Reach (IDR). There are five unregulated tributaries to the IDR and two downstream of the PDD. Minimum releases to Lower Putah Creek (LPC), downstream of PDD, are made through a venturi valve. The venturi provides fine tuning of releases and is accurately measured up to 100 cfs for most compliance needs. Lake Solano has very little storage capacity, so the PDD is operated to pass all unregulated flood water downstream to lower Putah Creek (LPC) through a series of twelve sluice gates where flow measurement is considerably less accurate.

The unregulated tributaries produce flows during most rainfall events. The rainfall-runoff response is flashy with considerable flow that typically lasts days to a couple weeks depending on the cadence of subsequent rain events. Once Lake Berryessa is filled the spillway can provide sustained flood flow for weeks to months depending on the hydrologic conditions. Flow releases for VA are not practical when the PDD is operating to pass unregulated flood water, or the Yolo Bypass is operating to pass unregulated flood flow from the Sacramento River. During periods of sustained flood flow the flexibility to VA release could be zero for the month.

Following the default implementation plan schedule, the annual voluntary volume translated to daily average operational releases are:

- 6 TAF: 100 cfs/d (30-Days); 17 CFS/d (NOV-MAR), 9 cfs/d (APR-MAY)
- 7 TAF: 117 cfs/d (30-Days); 20 CFS/d (NOV-MAR), 10 cfs/d (APR-MAY)

This range of flows are within the operating range of the venturi valve. The implementation can be satisfied by releasing 100 cfs for 30 days or spread out across the months in accordance with the Default Plan.

Instream Flow Requirements

Instream flow releases to LPC downstream of the PDD are governed by a local settlement agreement, the Lower Putah Creek Flow Accord (Putah Creek Accord or "Accord"). There is a minimum release schedule from PDD and a downstream compliance point at the Interstate 80 crossing (I-80). The Accord also has two pulse flow provisions: 1) a fall pulse flow for salmon spawning attraction, and 2) a spring pulse flow for trout spawning and salmon outmigration. Table 19 is a simplified summary of relevant Accord provisions.

Table 19. Instream Flow Requirements for Putah Creek Accord.

-	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Minimum Diversion Dam Release: "Normal" Year	20	25	25	25	16	26[a]	46	43	43	43	34	20
Minimum Diversion Dam Release: "Dry" Year[b]	15	25	25	25	16	26	46	33	33	33	26	15
Downstream Compliance Station (I-80): "Normal" Year	5	19[c]	19	19	19	25	50[d]	20	15	15	10	5
Downstream Compliance Station (I-80): "Dry" Year	2	2	2	2	2	2	2	2	2	2	2	2

[a] Sometime between February 15 and March 31, the following Diversion Dam three-day pulse release must be made: 150 cfs for the first 24 hours, 100 cfs for the second 24 hours, and 80 cfs for the third 24 hours. Immediately following this three-day release, must maintain a minimum flow of 50 cfs at I-80 bridge for the next 30 days (see "d" below)

[b] For the purposes of the Putah Creek Accord, a "dry year" release schedule is triggered when the total storage in Lake Berryessa is less than 750,000 acre-feet on April 1. "Normal-year" releases will be reinstated in the event that total Lake storage equals or exceeds 750,000 acre-feet prior to the following April 1. Additional rules apply when consecutive dry years occur.

[c] Between November 15 and December 15, must release enough water to maintain a 50 cfs flow, for five consecutive days, at the "Confluence with Toe Drain". Immediately following that five-day period, a minimum flow of 19 cfs must be maintained at the I-80 bridge. The 19 cfs criterion remains in effect through February.

[d] Immediately following the three-day pulse described in (a), must maintain a minimum flow of 50 cfs at I-80 Bridge for the next 30 days. Immediately following the 30-day period, stream flow releases are to be "gradually" ramped down over a seven-day period to match the prevailing stream flow release requirement (assuming there are no concurrent flood flow releases).

Riparian Agriculture Diversions

LPC flows along the Solano/Yolo County line from the PDD to I-80 and across the Yolo Bypass through the Yolo Basin Wildlife Area (YBWA) ultimately terminating in the "Toe Drain" (Figure 2).

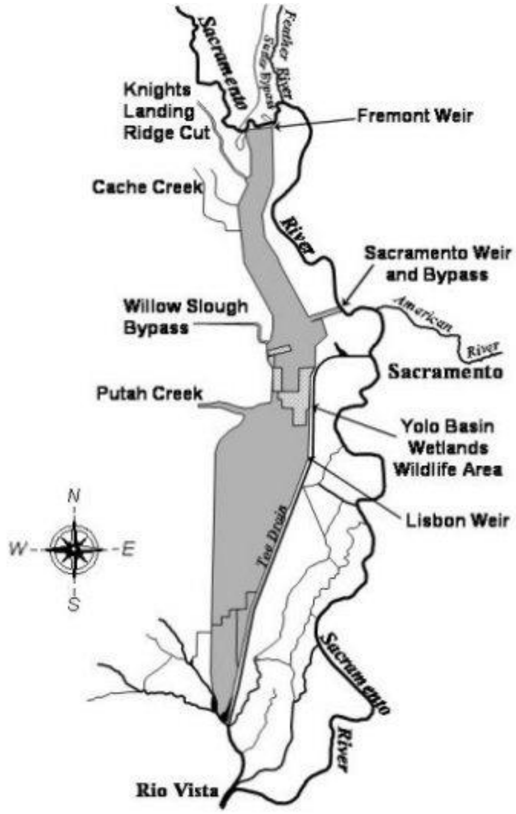

Figure 2: Putah Creek and Yolo Bypass Map

Each agriculture season two water impoundments are installed on LPC in the YBWA to manage water, initially for riparian agriculture diverters, and then for preparation of the Refuge by CDFW for hunting season. One impoundment is a temporary earthen crossing with culverts and the other is flashboard dam known locally as the “Los Rios” Dam. Once these structures are in-place and operational two conditions occur: 1) the structure impede the flow preventing any substantive flow increases from PDD without damaging them, and 2) riparian water use dominates the water management upstream of the toe-drain. Very little water makes it past the Los Rios Dam due to excessive diversions. These structures are typically in place from May through mid-November but could occur earlier in April under dry spring conditions. SCWA has no control of the installation or operation of these facilities and cannot deploy flows releases for VA while they are in place. This a considerable constraint to the viability of April-May releases.

VA Functional Flow Benefits

LPC terminates in the Toe Drain and Putah water ultimately finds its way to the Cache Slough Complex (CSC). The CSC is part of the North Delta Arc and is coveted as a prime location for tidal wetland habitat restoration that benefits many native species. The abiotic condition in the CSC habitat can be hostile to biotic needs of native species during extreme dry periods in the late-fall and winter as we have seen more regularly. Adverse conditions such as poor circulation, high water temperatures, low dissolved oxygen, low turbidity, and concentrated contaminants may be improved by deployment of VA flow assets.

LPC hydraulic connectivity to the Delta is a very circuitous route and the tidal flux into Cache Slough can be a formidable force to downstream progression of VA water. The LPC provides very little water to the Delta except during flood events[4]. LPC contribution would be most beneficial to CSC and salmon spawning in the LPC in the fall. VA contributions in the spring through March during extended dry conditions would

[4] Draft Hydrological and Operations Modeling Considerations for the Phase II Update of the 2006 Bay-Delta Plan (SWRCB 2016)

most benefit salmon smolts for emigration out of LPC before the irrigation dam is installed. VA contributions released in April through May have a low guarantee of benefit due to many constraints as discussed below but may be able to occur opportunistically.

In summary, the deployment of LPC VA contributions would have the greatest benefit regionally for:

- Augment Accord minimum release compliance conditions in LPC when they are controlling. (See Table 20 below).
- Extend/enhance the Accord pulse flow conditions. (See Table 21 below)
- Improve food transport akin to the North Delta Flow Action pilot program.
- Improve late-fall abiotic conditions in the CSC that favor biotic responses of native species during excessive dry periods.
- Adaptive management for habitat restoration in the CSC.

Table 20. Voluntary Agreement Flow Plan (cfs/d) for Putah Creek

Month	LPC Accord (Normal year)	VA Default (Normal Year)	LPC Minimum (LPC Accord + VA Default, Normal Year)	LPC Accord (Dry Year)	VA Default (Dry Year)	LPC Minimum (LPC Accord + VA Default, Dry Year)	Operational Constraints
Oct	20	0	20	15	0	15	Los Rios Dam, Ag Div
Nov	25	17	42	25	20	45	Pulse, Tribs, Spill
Dec	25	17	42	25	20	45	Pulse, Tribs, Spill
Jan	25	17	42	25	20	45	Tribs, Spill
Feb	16	17	33	16	20	36	Pulse, Tribs, Spill
Mar	26	17	43	26	20	46	Pulse, Tribs, Spill
Apr	46	9	55	46	10	56	Los Rios Dam, Ag Div
May	43	9	52	33	10	43	Los Rios Dam, Ag Div
Jun	43	0	43	33	0	33	Los Rios Dam, Ag Div
Jul	43	0	43	33	0	33	Los Rios Dam, Ag Div
Aug	34	0	34	26	0	26	Los Rios Dam, Ag Div
Sep	20	0	20	15	0	15	Los Rios Dam, Ag Div

Table 21. Description of operational actions

Operational Action	Modeled	Water Year Type	Monthly Distribution	Instream Flow	Constraints on Asset	Notes
2.5 TAF (Pulse Flow)	Yes	All but Wet	Nov to Dec	To be determined	Removal of Los Rios Dam	See "SWCA Notes" below
2.5 TAF (Ramp Down Flow)	Yes	All but Wet	Following Pulse Flow and through March	To be determined	n/a	See "SWCA Notes" below
1.0 TAF (Flushing Flow)	Yes	All but Wet	April to May	To be determined	Prior to installation of Los Rios Dam	See "SWCA Notes" below

SWCA Notes:

1) Proposed Pulse, Ramp Down, and Flushing Flows are in addition to streamflows required pursuant to the 2000 Putah Creek Accord

2) Proposed Pulse Flow will augment existing pulse flow releases and is for the purposes of attracting adult Chinook Salmon. Timing of the Pulse Flow must coincide with the annual removal of the seasonal Los Rios Dam in the Yolo Bypass (typically removed by mid-November). Magnitude and duration of Pulse Flow – other than total quantity of water committed for pulse flows – to be determined and cannot exceed 1,000 cfs due to Solano Project infrastructure constraints.
3) Proposed Ramp Down Flow will augment existing ramp down releases and enhance habitats for native fish assemblage. Magnitude of Ramp Down Flow – other than total quantity of water committed to ramp down flows – to be determined and cannot exceed 1,000 cfs due to Solano Project infrastructure constraints.
4) Proposed Flushing Flow will augment existing Flushing flows and is intended to encourage downstream migration of juvenile salmon. Timing of flushing flows must precede reinstallation of the Los Rios Dam (typically between mid and late May). Magnitude and duration of Flushing Flow – other than total quantity of water committed for Flushing Flows – to be determined and cannot exceed 1,000 cfs due to Solano Project infrastructure constraints.

2.9.2 Governance and decision-making for Putah VA Flow Measures

The flow to LPC is managed by the Solano County Water Agency. Monthly minimum and current seasonal pulse flow releases are governed by the Putah Creek Accord. Releases above the minimum requirements are required to pass flood water in the fall though spring, higher carriage water in dry spring through fall to meet monthly compliance targets further downstream, or to accommodate VA flow requests. The Systemwide Governance Committee can make recommendations within the Flexibility Brackets from November to May subject to real-time conditions, and within the operational and systematic limitations discussed above that are beyond the Agency's control. However, there are considerable constraints to the viability of April-May releases.

2.9.3 Additional Details on Flow Accounting for Putah VA Flow Measures

The Putah Creek VA flow assets are a volume of Putah Creek water to be released by SCWA from Putah Diversion Dam in excess of the controlled water releases that SCWA is presently obligated meet existing release requirements. Existing minimum release requirements are governed by the Putah Creek Accord.

SCWA would operate to provide LPC VA contributions from Putah Diversion Dam, above existing minimum instream flow requirements, up to the volumes specified under the hydrologic condition stipulated in Table 1.

The VA contributions will be made available each water year on October 1 as a dedicated volume (block) of water in storage for deployment within that corresponding water year. SCWA will consider deployment requests made by the Systemwide Governance Committee and accommodate reasonable requests within real-time systematic constraints or emergency conditions that may arise. SCWA will account aggregate VA contributions on a water year basis, any VA portion of LPC VA flow asset that is not able to be released due to conditions and constraints beyond SCWA control during each water year, such as specified below, will not carry-over to the following year.

SCWA will not be obligated to release VA contributions while uncontrolled releases are occurring at the Putah Diversion Dam (i.e., flood flows- inflow from tributaries downstream of Monticello Dam or the Glory Hole is spilling) or when the Yolo Bypass is passing uncontrolled flood water from the Sacramento River. Additionally, SCWA will not be obligated to provide VA contributions during the seasonal period (typically Apr-Nov) while the Los Rios Check Dam is installed in the YBWA by others for irrigation operations.

2.10 CVP/SWP Export Reduction Flow Measures

2.10.1 Default Plan and Flexibility Bracket

The VA Flow Measure for CVP/SWP Export Reduction is to contribute 175 TAF in Above Normal water years and 125 TAF in Below Normal and Dry water years. Table 22 presents the Default Plan and Flexibility Bracket for VA Flow Measures from CVP/SWP Export Reduction.

Table 22. Timing of VA Flow Measures from the CVP/SWP Export Reduction water source. Bolded numbers represent the Default Plan for VA Flow Measures and numbers in parentheses represent the Flexibility Bracket for any given year. There are no VA Flow Measures in wet and critical water years.

Water Year	Mar	Apr	May	Jun
Above Normal	**0%** (0-30%)	**50%** (30-70%)	**50%** (30-70%)	**0%** (0-30%)
Below Normal and Dry	**33%** (20-80%)	**33%** (20-80%)	**33%** (0-50%)	**0%**

2.10.2 Governance and decision-making for CVP/SWP Export Reduction VA Flow Measures

Reclamation and DWR are the implementing organizations and decision makers for the deployment of the CVP/SWP export reduction water source within the proposed Flexibility Bracket as described in Table 22. The main purpose of this Flexibility Bracket is to ensure that there is enough time to reduce exports and achieve the required additive water quantity for the VA. The Systemwide Governance Committee may make recommendations to Reclamation and DWR, however there is limited flexibility in the timing for this water source given the constraints that need to be met to ensure this is additional water.

2.11 PWA Water Purchase Program Flow Measures

2.11.1 Default Plan and Flexibility Bracket

Table 23 presents the Default Plan and Flexibility Bracket for VA Flow Measures from the PWA Water Purchase Program.

Table 23. Timing of VA Flow Measures from the PWA Water Purchase Program water source. Bolded numbers represent the Default Plan for VA Flow Measures and numbers in parentheses represent the Flexibility Bracket for any given year.

Water Year	Mar	Apr	May	Jun
Wet, Above Normal, Below Normal, Dry and Critical	**0%**[1]	**50%**[2]	**50%**[2]	**0%**[1]

[1] The flexibility bracket for these months is 0-40%

[2] The flexibility bracket for April to May is 60-100%

The Default Plan for the PWA Fixed Price Water Purchase Program would make water available in April and May; similar to the CVP/SWP Export Reduction measure (84-90% of the purchases, depending on year type, are planned in the CVP/SWP service area). The Default Plan for the PWA Market Price Purchase Program will depend on the amount, location, and mechanism for making water available.

In any given year, the timing of the Flow Measure will depend on the needs as determined by the Systemwide Governance Committee. The Purchase Program will have significant flexibility. The individual purchases will have similar characteristics to other measures in the VA Flow Program; i.e., purchases in the CVP/SWP service area will have similar flexibility to the CVP/SWP Export Reduction measure; purchases from land being fallowed in the Sacramento Valley will have similar flexibility to the Sacramento measure; and purchases that make water available through reservoir reoperation with refill criteria will have flexibility similar to the Yuba measure.

2.11.2 Governance and decision-making for PWA Water Purchase Program

Within the Flexibility Bracket defined in Table 23, the Systemwide Governance Committee will make decisions related to timing of use and exercise of flexibility of the water made available by each water purchase within the program. These decisions will need to be made in coordination with the entities that are making the water available.

2.12 State Water Purchases Flow Measures

2.12.1 Default Plan and Flexibility Bracket

Table 24 presents the Default Plan and Flexibility Bracket for VA Flow Measures from the PWA Water Purchase Program.

Table 24. Timing of VA Flow Measures from Permanent State Water Purchases. Bolded numbers represent the Default Plan for VA Flow Measures and numbers in parentheses represent the Flexibility Bracket for any given year.

Water Year	Jan	Feb	Mar	Apr	May	Jun
Wet, Above Normal, Below Normal, Dry and Critical	**0%**	**0%**[1]	**33.3%**[2]	**33.3%**[2]	**33.3%**[2]	**0%**[1]

[1] The flexibility bracket for these months is 0-40%
[2] The flexibility bracket for March to May is 60-100%

The Default Plan for the Permanent State Water Purchases is to target deployment of these Flow Measures in March, April, and May. This Default Plan will depend on the amount, location, and mechanism for making water available. The Flexibility Brackets are defined to be responsive to real-time hydrology and providing enhanced aquatic species benefits given variances in hydrology and species needs between years.

In any given year, the timing of the Flow Measure will depend on the needs as determined by the Systemwide Governance Committee. The State purchases will have similar characteristics to other measures in the VA Flow Program depending upon the location and mechanisms for making water available (e.g., purchases from land being fallowed will have similar flexibility to the Sacramento measure; and purchases that make water available through reservation reoperation with refill criteria will have flexibility similar to the Yuba measure, etc.).

2.12.2 Governance and decision-making for State Water Purchase Program

Within the Flexibility Bracket defined in Table 24, the Systemwide Governance Committee will make decisions related to timing of use and exercise of flexibility of the water made available by each water purchase within the program. These decisions will need to be made in coordination with the State and will depend upon any constraints in how the water is being made available.

3 Non-flow Measures Description

This section provides details on the proposed Non-flow Measures for the VA Program including the minimum additive contributions to habitat enhancement or restoration and other Non-flow Measures by geographic area (Section 3.1.1), an outline of the expected implementation timing of Non-flow Measures (Section 3.1.2), an approach for habitat accounting (Sections 3.1.3 and 3.1.3), and area-specific descriptions of Non-flow Measures, including a description of the relevant governance arrangements and/or Responsible Entities that will guide implementation, subject to Implementing Agreements, Enforcement Agreements and applicable regulatory requirements (Sections 3.1.3 to 3.10).

3.1 Overview of Non-flow Measures

3.1.1 Minimum Additive Contributions to Habitat Restoration

Table 25 describes the minimum additive contributions to habitat enhancement or restoration and other Non-flow Measures proposed for the VA Program by geographic area. These Non-flow Measures will be additive to physical conditions and regulatory requirements existing as of December 2018, when the State Water Board adopted Resolution 2018-0059. Implementation of such measures by Parties after that date, but prior to execution of the VAs, will be considered as contributing towards implementation of the Narrative Salmon Objective and Narrative Viability Objective (Term Sheet, Section 4.2).

Table 25: Minimum Additive Contributions to Habitat Restoration and other Non-flow Measures (Source: Appendix 2 of Term Sheet and associated amendments)*

Area	Total Acres[1]
San Joaquin Basin – Tuolumne[2]	77 (rearing/floodplain), >21.35 (spawning gravel)
Sacramento Basin – Sacramento	137.5 (instream), 113.5 (spawning)
Sacramento Basin – Sutter Bypass, Butte Sink, and Colusa Basin	20,000 (floodplain)[3], 20,000 (fish food production)[4] *Initial Targets per funding and permitting*
Sacramento Basin – Feather	15 (spawning), 5.25 (instream), 1,655 (floodplain)[5]
Sacramento Basin – Yuba[6]	50 (instream), 100 (floodplain)
Sacramento Basin – American	25 (spawning), 75 (rearing)
Sacramento Basin – Mokelumne	1 (instream), 25 (floodplain)
Sacramento Basin – Putah	1.4 (spawning)
North Delta Arc and Suisun Marsh	5,227.5[7]

* To expedite the completion of these projects, the State will commit to establish a new, multi-disciplinary restoration unit, with authority to coordinate and work collaboratively to obtain all permits required to implement the restoration activities. The unit will track and permit these projects and seek to: (1) encourage coordination between and among state and federal agencies, (2) avoid repetitive steps in the permitting process, (3) avoid conflicting conditions of approval and permit terms, and (4) provide an expedited path to elevate and resolve permitting challenges.

[1] This column represents the sum of habitat restoration commitments proposed in the Planning Agreement and habitat restoration acres identified in the State's VA Framework from February 2020 (modified to reflect the 8-yr VA term, State Team's discussion with participants, and modeling analysis).

[2] Tuolumne Parties will work to define habitat projects in collaboration with CDFW, drawing from the prior 15-year VA habitat list. Projects will be funded by the Tuolumne Parties and implemented, subject to and depending on obtaining applicable requirements for project-specific environmental review or regulatory approval, within the 8-year term of the agreement.

[3] Floodplain habitat will be generated via Tisdale Weir and other modifications. Subject to analysis showing that acreage meets suitability criteria.

[4] Subject to analysis of effectiveness. Water will be pumped onto rice fields, held for a period of time to allow fish food production (e.g., zooplankton), and then discharged to the river for the benefit of native fishes downstream.

[5] This consists of added instream habitat complexity and side-channel improvements.
[6] This constructed floodplain will be activated at 2,000 cfs.
[7] This will be tidal wetland and associated floodplain habitats.

3.1.2 Systemwide Implementation Schedule

Table 26 provides a system-wide overview of the implementation schedule for VA Non-flow Measures, drawing on the detailed area-by-area descriptions in the sections that follow. The numbers in Table 26 provide an indication of the general pace of implementation of the habitat restoration and other Non-flow Measures, and are provided with the following points of clarification:

- Acreages and numbers of projects planned for implementation during the Term of the VA (2025-2033) are approximate and intended to demonstrate the magnitude of anticipated habitat restoration and other Non-flow Measures.
- Acreages represented under the Early Implementation heading in Table 26 are approximate, and will be updated for consistency with the accounting approach for Non-flow Measures described in Section 3.1.4 upon finalization of the accounting methods.
- Where the anticipated acreages and numbers of projects identified in Table 26 and the area-specific tables exceed the commitments in Table 25 (Appendix 2 of the MOU and Term Sheet and associated amendments), these are not intended to constitute additional commitments, but instead to demonstrate that sufficient opportunity and flexibility exists to meet the requirements of the VA.
- All planned projects are subject to the availability of funding at the time of implementation and to the granting of required permits.

Table 26. Systemwide Summary of VA Non-flow Measures

Description of Measures	Early Implementation (Dec 2018 – 2024)	Years 1-3 (2025 – 2027)	Years 4-6 (2028 – 2031)	Years 7-8 (2032-2033)	Total
Spawning Habitat Construction, Restoration, & Enhancements (total acres)	114	47	86	43	291
Instream Rearing Habitat Construction, Restoration, & Enhancements (total acres)	144	29	233	28	434
Floodplain Rearing Habitat Construction, Restoration, & Enhancements (total acres)	4011	8982	10,991	3942	27,926
Tidal Wetlands Construction, Restoration, & Enhancements (total acres)	500	2500	2350	-	5350
Weir Improvements & Fish Passage Projects (# of projects)	8	5	1	-	14
Fish Food Production on Agricultural Land (annual acres)	30,000	20,000	20,000	20,000	20,000
Predator Control Activities (# of projects)	-	1	2	-	3
Other Salmonid Habitat Enhancements (# of projects)	-	4	3	1	8

3.1.3 Non-flow Measure Accounting and Assessments

The VAs will result in new Non-flow Measures, including habitat restoration and enhancements, that are intended to contribute to the achievement of the Narrative Objectives, and which will be implemented in specific geographic locations overseen by Tributary/Delta Governance Entities (Tributary/Delta GEs). Coordinated by the VA Science Committee, the Tributary/Delta GEs will conduct accounting and assessments of Non-flow Measures as follows:

- **Accounting for Non-flow Measures** will be conducted to inform the Systemwide Governance Committee and State Water Board on progress relative to the VA Parties' Non-flow Measure commitments as described in the March 2022 VA Term Sheet and applicable amendments, summarized in Table 25 above. The Non-flow Measure accounting process is described further in Section 3.1.4.
- **Habitat suitability assessments**, described in the VA Science Plan, consider habitat suitability design criteria, as well as additional factors (covariates) that may affect species utilization and their ability to feed, grow, avoid predators, and reproduce in the new or enhanced habitat. These covariate suitability metrics are additional to the metrics informing the habitat accounting procedures and often regard water quality (e.g., water temperature). For example, covariate suitability metrics for spawning habitat, in-channel rearing habitat, tributary floodplain habitat, bypass floodplain habitat, and tidal wetland habitat are described in VA Science Plan Hypotheses H_{S1}, H_{R1}, $H_{TribFP1}$, $H_{BypassFP4}$, and H_{TW1}, respectively. The habitat suitability assessment is separate from the habitat accounting method described in this document (Section 3.1.3) because it considers suitability metrics that may not be possible to control through project design but may affect utilization and biological effectiveness. The results of the habitat suitability assessments will be provided in VA Program reports as described in Section 9.4 of the VA Term Sheet as well as the ecological outcomes analysis to be provided prior to Year 7 of the VA Program, as described in Appendix 4 of the VA Term Sheet. The assessment methods for habitat suitability are described further in the VA Science Plan, Section 4.1.1.
- **Habitat utilization and biological effectiveness assessments**, described in the VA Science Plan, will be conducted to determine whether target species are using the new or enhanced habitat areas, are exhibiting expected near-term benefits (e.g., improved fish passage, increased growth rate) that can be attributed to the completed habitat action, and whether these measures are achieving or are likely to achieve the anticipated ecological outcomes by creating, restoring, or enhancing the habitat of one or more target species and lifestages. For example, Hypothesis H_{R4} in the VA Science Plan tests whether the new or enhanced rearing habitat for Chinook salmon has higher juvenile salmon densities compared to areas outside of the new or enhanced habitat project locations. The results of the habitat utilization and biological effectiveness assessments will be provided in VA Program reports as described in Section 9.4 of the VA Term Sheet as well as the ecological outcomes analysis to be provided prior to Year 7 of the VA Program, as described in Appendix 4 of the VA Term Sheet. The assessment methods for habitat utilization and biological effectiveness are described further in the VA Science Plan, Section 4.1.2.

3.1.4 Methods for VA Non-flow Measure Accounting

For VA implementation projects, Non-flow Measure accounting will occur according to the following steps:

1. Any project that implements all applicable design criteria in Table 27 will be counted toward the VA Non-flow Measure commitments identified in Table 25. If any project element deviates from the applicable design criteria identified in Table 27 or is a Tidal Wetland or Bypass Floodplain project, the project moves to Step 2. Otherwise, the project moves to step 3.

2. During the project planning stage, any variances from the design criteria in Table 27 will be proposed to the VA Science Committee and finalized according to the **design criteria review process** described below.

3. After construction is completed, the VA Non-flow Measure accounting procedure will count the new or enhanced non-flow habitat consistent with the approved project design criteria toward the appropriate VA Non-flow Measure commitments (identified in Table 25). Detailed scientific protocols for determining that constructed projects conform to approved design criteria will be coordinated by the VA Science Committee.

Note that early implementation projects will follow a different accounting process described in Section 3.1.5. Consistent with Section 4.2 of the VA Term Sheet, Non-flow Measures will only be counted if they are additive to physical conditions and regulatory requirements existing as of December 2018. In addition, enhancement projects will only be counted for the Bypass floodplain habitat projects included in VA Non-Flow Measure Commitments and their acreages will only be counted to the extent that areas of enhanced habitat meeting the design criteria are additive to the physical conditions and regulatory requirements existing in that habitat area as of December 2018.

Design Criteria Review Process - the design criteria review process will ensure all Non-flow Measures address the necessary design elements to contribute toward the VA objectives and have a design that is based on best available science and information. To facilitate a timely review, the project proponent will prepare a justification of the proposed design criteria with appropriate supporting rationale, including any applicable citations to the scientific literature and PDFs of all citations. This justification document will explain why variances are needed from the design criteria outlined in Table 27 and why alternative criteria would provide equivalent or similar benefits for the target species. The justification may include other benefits or constraints (e.g., traditional ecological knowledge, health and safety limitations) that inform the proposed alternative design criteria. For Tidal Wetland and Bypass floodplain projects, which have no established criteria, the justification will explain how the design criteria will result in benefits for the target species and how they align with the general guidelines outlined in Sections 3.1.4.4 and 3.1.4.5. The design criteria review process will follow the following steps:

1. The design criteria review process will rely on existing venues for early consultation used for permitting procedures to the maximum extent possible (e.g., Water Forum Habitat Team on the American River, Lower Yuba River Management Team on the Yuba River, Mokelumne River Technical Advisory Committee on the Mokelumne River, CVPIA Project Work Teams and Technical Advisory Committees for CVPIA funded projects). If a venue does not exist, the Tributary/Delta GE will establish a project work team or technical advisory committee for the project design criteria review process. These venues will allow for active participation by CDFW, USFWS, NMFS, SWB, and VA Science Committee members and the intent is to have a collaborative process to provide a timely review of the proposed design criteria. If consensus is reached on the design criteria at this step by the Tributary/Delta GE, CDFW, and SWB then the design criteria are approved for VA Non-flow Measure accounting purposes. If any of the Tributary/Delta GE, CDFW, or SWB do not approve of the proposed design criteria, then the design criteria review process moves to Step 2.

2. If consensus is not reached in step 1 within 30 days, the Tributary/Delta GE overseeing the project will bring the proposed design criteria to the Systemwide Governance Committee, who may refer questions to the VA Science Committee as necessary. If the Systemwide Governance Committee and SWB reach consensus on the proposed design criteria, then the design criteria are approved for VA Non-flow Measure accounting purposes.

3. If consensus is not reached at the Systemwide Governance Committee within 30 days, CDFW and SWB, in consultation with USFWS and NMFS, will seek agreement on the design criteria that the project would need to achieve for the purposes of VA Non-flow Measure accounting. As part of this process, SWB and CDFW may bring design criteria for peer review by an independent group

appropriate for the project in question. CDFW and SWB will have 30 days to agree to the project's design criteria for VA accounting purposes.

The above design criteria review process will also need to consider project constraints from other regulatory processes (e.g., Flood Board, USACE). Adaptive management will be necessary, and as the knowledge base evolves, there will be opportunities to incorporate Traditional Ecological Knowledge and other considerations (e.g., environmental justice) that may inform the design criteria review process for VA Non-flow Measure accounting. All projects are expected to engage in early consultation with CDFW on project design.

Triennial synthesis reports, as described in Term Sheet Section 9.4.B, will provide an opportunity to assess tributary-scale changes in acreage conforming to the Non-flow Measure accounting process within each geographic area (consistent with the analyses and scientific principles in the Final Draft Scientific Basis Report Supplement [SWB in preparation]), and confirm whether the changes described in this Strategic Plan and in the SBRS, in fact, materialize as anticipated. The results of this Non-flow Measure accounting will be one factor, in addition to the habitat suitability, and the utilization and biological effectiveness assessments described above, considered in the Year 8 Red/Yellow/Green assessment of the VA Program as a whole (as described in Term Sheet Section 7.4.C (iv)). Some VA parties remain concerned that this process has the potential to slow implementation of Non-flow Measures, and this will also be assessed as part of the Annual Reports and Triennial synthesis reports to ensure that the review process is working to both achieve expedited implementation and intended habitat outcomes.

The intention of the VA Parties is to align the benefits resulting from implementation of the committed Non-flow Measures with those anticipated in the Final Draft Scientific Basis Report Supplement (SWB in preparation). To achieve this, the VA Parties intend to plan, design, and construct new Non-flow Measures that reflect the best available science about the habitat needs of the species and lifestages the projects are intended to benefit. Table 27 provides quantitative and narrative design criteria for non-flow habitat measures for Sacramento Valley tributaries and floodplains and is based on the VA Parties' understanding of best available science at the time of writing. The acreage of each VA non-flow habitat project on Sacramento Valley tributaries that conforms to all applicable design criteria (either in Table 27 or approved through the design criteria review process described above) will be counted toward the VA Non-flow Measure commitments identified in Table 25. As demonstrated by tributary-specific flow-habitat relationships meeting VA design criteria, suitability of certain habitat acreages varies over a range of flows. Thus, in many cases habitat accounting does not assume 100% suitability for all constructed acres (per project or tributary) across all flows. Design criteria for the Tuolumne River are pending development and will target consistency with the Tuolumne River Scientific Basis Report that is being prepared by the State Water Board. For all aspects of habitat design, VA parties should also refer to established manuals for habitat restoration, such as the California Salmonid Stream Habitat Restoration Manual, 4th Edition, among other manuals approved by the CDFW Fish Restoration Grant Program[5], and the Conservation Planning Foundation for Restoring Chinook Salmon (*Oncorhynchus tshawytscha*) and *O. mykiss* in the Stanislaus River (Anchor QEA, LLC 2019).

Guidance for the design of other Non-flow Measure habitat enhancements (e.g., fish passage, fish food production, as listed in Table 26) is provided in the Science Plan. These include NMFS guidelines for fish passage facilities (NMFS 2023) and guidance for zooplankton production in shallow water areas for duration and water temperature conditions (e.g., as described in Corline et al. 2017).

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[5] https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=183423&inline

Table 27. Design criteria for the accounting of habitat measures included in VA Non-flow Measure commitments on Sacramento Valley tributaries and floodplains.

Habitat Type	Water Depth (ft)[1]	Water Velocity (fps)[1]	Other
Spawning Habitat	1.0 – 2.5	1.0 – 4.0	**Substrate[2]:** Dominant substrate size 2 cm-10 cm (0.75 in – 4.0 in)
In-stream Rearing Habitat	0.5 – 4.0	0.0 – 3.0	**Cover[3]:** Sufficient cover to provide suitable rearing habitat for juvenile salmonids, defined as a minimum of 20% coverage of cover features that have a Habitat Suitability Index (HSI) score ≥ 0.5 supported by the scientific literature (listed in Table 27) (further discussed below in Section 3.1.4.2).
Tributary Floodplain Rearing Habitat	0.5 – 4.0	0.0 – 3.0	**Cover[3]:** Sufficient cover to provide suitable rearing habitat for juvenile salmonids defined as a minimum of 20% coverage of cover features that have a Habitat Suitability Index (HSI) score ≥ 0.5 supported by the scientific literature (listed in Table 27) (further discussed below in Section 3.1.4.3). **Floodplain Function:** Sufficient frequency, magnitude, and duration of inundation to provide benefits for rearing salmonids (further discussed below in Section 3.1.4.3)[4].

[1] Water depth and velocity criteria for each habitat type are consistent with SWB in preparation and identified by the Conservation Planning Foundation for Restoring Chinook Salmon and O. mykiss in the Stanislaus River (Anchor QEA, LLC 2019). Proposed variances from these specific values will be reviewed in the design criteria review process outlined above.

[2] Dominant substrate is defined by the particles which compose more than fifty percent of the surface area (Gard 1998, 2006, 2009). Substrates in Gard 2006 with HSI Score ≥ 0.5 ranged between 2.5 cm and 10 cm (fall run Chinook salmon in the Merced River and Clear Creek). This range was reduced to 2 cm (0.75 in) to accommodate smaller sized spawning fish (i.e., including *O. mykiss*) using the equation developed in Riebe et al. 2014 and Merz et al. 2018. Proposed variances from these specific values will be reviewed in the design criteria review process outlined above.

[3] Table 28 synthesizes cover habitat categories with a habitat suitability index (HSI) Score ≥ 0.5. Cover will be evaluated at project completion in accordance with final phases and/or full implementation of the project design (e.g., vegetation at maturity).

[4] For instances where daily data or tributary-specific high-resolution models are available, a range of combined duration and frequency targets may adhere to the rationale of the MFE and provide opportunities for adaptive management.

3.1.4.1 Design criteria for tributary salmonid spawning habitat actions

Given the widely accepted premise that water depth, water velocity, and substrate size strongly influence choice of spawning location by salmonids, those characteristics will be used to account for implementation of spawning habitat enhancement projects included in VA Non-flow Measure commitments identified in Table 25. Dominant substrate is defined by the particles that compose more than fifty percent of the surface area (Gard 1998, 2006, 2009). Substrates in Gard 2006 with HSI Score ≥

0.5 ranged between 2.5 cm and 10 cm (approximately 1-4 inches, fall run Chinook salmon in the Merced River and Clear Creek). This range was reduced to 2 cm (0.75 inches) to accommodate smaller sized spawning fish (i.e., including *O. mykiss*) using the equation developed in Riebe et al. 2014 and Merz et al. 2018.

The specific accounting protocol for spawning habitat actions will be described in the VA Science Plan, and it will involve evaluating the acreage of habitat conforming to the approved design criteria at a range of flows compared to the pre-project condition. For accounting purposes, the VA Science Plan will also include the methodology for comparing the acreage of suitable habitat of non-flow habitat measures conforming to the design criteria against the flow-habitat relationships provided by VA parties for the Final Draft Scientific Basis Report Supplement (SWB in preparation).

3.1.4.2 Design criteria for in-stream salmonid rearing habitat actions

Cover has been identified as a key element of freshwater rearing sites within designated critical habitat for ESA-listed salmonids (NMFS 2005) and is therefore included as a narrative design criterion along with quantitative design criteria water depth and water velocity for both in-stream and floodplain rearing habitat enhancement projects intended to meet VA Non-flow Measure commitments (Table 25). Cover will be evaluated at project completion in accordance with final phases and/or full implementation of the project design (e.g., vegetation at maturity) by the Tributary GE, as coordinated by the VA Science Committee. Table 28 describes a range of cover habitat types with a habitat suitability index (HSI) Score ≥ 0.5. For in-stream and floodplain rearing habitat acreage to conform to the narrative criterion for cover, a minimum of 20% of the habitat acreage (i.e., cover features will constitute 20% of the habitat area) that meets the water depth and water velocity ranges in Table 27 will have combinations of features described in Table 28 (Raleigh 1986). Juvenile salmonids are often found within 1m of a cover element (Moniz and Pasternack 2019, Hardy et al. 2006), which represents the burst distance for juvenile salmonids (Hardin et al. 2005). Methods for quantifying change in habitat acreage will be substantiated by peer-reviewed literature and best available science. Detailed protocols and approaches for accounting for cover will be specified in the Science Plan, and in Tributary GE-specific science plans, as appropriate and drawing from existing methodologies (e.g., USEPA 1999, San Joaquin River Restoration Program 2012, YCWA 2013, Beakes et al. 2014). Other designs consistent with the intent of providing suitable and adequate cover for juvenile rearing can be considered through the design criteria review process described above. Cover is further addressed in the VA Science Plan through Hypothesis H_{R3}.

The specific accounting protocol for rearing habitat actions will be described in the VA Science Plan, and it will involve evaluating the acreage of habitat conforming to the approved design criteria at a range of flows compared to pre-project condition. For accounting purposes, the VA Science Plan will also include the methodology for comparing the acreage of suitable habitat for Non-flow Measures conforming to the design criteria against the flow-habitat relationships provided by VA parties for the Final Draft Scientific Basis Report Supplement (SWB in preparation).

Table 28. Cover feature categories with HSI Score ≥ 0.5, reviewed in San Joaquin River Restoration Program's "Minimum Floodplain Habitat Report for spring and fall-run Chinook salmon" November 2012. Additional references with HSI values were included if they presented empirical results or were the outcome of a clearly articulated collaborative process. The intent of a HSI score ≥ 0.5 is to identify highly suitable cover features for inclusion in rearing habitat actions.

Cover feature type	HSI Reference	Description
Woody debris	Raleigh 1986, Sutton et al. 2006, Gard 2006	Fine woody vegetation + overhead cover, branches (2.5-30.5 cm diameter) and logs (> 30.5 cm diameter, Gard 2006)
Boulder	Sutton et al. 2006	Small-medium (12-48 inches) and large (>34 inches) boulder (Sutton et al. 2006)
Cobble	WDFW 2004[1]	Small (3-6 inches) and large (6-12 inches, WDFW 2004)
Grass/ Herbaceous	Sutton et al. 2006, WDFW 2004	Emergent rooted aquatic grass and sedges (Sutton 2006), and tall (>3 feet) dense grass (WDFW 2004)
Willow and other riparian vegetation	Moniz and Pasternack 2019, YCWA 2013, Sutton et al. 2006	Trees, bushes, willow riparian, willow scrub and other riparian vegetation, Sutton et al. 2006) taller than 2 feet above the ground (YCWA 2013).
Undercut bank	Raleigh 1986, Sutton et al. 2006, WDFW 2004, Hampton 1988	Undercut at least 0.5 ft (Hampton 1988)
Aquatic vegetation	Sutton et al. 2006, WDFW 2004	Non-emergent rooted aquatic
Overhanging vegetation	Sutton et al. 2006, WDFW 2004	Near or touching water (WDFW 2004)
Root wad, logjam/submerged brush pile and large wood	Sutton et al. 2006, WDFW 2004, Hampton 1988	Logs and root wads greater than 9 inches in diameter (Hampton 1988)

[1] . The reference for cobble as a cover element is based on Recommended Preference (WDFW 2004). The San Joaquin River Restoration Program's "Minimum Floodplain Habitat Report for spring and fall-run Chinook salmon" November 2012 does not conclude that cobble has an HSI value > 0.5, however, cobble is included as an acceptable cover feature because the WDFW 2004 Recommended Preference values were developed from empirical observations from multiple habitat suitability studies, and were intended to be applied to instream flow and habitat modeling.

3.1.4.3 Design criteria for tributary floodplain salmonid rearing habitat actions

Intermittently or seasonally wetted areas that support floodplain processes are an important element of rearing habitat for salmonids. Therefore, in addition to the water depth, water velocity, and cover criteria for in-stream rearing habitat (Table 27, Section 3.1.4.2), tributary floodplain habitats will be designed with targets for inundation frequency and duration that are consistent with the intention of the Meaningful Floodplain Event (MFE) described in the Final Draft Scientific Basis Report Supplement (SWB in preparation). In addition, tributary floodplain inundation regimes may also be designed in a project-specific manner and in accordance with tributary-specific flow provisions.

Floodplain rearing habitat projects are intended to provide sufficient frequency, magnitude, and duration of inundation as described in Table 27 as well as the water depth, water velocity, and cover criteria. Habitat accounting for floodplain rearing habitat commitments will be based on modeled inundation frequency and duration, using modeling assumptions and hydrological time series consistent with those described in the Final Draft Scientific Basis Report Supplement (SWB in preparation).

For instances where daily data or tributary-specific high-resolution models are available, a range of combined duration and frequency targets may adhere to the rationale of the MFE and provide opportunities for adaptive management. For example:

- Inter-annual frequency: Inundation 2 out of every 3 years on average and within a range of 50% to 80% of years.
- If modeled duration of inundation is between seven and 18 days, floodplain projects should target at least two distinct inundation events in the February through June rearing period. Grosholz and Gallo (2006) recommend repeated flood pulses at intervals of 2- to 3-weeks to best support native fish.
- If floodplain projects are designed for duration of inundation greater than 18 days, a single inundation occurrence during the February through June rearing period will satisfy the intention of the MFE criteria. The inundation habitat criteria in the Chinook Salmon Habitat Quantification Tool (HQT) for the CVPIA Science Integration Team assert that floodplain suitability is highest at 18-24 days (suitability weight of 1.0).
- Other inundation designs which target floodplain function consistent with the intention of providing suitable rearing habitat will also be considered by the design criteria review process described above. Tributary floodplain inundation regime may also be designed in a project-specific manner and in accordance with tributary-specific flow provisions.

The specific accounting protocol for tributary floodplain rearing habitat will be described in the VA Science Plan, and it will involve evaluating the acreage of habitat conforming to the approved design criteria at a range of flows compared to the pre-project condition. For accounting purposes, the VA Science Plan will also include the methodology for comparing the acreage of suitable habitat of non-flow measures conforming to the design criteria against the flow-habitat relationships provided by VA parties for the Final Draft Scientific Basis Report Supplement (SWB in preparation). The observed inundation area, frequency, and duration will be tracked and reported as part of the habitat suitability assessment described in Section 4.1.1 of the VA Science Plan.

3.1.4.4 Design criteria for Bypass floodplain rearing habitat actions

Table 27Table 28Table 28As described in Final Draft Scientific Basis Report Supplement (SWB in preparation), the bypasses contain a unique set of challenges compared to floodplain restoration projects on the tributaries and the bypasses are also occupied seasonally by a broader range of native fish species. Quantified design criteria for bypass projects are not provided here due to the variety of fish species and life stages that are present in the bypasses. Consideration should be given to generally accepted habitat components for salmonid rearing habitat (as described for tributary floodplains) for actions promoting salmonid rearing, but also to connectivity, fish passage (e.g., adult salmonids and *ascipenserids*) and spawning (e.g., splittail). Project planning should give consideration to whether and to what extent, a project will address the aquatic ecosystem stressors that are described for the bypasses in the Final Draft Scientific Basis Report Supplement (SWB in preparation). Design consideration for bypass habitat enhancements (e.g., fish passage as listed in Table 26) is provided in the Science Plan. These include NMFS guidelines for fish passage facilities (NMFS 2023) as well as metrics for evaluating for zooplankton production in shallow water areas for duration and water temperature conditions during suitability and utilization and biological effectiveness assessments (e.g., as described in Corline et al. 2017).

To evaluate whether VA Non-flow Measures are implemented according to project specifications and design, the implementation metrics will be measured once project construction is completed, and the post-construction measured values of the implementation metrics will be compared to approved project design criteria. The project design criteria will reflect the best available science on the habitat requirements of the species and life stage the project is intended to benefit and will follow the **design** criteria **review process**. For enhancement projects, accounting will be based on the incremental change from baseline (physical conditions and regulatory requirements as of December 2018), with specific protocols for assessing this change proposed alongside the proposed design criteria. Habitat accounting will be based on modeled inundation with respect to physical aspects of the projects (e.g., water velocity). Observed inundation levels and aspects of habitat suitability (including appropriate ranges of water quality parameters such as temperature) will be tracked and reported as part of the habitat suitability assessment described in Section 4.1.1 of the VA Science Plan.

3.1.4.5 Design criteria for Tidal Wetland Restoration Actions

Design criteria for tidal wetland habitat measures will be site-specific and will include inundation levels of constructed channels and marsh plains in response to the daily tidal regime, among other metrics specific to the individual project goals and objectives. The reason that design criteria for these habitat actions will be project specific is that the intended benefits of tidal wetland projects will vary with location and target native fish species.

For example, tidal wetland structure (including structural attributes described in Sherman et al., 2017) is a driver of the capacity of tidal rearing habitats to support juvenile salmon and opportunity for juvenile salmon to access that capacity. Simenstad and Cordell (2000) list four suggestions for incorporating landscape structure in tidal marsh restoration for supporting Pacific salmon populations:

1. "Use natural landscape templates that are specific to the estuary and local region to guide restoration;
2. Emphasize corridors and other linkages among marshes and other tidal landscape elements that facilitate physiological, foraging, and refuge requirements of different fish species and life history stages;
3. Incorporate landscape elements and a mosaic that maintain a natural diversity of primary producers and detritus sources; and,
4. Promote landscape structure that accommodates fish responses to climatic variability and natural disturbance regimes."

Furthermore, Simenstad and Cordell (2000) propose additional landscape metrics, such as heterogeneity of topography, vegetation patch structure, channel system order, the number of channels, average sinuous length of channels, length of channel edge, drainage density, and the occurrence, distribution, and size of pans on the marsh plain. It has also been shown that bifurcation ratios can indicate opportunities for foraging interactions between prey being transported off the marsh and fish in larger channels (Coats et al. 1995; Simenstad et al. 2000). These are examples of design elements that may be considered to provide habitat opportunities for juvenile salmon; other design elements may be considered for goals of food production and export to pelagic areas or spawning or rearing habitat for other native fishes, such as Longfin Smelt.

Hydrologic connectivity to migration corridors and pelagic habitats should also be considered. Established marshes and migration corridors act as source populations for vegetation, detritus, nekton, and invertebrates for the restoration site, and will also influence marsh evolution, habitat function, and access to the restoration site. Particularly for salmonids, which are migratory species, the proximity of a restoration site to established marshes and migration corridors may affect juvenile salmon access to the wetland and the strength of cues that might attract them to the restored wetland (i.e., opportunity). Additionally, their available paths to the ocean by way of migration corridors will affect their survival, life history, and migration timing. Connectivity between marshes also provides refuge for juvenile salmon (Simenstad et al. 2000; Hering et al. 2010; Hanson et al. 2012). Considering both connectivity and structural complexity when evaluating restoration projects requires a landscape approach. However, urbanized estuaries can be constrained by the industries they support. For this reason, site selection provides important context, such as the influence of contaminants, invasions by non-native species, and alterations to flow (Sherman et al., 2017).

Quantified design criteria for tidal habitat restoration are not provided here due to the wide variety of target species, life-stages, and types of habitat goals associated with tidal wetland restoration actions. Values (as provided for tributary habitat actions in Table 27) would need to be generalized to a point that they would not provide meaningful targets. Therefore, to evaluate whether VA Non-flow habitat measures are implemented according to project specifications and design, the implementation metrics will be measured once project construction is completed, and the post-construction measured values of the implementation metrics will be compared to approved project design criteria. The project design criteria will reflect the best available science on the habitat requirements of the species the project is intended to benefit and will follow the **design criteria review process**. The area of the project conforming to the approved design criteria will count towards the Tidal Wetland Non-flow habitat measures in Table 25. Similar to tributary and bypass floodplain habitat actions, habitat accounting for tidal wetlands will be based on modeled inundation with respect to physical aspects of the projects (e.g., water velocity). Observed inundation levels and aspects of habitat suitability (including appropriate ranges of water quality parameters such as temperature, salinity, and turbidity) will be tracked and reported as part of the habitat suitability assessment described in Section 4.1.1 of the VA Science Plan.

As described above, project specific design criteria for tidal wetlands is subject to the **design criteria review process** outlined above in this document.

3.1.5 Early Implementation

As of Jan. 1, 2024, projects that have been completed since December 2018 or that are in more advanced stages of the project lifecycle (i.e., permitting, in-progress/implementation, or construction, see Table 29) will be considered as part of Early Implementation[6]. VA Parties request that CDFW and SWB staff are available to test the application of this accounting process for early implementation projects within 90 days after Jan. 1, 2024. Assuming that design criteria in this document are adopted by the SWB, then early implementation spawning, instream rearing, and tributary floodplain habitat Measures will count towards the Non-flow commitments in Appendix 2 of the VA Term Sheet as long as those projects meet the design and permitting requirements of the permitting agencies and the depth and velocity criteria in Table 27 at the time of post-construction habitat accounting or meet the criteria as approved through the design criteria review process. Early implementation projects for tributary rearing habitats will be expected to provide an explanation that is acceptable to State Water Board and CDFW that the projects provide suitable cover and inundation regimes for the intended benefits. The explanation may include other benefits or constraints (e.g., traditional ecological knowledge, health and safety limitations) that informed the project design and/or construction. Tidal Wetland and bypass floodplain projects will propose design criteria for accounting and undergo the design criteria review process specified above, with consideration for the advanced stages of many of those projects. The expectation for tributary spawning, instream rearing, and tributary floodplain habitat measures is that the area of suitable habitat conforms to the design criteria at a range of flows. For accounting purposes, the VA Science Plan will also include the methodology for comparing the acreage of suitable habitat of Non-flow Measures conforming to the design criteria against the flow-habitat relationships provided by VA parties for the Final Draft Scientific Basis Report Supplement (SWB in preparation). Detailed protocols for this evaluation will be provided in the VA Science Plan. As demonstrated by tributary-specific flow-habitat relationships meeting VA design criteria, suitability of certain habitat acreages varies over a range of flows. Thus, in many cases habitat accounting does not assume 100% suitability for all constructed acres (per project or tributary) across all flows.

Accounting for early implementation projects will be provided in the first Annual Report. All Non-flow Measures (including that completed under Early Implementation) will be subject to the same habitat

[6] Acreage represented under the Early Implementation heading in Table **26** may differ slightly from the Early Implementation acreage estimated through the accounting procedure described in this section.

suitability and habitat utilization and biological effectiveness assessments noted in Section 3.1.3 of this Strategic Plan.

Projects early in the planning and implementation lifecycle (i.e., proposed, or planning/scoping phases, see Table 29) as of Jan. 1, 2024, will not be considered as part of early implementation and will be subject to the accounting procedures described in Section 3.1.4.

Appendix D provides a non-exhaustive list of Non-flow Measures that may potentially be credited under Early Implementation, pending testing and refinement of the Non-flow Measure Accounting description provided above.

Table 29. An adaptation of EcoAtlas "Site Status" definitions, used to identify projects under Early Implementation.

Phase	Description	Project status as of Jan. 1, 2024…
Proposed	Project has been proposed. Only displayed if marked as public.	VA Implementation
Planning/Scoping	Project is in the planning/scoping phase.	VA Implementation
Permitting	Permit has been submitted.	Early Implementation
In-progress/Implementation	Project is in-progress or is being implemented.	Early Implementation
Construction planned	Construction is planned but has not started.	Early Implementation
Construction in-progress	Construction has started at the site.	Early Implementation
Construction completed	Construction has been completed.	Early Implementation
Completed	Project has been completed.	Early Implementation

3.2 Sacramento Mainstem

3.2.1 Non-flow Measure Descriptions

Consistent with the MOU Advancing a Term Sheet for VAs (March 2022), the Sacramento River VA physical improvements (habitat) action is for the restoration of 137.5 acres of instream habitat for juvenile Chinook salmon rearing and 113.5 acres of spawning habitat. Each individual VA habitat measure could consist of a mixture of habitat features, including both instream and spawning habitats.

Salmonid habitat improvements within the Sacramento Mainstem have been planned and implemented by Federal and Non-Federal partnerships, with the support of financial contributions from Federal, State and local agencies, in addition to non-governmental organizations contributions. Habitat planned or proposed for implementation during the VA term is part of an ongoing and robust salmonid habitat improvement program informed by science through the multi-State, Federal, and Non-Federal participants of the CVPIA Science Integration Team (SIT). These actions are implementing both the National Marine Fisheries Service's Recovery Plan for the Sacramento River and the California Natural Resources Agency's Sacramento Valley Salmon Resiliency Strategy. They continue the work of Sacramento Valley Salmon Recovery Program, a collaborative partnership of local water management entities, conservation organizations and state and federal fisheries and water management agencies formed to complete projects and improve science to promote recovery of salmon and other species of fish in the region. Since December 2018, 12 spawning/rearing combination projects contributing to the VA environmental targets have been implemented in the Sacramento mainstem.

For the Sacramento River Mainstem, early implementation projects are contributing 71.85 acres of spawning habitat and 105.65 acres of instream habitat (in-channel rearing habitat) towards the habitat restoration targets established in the MOU. Additional early implementation projects are contributing 138.2 acres of tributary floodplain rearing habitat, 3.5 acres of fish passage improvement habitat and 31.9 acres of predation reduction and other salmon recovery projects. During the term of the agreements, additional acres of habitat will be constructed to meet, and potentially exceed, the targets established in the MOU.

Program habitat planned to be implemented or maintained during the VA term includes spawning habitat, perennially inundated rearing habitat (side channels), and seasonally inundated rearing habitat (floodplain grading/planting).

3.2.2 Default Implementation Schedule

Table 30. Default implementation schedule for Non-flow Measures on the Sacramento Mainstem.

Description of Measures	Early Implementation (Dec 2018 -2024)	Years 1-3 (2025 – 2027)	Years 4-6[1] (2028 – 2031)	Years 7-8[1] (2032-2033)	Total[2]
Spawning (acres)[3]	71.85	45.37	73.20	42.20	232.62
Rearing: In-Channel (Instream) (acres)[4]	105.65	8.07	121.70	3.00	238.42
Rearing: Tributary Floodplain (acres)[4]	138.20	328.20	5,476.00	0	5,942.40
Fish passage improvements (# of acres)[4]	3.50	0	0	0	3.50
Other (predation reduction/combination of acres and number of clusters)	31.9 acres predation / 2,085 clusters	0 acres predation / 50 clusters	2 acres predation / 193.3 clusters	0 acres predation / 50 clusters	33.9 acres predation / 2,378.30 clusters

[1]Assumes adequate funding exists at the time of implementation.
[2] Table includes all likely feasible acreage planned for implementation and/or maintenance under existing and ongoing habitat program, based on the current implementation schedules. More habitat may be constructed during the VA timeframe above than required. The VA commitment includes 135.5 acres of rearing and 113.5 acres of spawning habitat. Any acreages created during the VA term above those obligations will not be subject to VA governance or Board oversight.
[3] Includes implementation of current programmatically permitted and designed spawning/rearing combination sites and ongoing maintenance of spawning sites, to ensure continued habitat function at early implementation program (EIP) funded sites through the period of performance for the Voluntary Agreements.
[4] Includes implementation of current programmatically permitted rearing and spawning combination habitat sites and implementation of new rearing-only sites that have not yet been permitted and for which designs are currently at the conceptual level.

3.2.3 Implementation Details

Lead implementation of Non-flow Measures will continue to be Reclamation, DWR, and working with Water Districts and other non-governmental agencies under existing habitat programs.

Acreages presented in Table 30 include a mix of projects along the Sacramento River: 1) currently designed (65% level) and programmatic permitted combination spawning/rearing habitat sites, which are generally implemented in the following manner - material excavated from existing gravel bars is sorted to specified sizes and placed in the river for spawning gravel, and the subject excavated area is reworked to provided adjacent paired rearing habitat, 2) rearing-only sites of varying sizes and complexity which are currently at the conceptual design level and do not yet have regulatory coverage but would be constructed through localized grading and the addition of willow/riparian plantings and/or large woody material, and 3) maintenance of early implementation program sites using gravel from designated borrow sites (for spawning habitat) and targeted grading (for rearing habitat) to ensure continued habitat function at previously implemented project sites through the period of performance for the Voluntary Agreements.

The acreage totals provided in the table reflects what is prescribed for VA non-flow actions on the Sacramento River. However, proposing a mix of potential projects, of varying sizes along the river continuum, offers the existing program flexibility in support of the following objectives: continued annual implementation and maintenance of salmonid habitat, maintaining vital landowner and stakeholder support, operating mindfully within the constraints of available funding, coordinating schedules with other entities planned work in the river corridor, and allowing for adaptive management while fully meeting VA habitat acreage requirements during the term.

3.3 Sutter Bypass, Yolo Bypass, Butte Sink, and Colusa Basin

3.3.1 Non-flow Measure Descriptions

Consistent with the Sutter Bypass, Butte Sink and Colusa Basin section in the MOU Advancing a Term Sheet for VAs (March 2022), the Sutter Bypass, Butte Sink, and Colusa Basin non-flow (habitat) action is for the restoration of 20,000 acres of floodplain habitat and 20,000 of fish food production (initial targets per funding and permitting). Additional habitat measures are planned to provide weir improvements and fish passage projects.

Floodplain Habitat

New floodplain habitat enhancement areas totaling at least 20,000 acres will be developed in the Sutter and Yolo Bypasses, Butte Sink and the Colusa Basin. This enhanced floodplain habitat will provide rearing habitat and food production for resident and migratory fish species. Spreading out and slowing down water moving across this landscape is a nature-based, natural infrastructure solution that mimics natural floodplain processes and provides multiple benefits year-round by allowing farmers to cultivate rice and other crops for humans during the spring and summer, provide food and habitat for a diversity of migratory birds and other wetland-dependent wildlife in the fall and winter, and food for juvenile native fish species in the winter. These innovative habitat restoration and floodplain reactivation concepts are intended to quickly improve and enhance fish and wildlife habitat by increasing opportunities for juvenile salmonid rearing and additional water onto the floodplains to stimulate fish food production and to support the millions of migratory and resident birds that rely on the Sacramento Valley.

Fish Food Production

This out-of-stream floodplain reactivation will support recovery of endangered species by producing needed food resources. Fish species benefiting from this habitat acreage include resident and migratory species. In fall after rice harvest, farmers re-flood their rice fields using the same irrigation canals that were used to irrigate the fields in summer. This water is being used to mimic the natural floodplain conditions needed to reactivate the floodplain's explosively productive aquatic food web. In the shallow water, bacteria and fungi break down the plant matter that grew on the floodplain during summer, these microbes are then eaten by billions of small crustaceans and insects called zooplankton. This food-rich water is returned to the river using existing water management infrastructure, where it feeds young fish. The annual 20,000 acreage target for fish food production is expected to be met and likely exceeded during the term of the VAs.

Weir Improvements and Fish Passage Projects

In addition to the targets identified in the Term Sheet, these areas will also be the location for several weir improvements and fish passage projects within the weirs and bypasses. These projects will enhance passage success for migrating juvenile and adult fish through weir structures and within bypasses.

3.3.2 Default Implementation Schedule

Table 31. Default implementation schedule for Non-flow Measures in Sutter and Yolo Bypasses, Butte Sink, and Colusa Basin.

Description of Measures	Early Implementation (Dec 2018 – 2024)	Years 1-3 (2025 – 2027)	Years 4-6[1] (2028 – 2031)	Years 7-8[1] (2032-2033)	Total
Floodplain Habitat (Includes Upstream and Tidal Floodplain acres)	3,600	8,600	[Additional acres will be constructed in these years to achieve, and potentially exceed, VA requirements]	[Additional acres will be constructed in these years to achieve, and potentially exceed, VA requirements]	20,000
Fish Food Production on Agricultural Land (annual acres) [2]	30,000[3]	20,000	20,000	20,000	20,000
Weir Improvements & Fish Passage Projects (# of projects) [4]	4[5]	3[6]	-	-	7

[1]Assumes adequate funding exists at the time of implementation.
[2] Table includes acreage planned for implementation and/or maintenance under existing and ongoing habitat program, based on the current implementation schedules. More habitat may be constructed during the VA timeframe above that required
[3] Represents acreage implemented in 2022-2023 season.
[4] These salmon recovery projects are in addition to targets contained in the Sutter Bypass, Butte Sink and Colusa Basin section in the MOU Advancing a Term Sheet for VAs
[5] Illustrative projects include: Tisdale Weir Improvements and Fish Passage; Sutter Bypass Weir 2; Los Rios Check Dam Fish Passage Project; County Road 106a Fish Passage Project
[6] Illustrative projects include: Butte Slough Outfall Gates; Sutter Bypass Weir 2; Lisbon Weir

3.3.3 Implementation Details

Projects will be implemented through collaborative partnerships organized from a group of water management entities, local governments, landowners, conservation organizations, universities and state and federal water management and fisheries organizations. The implementation schedule will be dependent on funding availability and permitting support from the regulatory agencies.

3.4 Feather

3.4.1 Non-flow Measure Descriptions

Non-flow measures in the Feather River include restoring salmonid spawning habitat and creating additional side-channels and access to floodplain habitat to improve rearing conditions for juvenile salmonids. There are also measures to improve fish passage and reduce the impacts of predators. Collectively, these measures should increase the number of juvenile fish produced, their survival to the ocean, and ultimately the number of spawning adults returning to the Feather River.

In the early implementation phase of the VA, DWR is restoring 9 acres of spawning habitat in the upper reaches of the Feather River with the addition of approximately 13,000 cubic yards of gravel. Within this phase, Sutter Butte Flood Control Agency (SBFCA) has also restored 100 acres of floodplain habitat in the Oroville Wildlife Area improving rearing conditions for juvenile Chinook salmon in the lower Feather River.

In subsequent phases of the VA, DWR proposes projects that will improve spawning conditions of an additional 6 acres of habitat in the upper reaches of the Feather River, as well as the creation of approximately 1,300 linear feet of side-channel habitat. DWR is also developing plans for several levee set-back levee projects in the Feather River corridor that would create approximately 1,000 acres of additional floodplain habitat.

CDFW continues to develop a floodplain project at Nelson Slough that would lower and widen an existing slough within the existing levees of the lower Feather River corridor downstream of Highway 99 and connecting it with Nelson Slough in the Sutter Bypass. This would allow Feather River basin water to flow into the Sutter Bypass with much greater frequency than the current condition connecting a remnant floodplain in the lower Feather River corridor with existing floodplain in the Sutter Bypass. The project could increase floodplain habitat available to Feather, Yuba, and Bear River salmonids by approximately 3,000 acres. Additional floodplain inundation resulting from this project could provide rearing benefits to Sacramento River origin juvenile winter and spring-run Chinook salmon, juvenile Butte Creek spring-run Chinook salmon in the Sutter Bypass as well as to Feather River basin spring-run Chinook salmon. This project has an approved CVPIA charter.

SBFCA continues to develop planned restoration projects including the addition of side-channel and floodplain habitat in the Robinson’s Riffle complex of the Feather River — a prime rearing area for salmonids. Filling in Robinson’s Pond (a gravel borrow pond) will create additional floodplain and in-river rearing habitat, as well as eliminate predator refugia.

3.4.2 Default Implementation Schedule

Table 32. Default implementation schedule for Non-flow Measures on the Feather River.

Description of Measures	Early Implementation (Dec 2018 -2024)	Years 1-3 (2025 – 2027)	Years 4-6[1] (2028 – 2031)	Years 7-8[1] (2032-2033)	Total
Spawning (acres)	9	-	6[2]	-	15[2]
Rearing: In-Channel (acres)	-	-	1	4.25	5.25
Rearing: Tributary Floodplain (acres)	100	-	1555[2]	-	1655[2]
Fish passage improvements (number of projects)	-	-	1	-	1
Other Predation reduction	-	-	1	-	1

[1]Assumes adequate funding exists at the time of implementation.
[2]More habitat is planned for the program during this timeframe than is required under the VA Agreement. Additional acres above VA requirements and are not included in the total quantities here.

3.4.3 Implementation Details

The primary implementing entities include the following:

- Department of Water Resources
- Sutter Butte Flood Control Agency
- Department of Fish and Wildlife

Measures to be implemented before 2031 assume permits and funding will be granted.

3.5 Yuba

3.5.1 Non-flow Measure Descriptions

Consistent with the MOU Advancing a Term Sheet for VAs (March 2022), the Yuba River VA non-flow (habitat) action is for the restoration of 50 acres of instream habitat and 100 acres of floodplain habitat for juvenile Chinook salmon rearing. Each individual VA habitat measure will consist of a mixture of habitat features, including both instream and floodplain habitats.

Instream (In-Channel) Habitat

Instream (i.e., in-channel) habitat is defined as certain components (i.e., "features") of the habitat portfolio that occur within the bankfull boundaries of the lower Yuba River. The bankfull channel has been delineated by the wetted channel boundary corresponding with a flow of approximately 5,000 cfs[7]. Importantly, instream habitat is not defined by a specific flow threshold. Rather, instream habitat occurs within the bankfull channel geospatial boundary generally associated with 5,000 cfs. Instream habitat associated with VA habitat measures can be comprised of various features including perennial side-channels, ephemeral side-channels, backwater and alcoves, and channel edge habitats.

The Draft Scientific Basis Report Supplement in Support of Proposed Voluntary Agreements for the Sacramento River, Delta, and Tributaries Update to the Bay-Delta Water Quality Control Plan (Draft SBRS) (p. 5-6) suggests that an appropriate representation would characterize proposed VA instream juvenile Chinook salmon rearing habitat corresponding with the State Team's suitability criteria[8] at different flow levels, which would include minimum, maximum, and target or other intermediate flows. In general conformance with this representation scheme, lower Yuba River juvenile Chinook salmon VA instream rearing habitat will be characterized as being constructed and suitable as follows.

- Yuba River proposed VA instream juvenile Chinook salmon rearing habitat would be constructed such that it would be at least 50% suitable (i.e., conforming to the State Team's depth and velocity suitability criteria from the Draft SBRS) on an areal extent basis at baseflow (730 cfs above Daguerre Point Dam, and 560 cfs below Daguerre Point Dam), and be at least 80% suitable at 2,000 cfs, measured at Smartsville for above Daguerre Point Dam and Marysville for below Daguerre Point Dam locations.

Yuba River proposed VA instream juvenile Chinook salmon rearing habitat would not be designed to be constructed within the river bankfull channel at elevations exceeding those associated with a flow of 2,000 cfs. Rearing habitat would be designed and constructed such that it would remain at least 70% suitable up to bankfull flows (for assessment purposes, 5,000 cfs), while recognizing that proposed VA instream rearing habitat would continue to exhibit suitability (albeit at reduced levels) at flows exceeding bankfull.

Floodplain Habitat

The Draft SBRS apparently differentiated lower Yuba River instream versus floodplain rearing habitats by equating instream habitats as those occurring at flows less than or equal to 5,000 cfs, and floodplain habitats as those occurring at flows greater than 5,000 cfs. While Yuba Water recognizes the State Team's need to simplify habitat characterization for the purpose of distinguishing in-channel versus floodplain habitat, habitat features in the lower Yuba River occurring in the bankfull channel at flows up to 5,000 cfs can serve a variety of ecological functions, including some functionality as floodplain habitat. Floodplain habitat associated with VA habitat measures consists of broad areas that may be flat or have a gentle

[7] Wyrick, J. and G. Pasternack. 2012. Landforms of the Lower Yuba River. Prepared for the Lower Yuba River Accord Planning Team. Lower Yuba River Accord Monitoring and Evaluation Program. April 2012.

[8] As specified in the Draft SBRS (p. 5-6, Table 5-3), the instream rearing habitat depth suitability range is 0.5 – 4.0 ft, and the velocity suitability range is 0.0 – 3.0 fps.

slope and tend to be characterized by relatively low velocities with little to no concentrated flow paths. Consistent with the March 2022 MOU, floodplain habitat activates at 2,000 cfs. Floodplain habitat suitability will conform with the State Team's depth and velocity criteria[9]. However, because floodplain habitats are intended to increase aquatic habitat productivity (primary and secondary) and food availability to encourage juvenile Chinook salmon growth, floodplain habitats will be designed and constructed to be functional at the lower end of the suitable depth and velocity ranges over a range of flows.

As specified in the March 2022 MOU, the Yuba River proposed VA floodplain habitats would be constructed to be inundated at 2,000 cfs and, in accord with the Draft SBRS (p. 5-10, Table 5-6), would be assumed to be suitable (i.e., meeting the State Team's depth and velocity criteria) when inundated (i.e., above flows of 2,000 cfs in the lower Yuba River).

3.5.2 Default Implementation Schedule

Table 33. Default implementation schedule for Non-flow Measures on the Yuba River.

Description of Measures	Early Implementation (Dec 2018 -2024)	Years 1-3 (2025 – 2027)	Years 4-6[1] (2028 – 2031)	Years 7-8[1] (2032-2033)	Total
Hallwood Side Channel and Floodplain Restoration Project (Constructed in 4 phases)	Total Floodplain habitat: ~138 ac Total Instream habitats: ~6 ac Total Other habitats: ~13 ac	-	-	-	Approximate 157-acre project footprint
Long Bar Salmonid Habitat Restoration Project (Lower Long Bar)	Floodplain habitat: ~ 18 acres Instream habitat: ~12 ac Other habitats: ~13 ac	-	-	-	Approximate 43-acre project footprint
Upper Rose Bar Restoration Project[2]	Spawning habitat[3]: ~5 acres Instream habitat: ~1.2 acres Other habitats and construction areas: ~37 ac	-	-	-	Approximate 43-acre project footprint

[9] As specified in the Draft SBRS (p. 5-6, Table 5-3), the floodplain rearing habitat depth suitability range is 0.5 – 4.0 ft, and the velocity suitability range is 0.0 – 3.0 fps.

Description of Measures	Early Implementation (Dec 2018 -2024)	Years 1-3 (2025 – 2027)	Years 4-6[1] (2028 – 2031)	Years 7-8[1] (2032-2033)	Total
Upper Long Bar Habitat Enhancement Project	-	Preliminary concept is to create a diversity of seasonal off-channel juvenile salmonid rearing habitat types (e.g., floodplain, side channel, alcove). Project contingent upon funding and permitting, timeline for implementation is TBD[4], but could occur with the term of the VA.			Approximate 100 acres[5] of floodplain and instream rearing habitat
Rose Bar Comprehensive Restoration Plan	-	Preliminary concept includes creating instream/rearing, spawning, floodplain, and fish food production habitat functionalities. Project contingent upon funding and permitting, timeline for implementation is TBD, but could occur with the term of the VA.			Approximate 50 acres[5] of floodplain and instream rearing habitat

[1]Assumes adequate funding exists at the time of implementation.
[2]Permits have been drafted, ESA consultation initiated, and funding application submitted to CDFW Fisheries Restoration Grant Program during April 2022.
[3] Yuba River VA does not include spawning habitat restoration actions.
[4]Funding for project planning has been secured from Yuba Water and the Wildlife Conservation Board. Implementation funding sources have not yet been identified but may potentially include Yuba Water and other grant funds (e.g., Prop 68), among others.
[5]Proportionate amount of instream and floodplain habitats that will be created under this habitat enhancement project will be determined through further design development.

3.5.3 Implementation Details

Consistent with the March 2022 MOU, Yuba Water would contribute $10 million[10] together with additional state funds as needed to meet the 50 acres of instream and 100 acres of floodplain juvenile Chinook salmon rearing habitat enhancement component of the Yuba River VA over the term of the Yuba River VA[11].

The primary objectives of the habitat enhancement component of the Yuba River VA proposal are to improve the productivity, complexity and diversity of anadromous salmonid juvenile rearing habitat in the lower Yuba River, and therefore provide greater opportunities for a more diverse portfolio of rearing and outmigration life history strategies. The anticipated outcomes include increased growth and survivability

[10] Table 4 (Funding for VAs' Framework) of Appendix 3 to the March 2022 MOU references the December 2018 Framework for overall VA funding commitments. In the December 2018 Framework, Yuba Water's proposal included contribution of $10 million for habitat enhancement measures over the 15-year term of the VA. However, pursuant to the March 2022 Term Sheet, the VAs will remain in effect for a term of 8 years after the Effective Date (i.e., on the date the Government Code section 11415.60 Agreements are executed). As such, the Yuba Water funding amount specified in the December 2018 Framework would be prorated over the actual term of the VA.

[11] Implementation of the habitat enhancement component of the Yuba River VA proposal would be subject to and dependent upon the availability of, and access to, appropriate land, legal constraints and other external factors. The habitat enhancement conceptual design regarding inundation elevations and associated flows are not yet at the stage of final project designs. Although work is in progress, specific habitat enhancement measures have not all been identified and are subject to 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.

of juvenile anadromous salmonids, and subsequent contribution to spawning stock escapement. The Yuba River VA proposed habitat enhancement measures are intended to provide physical habitat conditions that would support broad temporal and spatial distributions of juvenile anadromous salmonid rearing, and larger individuals in better condition with higher survivorship by providing: (1) physical habitat structure (i.e., complexity, sinuosity, diversity, instream object and over-hanging cover); (2) improved food availability, quality and diversity; (3) refugia from predators; and (4) refugia from high flows.

The Yuba River proposed VA habitat enhancement strategy originates from biological and ecological functionality, not strict geomorphology or hydrological statistical characterization of flow exceedance probabilities. In other words, adherence to a simplistic definition of flow levels or suitability criteria does not reflect the holistic definition of ecological diversity that contributes to the viability of native fish populations. Rather, each habitat enhancement measure reflects ecological diversity through variation in ecological functionality resulting, in part, from variable flow regimes and their interaction with the physical habitat structure associated with each habitat enhancement measure.

The habitat acreages provided in Section 3.5.2 (above) are beyond what is proposed for the Yuba River VA non-flow (habitat) actions. Each habitat enhancement project consists of up to several different habitat types, including instream rearing (e.g., perennial side-channels, ephemeral side-channels, backwater and alcoves, and channel edge habitats), floodplain rearing, and in some instances, spawning habitat components. The areal extent (or project footprint) of each habit enhancement project is a composite of the areal extent of all the habitat types, and potentially includes other habitats and construction areas. The preliminarily identified habitat enhancement projects could contribute towards meeting the Yuba River proposed VA habitat acreages during the term of the VA.

Additional details regarding each of the projects identified in Section 3.5.2 are available and are summarized below. The early implementation (2018-2024) projects are ongoing efforts to which Yuba Water has committed resources and funding for design, permitting, and construction. The longer-term implementation (2024 and beyond) projects are specific examples of potential Yuba River VA projects for which preliminary conceptual outlines, designs or other planning efforts already been initiated, and which, if completed within the term of the VA, could contribute to the Yuba River VA non-flow (habitat) actions of 50 acres of instream habitat and 100 acres of floodplain habitat for juvenile Chinook salmon rearing.

3.5.4 Early Implementation (2018 – 2024) Projects

The following habitat enhancement projects are identified as "early implementation" (2018 – 2024) projects for which Yuba Water has committed resources and funding for the design, permitting, and construction of these projects. These projects will contribute toward the 50 acres of instream and 100 acres of floodplain juvenile Chinook salmon rearing habitat Yuba River VA commitments, and include Hallwood Side Channel and Floodplain Restoration Project, Long Bar Salmonid Habitat Restoration Project (Lower Long Bar), and Upper Rose Bar Restoration Project.

Hallwood Side Channel and Floodplain Restoration Project

The Hallwood Side Channel and Floodplain Restoration Project (Hallwood Project), located in the lower Yuba River downstream of Daguerre Point Dam, is a floodplain rearing habitat enhancement project developed by the U.S. Fish and Wildlife Service (USFWS), Yuba County, and the South Yuba River Citizens League (SYRCL). Yuba Water joined the project through funding implementation and construction during the summer of 2019. The project would increase the extent and duration during which juvenile salmonids are able to access the floodplain over a range of flows, as well as create and enhance perennial and seasonal side channel habitat.

The Hallwood Project consists of 4 phases, enhancing approximately 157 acres of seasonally inundated riparian floodplain, perennial side channels, and seasonally inundated side channels, alcoves, and swales.

- Phase 1 represents an enhancement of floodplain rearing habitat within a grading footprint of 89 acres and includes instream habitat of approximately 1.7 miles of perennial side channels and 6.1 miles of seasonally inundated side-channels, alcoves, and swales. Phase 1 of the Hallwood Project was completed during 2020.
- Phase 2, which involved removal of about 800,000 yards^3 of sediment from the Middle Training Wall and surrounding floodplains in the upper reach and enhancing 34 acres of floodplain and seasonally inundated side channel habitat was completed during 2021.
- Phase 3 removed approximately 825,000 yards^3 of mainly Middle Training Wall material, with an overall footprint of 13 acres of created floodplain habitat. Phase 3 was completed in 2022.
- The remaining phase (Phase 4) of the Hallwood Project will remove a total of about 400,000 yards^3 of sediment from portions of the Middle Training Wall and enhance an additional 21 acres of floodplain and seasonally inundated side channel habitat. Construction of Phase 4 is expected to be completed in 2024 (Yuba Water Agency 2022).

For planning purposes, the design for all 4 phases of the Hallwood Project represents the creation of approximately 138 acres of floodplain, and about 6 acres of instream juvenile rearing Chinook salmon habitat, and 13 acres of other habitats (e.g., high terrace).

Long Bar Salmonid Habitat Restoration Project (Lower Long Bar)

Located upstream of Daguerre Point Dam, the Lower Long Bar Salmonid Habitat Restoration Project was designed to enhance approximately 43 acres along the lower Yuba River in an area referred to as Long Bar (USFWS and Yuba County 2021). This is a collaborative project developed and funded by Yuba Water, USFWS, SYRCL, the Long Bar Mine LLC, Western Aggregates, and Silica Resources Inc. The project involves removing about 350,000 yards^3 of hydraulic mining debris to lower the floodplain and create juvenile anadromous salmonid rearing habitat. In addition to riparian plantings adjacent to re-graded areas, other habitat features will include enhanced floodplain areas (17.9 acres), perennial backwater channels (5.4 acres), riparian terraces (2.9 acres), side channels (4 acres), secondary and low flow channels (2.4 acres), and terraces (6.4 acres), among others (USFWS and Yuba County 2021). Construction began in 2020 and was completed in 2022, and about 80,000 yards^3 of material was removed as of July 2022 (SYRCL 2022).

For planning purposes, the Long Bar Salmonid Habitat Restoration Project represents the creation of approximately 18 acres of floodplain, and 12 acres of instream juvenile rearing Chinook salmon habitat, in addition to other habitat features (described above).

Upper Rose Bar Restoration Project

The Upper Rose Bar Restoration Project is located on private property owned by Yuba Water along the lower Yuba River near the community of Smartsville in Yuba County, California. The project, including design, permitting, construction, and monitoring, is funded and directed by CDFW through the Proposition 1 grant program, and designed by SYRCL. The project footprint is approximately 43 acres and will provide approximately 5 acres of Chinook salmon spawning habitat. The project also includes placement of large wood, and other measures that provide refugia and suitable rearing habitat for juvenile salmonids, resulting in approximately 1.2 acres of juvenile Chinook salmon instream rearing habitat. Construction is anticipated to occur in 2023 and require only one year to complete (Cramer Fish Sciences 2022).

3.5.5 Longer-term Implementation (2024 and beyond) Projects

Preliminary conceptual outlines, designs or other progress for potential longer-term (2024 and beyond) habitat enhancement projects that may contribute to the Yuba River VA non-flow (habitat) actions of 50 acres of instream habitat and 100 acres of floodplain habitat for juvenile Chinook salmon rearing include the Upper Long Bar Habitat Enhancement Project (Upper Long Bar) and Rose Bar Comprehensive Restoration Plan (preliminary details available upon request). Timing for permitting, funding, and construction of these projects will need to be assessed by project proponents, but could be completed within the term of the VA.

References:

Cramer Fish Sciences. 2022. Upper Rose Bar Salmonid Spawning Habitat Restoration Project Biological Assessment. May 2022. West Sacramento, CA.

South Yuba River Citizen's League (SYRCL). 2022. Lower Long Bar Restoration Project. Available online at: https://yubariver.org/our-work/lower-yuba-restoration/active-lower-yuba-projects/long-bar-restoration-project/. Accessed on October 26, 2022.

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Yuba Water Agency (Yuba Water). 2022. Hallwood Side Channel and Restoration Project website and fact sheet. Available online at: https://www.hallwoodproject.org/. Accessed on February 23, 2023.

3.6 American

3.6.1 Non-flow Measure Descriptions

Salmonid habitat improvements along the Lower American River have been planned and implemented by the Water Forum since 2008, with the support of Federal and State funding. As members of the Sacramento Water Forum, American River signatories have also provided significant support to this effort. Habitat planned or proposed for implementation during the VA term is integrated into a salmonid habitat improvement program informed by American River-specific fisheries, topographic/bathymetric, hydraulic, and hydrologic data. To date, twelve spawning/rearing combination projects have been implemented and/or maintained under the existing salmonid habitat program and this is expected to grow with additional VA funding opportunities.

The Water Forum has a long, successful history of implementing habitat projects on the Lower American River. It is anticipated that the American River signatories will continue to rely on the Water Forum's ability to deliver habitat projects for the purposes of VA implementation. The Water Forum's currently permitted combination spawning/rearing program sites consist of 10 separate implementation areas concentrated in the upper portion of the river (RM 13-23). These spawning/rearing sites and their ongoing implementation and maintenance are planned to be used to fulfill a portion of the VA habitat requirements. Current program sites have been refined to a 65% level of design and have been individually and cumulatively analyzed using 2017 Digital Elevation Model (DEM) information incorporated into our HEC-RAS 2D hydrodynamic model developed and calibrated for the American River. The 10 program sites are also covered under a comprehensive programmatic permitting and regulatory framework, which includes the following: Corps 408 Programmatic Permission, Corps 404 Regional General Permit 16, Central Valley Flood Protection Board Encroachment Permit (annual), USFWS and NMFS Biological Opinions, Central Valley Regional Water Quality Control Board 401 Certification, CDFW 1600 Waivers, SHPO/106 Tribal Cultural consultations, a State Lands Commission lease, NPS Wild & Scenic concurrence, and NEPA/CEQA compliance. Additionally, there are several additional sites identified on the American River that have the potential to further support VA habitat projects. These sites are currently at the conceptual design level, and a portion of these site designs are planned to be refined, permitted, and implemented during the next 10 years, to fulfill the remainder of the VA rearing habitat requirements for the American River. The habitats described above will continue to be constructed and maintained throughout the VA term and beyond with the support of future funding sources.

The design process for all sites is and will be based on adaptive management, ongoing monitoring, and analysis of prior implemented projects along the American River. A long-term consistent team (Water Forum, consultants, and Reclamation fisheries staff) has collaborated on planning, analysis, design, implementation, outreach, and monitoring of all sites. It is anticipated that the same or similar team, along with American River signatories, will continue this collaboration for future projects. All designs include and will continue to include analysis required for habitat optimization of spawning and/or rearing hydraulics, cut/fill volume balancing, bed mobility assessment and consideration of landowner and stakeholder concerns.

Habitat planned to be implemented or maintained during the VA term includes spawning habitat and in-stream rearing habitat. 75 acres of rearing habitat were committed to being constructed on the American Rive, in the Term Sheet. However, neither the 75-acre total commitment nor the total rearing acreage of a single constructed project would meet suitability criteria 100% of the time under all conditions. In-stream rearing habitat is designed to complement the geomorphic and hydrologic/operational regime of the American River and would become inundated and optimized (for flow and velocity) over a varying range of flows (and thus water year types). These designs also incorporate cover elements appropriate to the existing character of the American River and as allowed by permitting agencies. Based on habitat effectiveness monitoring, this design approach has proven successful to provide suitable habitat for rearing juveniles in the American River, over a range of water year types.

3.6.2 Default Implementation Schedule

Table 34. Default implementation schedule for Non-flow Measures on the American River.

Description of Measures	Early Implementation (Dec 2018 - 2024)	Years 1-3 (2025 – 2027)	Years 4-6[1] (2028 – 2031)	Years 7-8[1] (2032-2033)	Total Acres for VA[2]
Spawning[3]	25 [Additional acres have been constructed in these years above VA requirements and are not included in the total quantities here]	[Additional acres will be constructed in these years above VA requirements and are not included in the total quantities here]	[Additional acres will be constructed in these years above VA requirements and are not included in the total quantities here]	[Additional acres will be constructed in these years above VA requirements and are not included in the total quantities here]	25
Rearing: In-Channel[4]	26	13	23	13 [Additional acres will be constructed in these years above VA requirements and are not included in the total quantities here]	75

[1] Assumes adequate funding exists at the time of implementation.

[2] The VA commitment includes 75 acres of rearing and 25 acres of spawning habitat. More habitat may be constructed during the VA timeframe above that required. Any acreages created during the VA term above those obligations will not be subject to VA governance or Board oversight.

[3] Includes implementation of current programmatically permitted and designed spawning/rearing combination sites and ongoing maintenance of spawning sites, to ensure continued habitat function at early implementation program (EIP) funded sites through the period of performance for the Voluntary Agreements.

[4] Includes implementation of current programmatically permitted rearing and spawning combination habitat sites and implementation of new rearing-only sites that have not yet been permitted and for which designs are currently at the conceptual level.

3.6.3 Implementation Details

The American River signatories, in collaboration with the Water Forum, are expected to continue to lead implementation of non-flow measures on the American River.

Acreages presented in Table 34 include a mix of projects along the American River: 1) currently designed (65% level) and programmatically permitted combination spawning/rearing habitat sites, which are generally implemented in the following manner - material excavated from existing gravel bars is sorted to specified sizes and placed in the river for spawning gravel, and the subject excavated area is reworked to provided adjacent paired rearing habitat, 2) rearing-only sites of varying sizes and complexity which are currently at the conceptual design level and do not yet have regulatory coverage but would be constructed through localized grading and the addition of willow/riparian plantings and/or large woody material, and 3) maintenance of EIP sites using gravel from designated borrow sites (for spawning habitat) and targeted grading (for rearing habitat) to ensure continued habitat function at previously implemented EIP sites through the period of performance for the Voluntary Agreements.

Final habitat acreages for each site are refined during the final design process and are dependent on site-specific hydraulic conditions and constructability. Spawning/rearing combination sites are concentrated in the upper 10 miles of the river (RM 13-23), where hydraulic and substrate conditions are most suitable for spawning and where ongoing monitoring shows a concentration of spawning activity. Rearing-only sites extend into the lower portion of the river (RM 3-13).

3.7 Mokelumne

3.7.1 Non-flow Measure Descriptions

Consistent with the Mokelumne River amendment (August 2022) to the MOU Advancing a Term Sheet for VAs (March 2022), the Mokelumne River VA non-flow (habitat) action is for the restoration of 25 acres of floodplain rearing habitat and 1 acre of instream rearing habitat. Additional habitat measures are planned to provide a suite of habitat improvements to benefit the Mokelumne River anadromous fish populations, including screening riparian diversions and maintenance of restored gravel sites to maintain suitability throughout the term of the VA.

Twenty-five acres of new floodplain rearing habitat enhancement measures will be created. In addition, EBMUD has committed to the annual maintenance of a restored 1-mile (15 acres) spawning reach. No designated spawning habitat is required under minimum required habitat goals, but EBMUD has implemented 1.27 acres of new spawning habitat and 0.87 acres of maintenance of existing habitat as early implementation actions and will continue to implement habitat improvements above the minimum required as landowner and funding opportunities allow. One acre of suitable instream rearing habitat will be implemented through screening diversions and providing habitat complexity during spawning habitat restoration work.

Floodplain Habitat Enhancement Projects

New floodplain habitat enhancement areas would be designed to primarily be inundated at river flows between 900 cubic feet per second (cfs) and 1,500 cfs, and portions of the habitat enhancement areas would provide suitable juvenile rearing habitat at flows as low as 700 cfs, and as high as 5,000 cfs. Under the current flow regime, the recurrence interval for inundation of these habitats is once every 1.5 years. This frequency could change depending on how voluntary agreement flow assets are allocated.

Spawning Habitat Enhancement (Maintenance) and Augmentation (New) Projects

New and maintained suitable spawning habitat areas would be designed to be inundated at river flows between 200 cfs and 600 cfs, and a portion of the habitat would provide suitable salmonid spawning habitat at flows as low as 150 cfs, and as high as 1,000 cfs.

The habitat augmentation projects add to existing habitat within the lower Mokelumne River. These projects would also provide additional juvenile rearing space, habitat complexity, and ultimately provide conditions that would allow for meeting habitat suitability metrics related to juvenile salmon size and survival.

Water Diversion Screening Projects

Surface water diversion structures have been indicated as a significant threat to the salmonid populations in the California Central Valley, with hydrologic conditions, timing of juvenile fish emigration, and timing of water diversions, identified as important factors in juvenile entrainment (Moore et al. 1996; Vogel 2013; Goodman et al 2017). Therefore, one of the priorities of the Central Valley Project Improvement Act (CVPIA), is to modify and/or replace unscreened diversions in order to protect juvenile anadromous fish in both the Sacramento and San Joaquin watersheds.

On the Mokelumne River, a critical time-period has been identified in which juvenile salmonid are rearing and/or out-migrating (February - July) and agriculture irrigation season (April - August) is on-going, in which farms with water rights (riparian or appropriative) pull water directly from the river via privately-owned pumps. During this time-period, both Fry (Length < 2.36 inches: 60 mm) and Fingerling (Length > 2.36 inches: 60 mm) size salmonids are present and distributed throughout the Mokelumne River. Based on this information, the screens that are fabricated and installed on water diversion structures in the Mokelumne River must meet the strictest criteria (fry criteria) set forth by the National Marine Fisheries Service (NMFS; NMFS, 1997), which ensures a project's effectiveness at protecting a variety of aquatic species and life stages based on swimming ability and project design criteria.

<u>Criteria for Water Diversion Screening Projects</u>

- Screens must accommodate the expected range of water surface elevations
- Screens must be generally parallel to river flow and aligned with the adjacent bank line
- Approach velocities must be ≤ 0.33 f/s (0.10 m/s)
- Sweeping velocities must be ≤ approach velocity
- Perforated plate screen face ≤ 3/32 inches (2.38 mm)

As juvenile salmonids out-migrate from the Mokelumne River (0 - 103 river kilometers (rkm)) they may encounter up to 300 water diversion structures, of which over 90% of these water diversions lack a screening design sufficient to prevent fish entrainment (PSMFC 2017). Based on this knowledge, researchers with EBMUD conducted field surveys of water diversions in the Mokelumne River (46-103 rkm) in which data was collected (i.e., intake size, pipe size, site hydraulics, channel substrate, and vegetation/cover). This information was then paired with historic data from riparian water diversions and juvenile fish outmigration timing to create a Relative Risk Model (RRM; Bilski, 2019). The RRM enabled researchers to rank each water diversion and therefore identify the diversion that pose the greatest threat to the native anadromous salmonids. Due to the potential harm to native salmonids caused by unscreened water diversion structures in the Mokelumne River, EBMUD has made it a priority to work with local, regional, state, and federal partners to screen high priority water diversion structures identified by the RRM (priority water diversions 1-50).

In order to ensure that water diversion screening projects meet the NMFS screening criteria, water velocity field surveys will be conducted pre- and post-screen construction using an acoustic doppler current profiler (ADCP), which uses an unmanned remote operated boat to map the water column velocities around each of the active water diversion locations. Measuring the three-dimensional velocity field in the vicinity of the water diversions provides a means of assessing the projects effectiveness for protecting a variety of aquatic species and life stages based on their swimming ability and project design criteria.

3.7.2 Default Implementation Schedule

Table 35. Default implementation schedule for Non-flow Measures on the Mokelumne River.

Description of Measures	Early Implementation (Dec 2018 -2024)	Years 1-3[1] (2025 – 2027)	Years 4-6[1] (2028 – 2031)	Years 7-8[1] (2032-2033)	Total[2]
Spawning (acres)	2.14	0.6	0.6	0.6	3.94
Rearing: In-Channel (acres)	0.87	1.14	-	-	2.01
Rearing: Tributary Floodplain (acres)	3.67	11	11	-	25.67
Fish passage improvements[3] (# of projects)	3 Screens[4] (0.87 acre of In-Channel rearing habitat)	2 Screens[5] (1.14 acre of In-Channel rearing habitat)	-	-	5 Screens (2.01 acre of In-Channel rearing habitat)

[1]Assumes adequate funding exists at the time of implementation.
[2]More habitat is planned for the program during this timeframe than is required under the VA Agreement. Although more habitat is planned than required under the VAs, by providing a programmatic view of potential feasible acreages, it offers flexibility for adaptive management while fully meeting VA habitat acreage requirements.
[3]Screening projects are converted to acres of in-channel rearing habitat for juvenile salmonids habitat improvement based on Flowwest/USBR calculation (20 cfs screened = 1 acre; USBR 2021)
[4]Site #1 = 8.47 cfs; Site #2 = 4.46 cfs; Site #3 = 4.46 cfs; Total cfs = 17.39; Total acres = 0.87
[5]Site #1 = 11.4 cfs; Site #2 = 11.4 cfs; Total cfs = 22.8; Total acres = 1.14

3.7.3 Implementation Details

EBMUD will be the lead implementing agency with support from the federal and state fisheries agencies (USFWS, NMFS, CDFW) and the Joint Settlement Agreement Partnership Coordinating Committee (JSA PCC). The implementation schedule will be dependent on funding availability and permitting support from the regulatory agencies.

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US Bureau of Reclamation (USBR). (2021). Central Valley Project Habitat & Facility Improvements: Notice of Funding Opportunity No. R21AS00617 - FY2022, FY2023, FY2024. 1–58 (2021). Sacramento, California.

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3.8 Putah

3.8.1 Non-flow Measure Descriptions

The Solano County Water Agency (SCWA) in association with the Yolo Bypass Wildlife foundation and CDFW completed the Program Environmental Impact Report for the Lower Putah Creek Restoration Project – Upper Reach Program in 2022 (PEIR, 2022). The overall Program purpose is to restore and rehabilitate the creek channel, banks, and associated habitats to more natural, self-sustaining form and function, consistent with the current (post-Monticello Dam) hydrologic regime. The Program is being implemented to stop further degradation of the creek corridor and to “jump-start” natural geomorphic and ecological processes systematically.

Although Lower Putah Creek (including its riparian corridor) is one of the largest remaining tracts of high-quality wildlife habitat in Yolo and Solano counties and provides habitat for a unique assemblage of fish and wildlife species native to the Central Valley, it is characterized by altered channels and eroding banks, habitat loss and degradation, flood and flood control related impacts, invasive weed infestations, and other problems. The Lower Putah Creek channel is, in many locations, no longer in natural form and function in response to the modified flow regime post-dam. Additionally, historic gravel extraction, channelization, vegetation removal, and other channel modifications have caused significant degradation of natural channel form, process, and ecology. As a result, the Putah Creek channel has become deeply incised, overly wide and is generally lacking in pool-riffle-run sequences, natural meander patterns, and functional floodplains. The existing channel condition cannot ‘self-adjust’ to a more natural morphology because flow velocities are insufficient to mobilize sediment, and natural gravel recharge is substantially arrested. In this condition, the creek is virtually devoid of riffles and spawning habitat, and lacks the materials and functions needed to build such features naturally.

Proposed Program activities will reconfigure degraded areas of the creek channel to more natural cross-sectional form (confined, sinuous low flow channel with adjacent floodplain surfaces) to stabilize eroding banks, facilitate channel shading with bank-side riparian vegetation, and improve habitat values for native fish species. A narrower (more efficient) low flow channel will also serve to increase flow velocities, lower water temperatures, restore competency of the channel to mobilize gravels (for spawning), and restore geomorphic processes that support natural channel and ecosystem dynamics. Implementation of these activities would expand the geographical extent of high-quality habitat for native fish species, including local fall-run Chinook salmon and rainbow trout, and increase riparian habitat by converting shallow, open water areas to floodplains. Channel reconfiguration activities may consist of modifications to channel geometry, construction of grade/flow control structures (i.e., rock-vanes), stabilizing channel banks, creating side-channels, improving spawning gravels, and/or filling abandoned gravel pits.

3.8.2 Default Implementation Schedule

Table 36. Default implementation schedule for Non-flow Measures on Putah Creek.

Description of Measures	Early Implementation (Dec 2018 -2024)	Years 1-3 (2025 – 2027)	Years 4-6[1] (2028 – 2031)	Years 7-8[1] (2032-2033)	Total
Spawning (acres)	1.4	-	-	-	1.4

[1]Assumes adequate funding exists at the time of implementation.

3.8.3 Implementation Details

SCWA has nearly 20 years of practical experience in adaptive management of functional flow relationships aligned with habitat restoration with much success and is well versed in the hydrology and aquatic biology of Lower Putah Creek. Since the execution of the Putah Creek Accord, SCWA has restored, enhanced, and managed many miles of Putah Creek and its tributaries.

SCWA has secured Prop 68 grant funding (#H90410-0) from CNRA to construct the first shovel ready project approved in the Lower Putah Creek Restoration Project – Upper Reach Program. SCWA as the lead CEQA agency will tier off of the PEIR and permitting is in progress with construction planned for summer-fall 2024. The project area encompasses 29 acres of primarily riparian habitat and 0.5-mile section of Lower Putah Creek channel in Yolo and Solano counties. The proposed project objective is to restore this section of active channel that is currently in an over-widened condition and degraded aquatic habitat for native assemblages (i.e., lacking floodplain habitat, essentially stagnant velocities, and long residence time in pools with excessive solar exposure that increases water temperatures). The plan is to create a narrow design channel in a more central, meandering form and new spawning side channels in conjunction with other floodplain habitat improvements that will be more conducive to the favor the needs of native species over invasives. The goal of this proposed project is to create 62,000 sq ft of new spawning habitat in Lower Putah Creek and 0.5 mile of nearly continuous instream and riparian habitat to double the available salmonid spawning habitat in Lower Putah Creek.

In addition, SCWA has a CDFW Routine Maintenance Agreement to implement approximately 0.4 acres of gravel scarification, a mechanized process of loosening embedded gravels in locations where armoring by cementation has rendered streambed gravels inaccessible for use by spawning salmon, annually. The scarification program began in 2014 and results have shown that between 2014 and 2019, 89 -100% of newly reclaimed spawning areas were occupied by spawning adult salmon and rainbow trout.

SCWA has additional conceptual projects that may be implemented in years 1-8 dependent on availability of resources and funding.

3.9 Tuolumne

3.9.1 Non-flow Measure Descriptions

Consistent with the MOU Advancing a Term Sheet for VAs (November 2022), the Tuolumne River Partners propose a number of non-flow actions that, in combination with the proposed VA flow commitments, are intended to improve salmonid spawning and rearing habitat on the lower Tuolumne River. Some of the highlights of the Tuolumne non-flow measures include additional in-channel spawning and rearing habitat, as well as 77 acres of rearing/floodplain habitat that will be inundated at the flows proposed in the MOU for the VA. Many of the proposed projects include a mixture of habitat features that include both instream and floodplain benefits. The non-flow actions proposed by the Tuolumne River Partners go beyond habitat restoration projects and include additional measures, such as predation management, that are also intended to improve conditions for native fish on the lower Tuolumne River.

The non-flow measures for the lower Tuolumne River are based on science developed on the lower Tuolumne River over several decades, including the most recent studies completed as part of the relicensing of the Don Pedro hydroelectric project. The non-flow measures identified for the 8-year term of the VA are included in the tables below and descriptions of the various actions are also provided. All of the non-flow measures described below are supported by studies conducted as part of the Amended Final License Application (AFLA) for the Don Pedro Hydroelectric Project and can be found at the Don Pedro relicensing website: www.donpedro-relicensing.com. Of importance is the fact that the projects and resulting acreages listed in the tables below were developed for the AFLA and are subject to adjustment as part of ongoing and future project specific design.

Non-flow habitat projects *1, 2, 3, 4, 6, 7, 8, 9, 11* as listed in the table below will improve spawning gravel quantity and quality through (1) gravel augmentation of approximately 75,000 tons between RM 52 and 39 and 25,000 tons between RM 39 and 24.5; (2) gravel cleaning of selected gravel patches for two to three weeks for 5 years to expand availability of high quality gravel which would improve spawning success and egg-to-emergence survival for fall-run Chinook salmon; and (3) placement of properly-sized and designed large woody debris between RM 43- 50 to provide favorable micro-habitats for *O. mykiss* and promote localized scour of fines to benefit fall-run Chinook salmon spawning.

The Lower Tuolumne River Habitat Improvement Program (project 5) 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 in the Tuolumne River VA. 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.

Non-flow habitat projects 12 &13 target a reduction in annual predation rates of 10% below RM 25.5 and 20% above RM 25.5 through (1) construction and operation of a fish barrier and counting weir that will prohibit the movement of striped bass into 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; and (2) annual predator suppression activities not limited to, removal and/or isolation methods such as electro-fishing, fyke netting, seining and other positive collection methods.

Non-flow habitat project 14 will involve deployment of a temporary barrier when female spawners counted at the RM25.2 counting facility reaches 4,000 to encourage use of suitable habitats at locations further downstream.

Non-flow habitat project 10 will complete/construct and operate two infiltration galleries 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.

3.9.2 Default Implementation Schedule

Table 37. Non-flow measures in the Tuolumne VA, including information on location, approximate area, and estimated implementation timing.[1]

Project No.	Project and location	Description	Life stage	Benefits	Early Implementation (Dec 2018-2024)	Years 1-3	Years 4-6	Years 7-8	Total
1	Riffle A2 Rehabilitation River Mile (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	-	0.15 acres	-	-	0.15 acres
2	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	-	1.00 acres	-	-	1.00 acres
3	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	Spawning incubation and juvenile rearing	Improved egg-to-emergence survival and expanded floodplain rearing habitat	-	-	0.50 acres	-	0.50 acres
4	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	-	†	†	-	-
5	Lower Tuolumne River Habitat Improvement Program	$19M capital fund shall be used for a variety of improvement and restoration projects to	Juvenile rearing, smolt outmigration	Expanded floodplain rearing; expanded in-channel rearing;	-	-	77 acres	-	77 acres

Project No.	Project and location	Description	Life stage	Benefits	Early Implementation (Dec 2018-2024)	Years 1-3	Years 4-6	Years 7-8	Total
	RM 5-48	be developed in conjunction with the TRPAC (below). Examples of likely projects include floodplain lowering, floodplain connectivity, riparian plantings, in-channel placement of LWD		and improved smolt outmigration survival					
6	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	2.78 acres	-	-	-	2.78 acres
7	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	2.29 acres	-	-	-	2.29 acres
8	Basso Pool RM 47.0-47.3	Construct medial bar: riffle pool-tail morphology	Over-summering *O. mykiss* juvenile and adults	Improved juvenile rearing; improved foraging; improved spawning habitat	-	-	8.78 acres	-	8.78 acres
9	Large Woody Debris	Improve instream habitat complexity through targeted	*O. mykiss* Juvenile rearing	Improved juvenile rearing and increased	-	Place 6,535 cubic feet	-	-	6,535 cubic feet of

Project No.	Project and location	Description	Life stage	Benefits	Early Implementation (Dec 2018-2024)	Years 1-3	Years 4-6	Years 7-8	Total
		addition of LWD to the lower Tuolumne River		in-channel rearing area		of large woody material			large woody material
10	Infiltration Galleries (IG) RM 26	Construct IG#2 and operate IG#1 (existing) and IG#2 (proposed) from June through mid- October, enabling an increase of flow between La Grange and the IGs to benefit *O. mykiss*	*O. mykiss* Juvenile rearing and over-summering adults.	Improve temperature conditions for *O. mykiss* juvenile rearing and adult habitat	-	Operate IG #1	Construct IG #2	-	-
11	Riffle A3/A4 (RM 51.5); Gravel Augmentation	Spawning gravel size and distribution integrated with VA flow regime	Stream geomorphology	Resorting gravels and improved gravel size for Chinook spawning	-	-	5.85 acres	-	5.85 acres
12	Fish Counting Barrier and Weir RM 25	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	-	Construct Fish Counting and Barrier Weir	-	-	-
13	Predator Control	Improve rearing and migration conditions by reducing predation	Fry and juvenile rearing; smolt outmigration	Reduce predation on fry and juvenile fall-run Chinook salmon	-	-	Implement Predator Control	Implement Predator Control	-
14	Reduce Redd Superimposition (seasonal weir) RM 47-52	Construct a seasonal weir when upstream gravel patches are at capacity to encourage use of suitable	Spawning and incubation	Improve overall fall-run Chinook spawning success by	-	‡	‡	‡	-

Project No.	Project and location	Description	Life stage	Benefits	Early Implementation (Dec 2018-2024)	Years 1-3	Years 4-6	Years 7-8	Total
		habitats at downstream locations		reducing red superimposition					

[1] The projects and their associated attributes listed in above table were derived as part of on-going FERC relicensing activities and are subject to adjustment as part of ongoing and future project specific design.

† Clean selected gravel patches in the lower Tuolumne River at or below the confluence of intermittent streams downstream from La Grange Diversion Dam, including Gasburg Creek (RM 50.3) and Peaslee Creek (RM 45.5), for two to three weeks each year for 5 years

‡ Implement seasonal weir operational when >5,000 female spawners are observed in the Tuolumne River.

Table 38. Gravel augmentation volumes for specific non-flow measure projects.

Riffle location	Volume (cu. yds.)	Tons
Project 1: Riffle A2	519	700
Project 2: Riffle A3	3,707	5,000
Project 6: Riffle A5	9,637	13,000
Project 7: Riffle A6	14,456	19,500
Project 8: Basso Pool	27,281	36,800
Totals	**55,600**	**75,000**
Project 11: Riffle A3/A4[2]	**TBD**	**TBD**
Project 3: Riffle 3A/3B[2]	**TBD**	**TBD**
New Project(s) TBD between RM 39 and 24.5	**18,535**	**25,000**

[2] These riffle projects will include gravel augmentation above the VA MOU commitment of 75,000 tons of new gravel between RM 52 and 39.

3.9.3 Implementation Details

The Tuolumne River Partners will be responsible for funding and implementing the Non-flow Measures, as well as the formation of the Tuolumne River Partnership Advisory Committee (TRPAC) which shall include USFWS, CDFW, SF, MID and TID as initial members; other resource agencies will be invited to actively participate. The TRPAC will provide advice regarding the selection and design of individual habitat projects and the management of spill to benefit salmonids. The TRPAC could function as an appropriate forum for implementing the Tuolumne River VA, including consideration of recommendations from the Systemwide Governance Committee.

The VA timeframes identified in the table for implementation include the expected timeframe for construction to be completed as well as the timeframes associated with performing activities associated with project implementation. For example, under “Predator Control,” the fish counting and barrier weir would be in place by Year 3 and the predator suppression would occur in tandem with placement and continue through Years 4 through 8.

3.10 North Delta Arc and Suisun Marsh

3.10.1 Non-flow Measure Descriptions

Non-flow measures in the North Delta Arc and Suisun Marsh involve restoration of shallow-water habitat for native fish spawning, rearing, and to restore ecosystem function including increased production of zooplankton and macroinvertebrate taxa that support growth of native fishes. The target species list is an assemblage of natives, including Delta and Longfin smelt, Chinook salmon, as well as tule perch and native minnows such as Sacramento blackfish, Sacramento splittail, and hitch. Restored project areas in many cases will consist of tidal wetlands, floodplain, subtidal areas, riparian habitat, enhanced fish food production areas, and enhanced channel margins. Some non-flow projects may be located within areas and/or designed to be enhanced from VA flow actions.

3.10.2 Default Implementation Schedule

Table 39. Default implementation schedule for non-flow measures for the North Delta Arc and Suisun Marsh.

Description of Measures	Early Implementation (Dec 2018 -2024)	Years 1-3 (2025 – 2027)	Years 4-6[1] (2028 – 2031)	Years 7-8[1] (2032-2033)	Total
Tidal Wetland and associated restored habitats (acres)	500	2,500	2,350	-	5,350

[1]Assumes adequate funding exists at the time of implementation.

3.10.3 Implementation Details

A variety of federal, State, and local entities are anticipated to implement the habitat measures described above. Funding for these habitat measures is anticipated to come from a variety of sources including State, federal, and funding collected from VA implementing entities. The Department of Water Resources (DWR), in collaboration with other State, federal, and local entities, is in the preliminary planning stages for several projects within the North Delta Arc, with potential implementation beginning in late 2024 or early 2025. Funding for some of these planning projects is partially secured and DWR is actively working with project partners to secure additional funding to support implementation.

Appendix A

Memorandum of Understanding (March 29, 2022) and associated amendments

GAVIN NEWSOM
GOVERNOR

YANA GARCIA
SECRETARY FOR ENVIRONMENTAL PROTECTION

State Water Resources Control Board

TO: Interested Parties

FROM: State Water Board Staff

This is a cover page for the following Memorandum of Understanding Advancing a Term Sheet for the Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan, and Other Related Actions (MOU). The revised MOU was received by the State Water Board from external parties in November of 2022, however it does not meet the State Water Boards' webpage accessibility standards. This version of the MOU was reformatted to meet the State Water Boards' standards for webpage accessibility. State Water Board staff attempted to maintain the accuracy and substance of the MOU during the process of making this accessible version. Please report any concerns or identified errors that may have occurred during the conversion process to State Water Board staff at LSJR-SD-Comments@waterboards.ca.gov.

The following list broadly summarizes the changes that were made to make this version of the MOU consistent with webpage accessibility standards[1].

1. The PDF document tag structure was adjusted.
2. Alternative text was added in the background to images and figures in the PDF document.
3. One table in the document was reformatted.
4. Several line separators in the document were reformatted and marked as decorative lines.

[1] Last updated April 17, 2023

<u>MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS</u>

March 29, 2022

This "Memorandum of Understanding" (MOU) is signed by the Parties, through their executive leadership, to advance the attached Term Sheet for Voluntary Agreements.

RECITALS

A. The State Water Resources Control Board (State Water Board) and the nine regional water quality control boards administer the Porter-Cologne Water Quality Control Act (Wat. Code, § 13000 *et seq*.) (Porter-Cologne Act) to achieve an effective water quality control program for the state and are responsible for the regulation of activities and factors that may affect the quality of the waters of the state.

B. The State Water Board is authorized to adopt a water quality control plan in accordance with the provisions of Water Code sections 13240 through 13244, insofar as they are applicable (Wat. Code, § 13170).

C. The State Water Board has adopted a Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). It first adopted the plan in 1978, amending it in 1995, 2006, and 2018. In 2008, it initiated its periodic review and began proceedings to update the current Bay-Delta Plan.

D. The Bay-Delta Plan designates beneficial uses of the waters of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta watershed), establishes water quality objectives for the protection of those beneficial uses, and establishes a program of implementation to implement those objectives.

E. In May 2017 then-Governor Edmund G. Brown, Jr. issued "Principles for Voluntary Agreements" stating in relevant part: "The goal is to negotiate durable and enforceable Voluntary Agreements that will be approved by applicable regulatory agencies, will represent the program of implementation for the water quality objectives for the lower San Joaquin and Sacramento Rivers and Delta, will forego an adjudicatory proceeding related to water rights, and will resolve disputes among the parties regarding water management in the Sacramento-San Joaquin-Bay-Delta Watershed."

F. Interested parties, including state and federal agencies, municipal and agricultural water suppliers, and others undertook extensive efforts beginning in 2017 to negotiate Voluntary Agreements. On December 12, 2018, the Directors of California Department of Fish and Wildlife (CDFW) and California Department of Water Resources (CDWR) appeared before the State Water Board and presented the results of the negotiation process to date. Specifically, the Directors presented a "Framework Proposal for Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan" (Framework Proposal).

G. On December 12, 2018, the State Water Board adopted Resolution No. 2018-0059 to update the 2006 Bay-Delta Plan. First, it amended the water quality objectives for the protection of fish and wildlife beneficial uses in the Lower San Joaquin River (LSJR) and its three eastside tributaries, the Stanislaus, Tuolumne, and Merced Rivers, and agricultural beneficial uses in the southern Delta. It also amended the program of implementation for those objectives. It approved and adopted the Substitute Environmental Document (SED) for the Lower San Joaquin River. Ordering paragraph 7 of Resolution No. 2018-0059 states:

> "The State Water Board directs staff to provide appropriate technical and regulatory information to assist the California Natural Resources Agency in completing a Delta watershed-wide agreement, including potential flow and non-flow measures for the Tuolumne River, and associated analyses no later than March 1, 2019. State Water Board staff shall incorporate the Delta watershed-wide agreement, including potential amendments to implement agreements related to the Tuolumne River, as an alternative for a future, comprehensive Bay-Delta Plan update that addresses the reasonable protection of beneficial uses across the Delta watershed, with the goal that comprehensive amendments to the Bay-Delta Plan across the Delta watershed may be presented to the State Water Board for consideration as early as possible after December 1, 2019."

H. In January 2019, Governor Gavin Newsom confirmed his intention to complete the efforts to reach Voluntary Agreements. On March 1, 2019, the Directors of CDFW and CDWR entered into a "Planning Agreement Proposing Project Description and Procedures for the Finalization of the Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan" (Planning Agreement).

I. After evaluation of the Planning Agreement, the Parties developed the "Term Sheet for the Voluntary Agreements Program to Update and Implement the Bay-Delta Water Quality Control Plan" (Term Sheet, as attached).

UNDERSTANDINGS

1. Intent of the Signatories

1.1. In the Bay-Delta watershed, a comprehensive approach to managing habitat, flow, and other factors is required to protect native fish and wildlife species, while concurrently protecting water supply reliability, consistent with the legal requirement of providing reasonable protection for all beneficial uses.

A. The Bay-Delta Plan requires flow measures, and while creating opportunities for other actions, it does not require measures to directly address other limiting factors, including invasive species, ocean and tidal conditions, physical modifications of channels and wetlands, and loss of floodplain habitat.

B. The Parties seek to take a comprehensive approach to integrate flow and non-flow measures, including habitat restoration, subject to ongoing adaptive management based on a science program. The attached Term Sheet describes a Voluntary Agreements Program to effect this comprehensive approach.

1.2. The Parties intend to cooperate to submit the Term Sheet to the State Water Board, so that it may consider including the Voluntary Agreements Program, consistent with Resolution 2018-0059, as the pathway to implement the Narrative Salmon Objective and a proposed Narrative Viability Objective for the VA Parties. The Parties further intend to undertake a process to assist the State Water Board in its independent analysis of that pathway.

1.3. The Parties intend to continue work on these further related actions:

A. Plan for implementation of flow and non-flow measures in advance of the State Water Board's action on the alternative described in the Term Sheet, subject to any applicable requirements for project-specific environmental review or regulatory approval;

B. Continue to work toward resolution of litigation related to the 2018 Bay-Delta Plan, the 2019 Biological Opinions for the State Water Project and Central Valley Project, the 2020 Incidental Take Permit for the State Water Project, including Interim Operations, Clean Water Act section 401 certifications, and other regulatory authorizations and proceedings that relate to the actions described in the Term Sheet;

C. Develop the Voluntary Agreements in a proposed complete and legally appropriate and binding form.

1.4. The Parties recognize that State Water Board will be the lead agency under the California Environmental Quality Act (CEQA) in preparation of the Substitute Environmental Document (SED) to update the Bay-Delta Plan. The Parties intend to propose that CDFW, CDWR, and other public agency Parties will participate in the environmental review as responsible and/or trustee agencies, with respect to the Voluntary Agreements Program. The Parties expect that the SED will include at least programmatic environmental review of all elements of the Voluntary Agreements as reflected in the Term Sheet, and that the Parties responsible to implement measures will undertake project-specific environmental review as needed. The Parties recognize that execution of Voluntary Agreements will not occur until required environmental review has been completed and that the ultimate terms in those agreements will reflect the results of that review.

2. General Provisions.

2.1. This MOU is signed by executive leadership for the Parties. For each party, implementation is conditioned upon and subject to review and approval by the decisional body of the Party, if required. By signing this MOU, the Parties agree to advance the VA Program as reflected in the Term Sheet to the decisional body, if any, for consideration as outlined in the Term Sheet.

2.2. The Parties reserve judgment whether they each will sign or otherwise support the Voluntary Agreements and do not at this time, commit to any actions described in the Term Sheet. They will decide whether or not to commit to take these actions after the State Water Board adopts a SED and resolution to update the Bay-Delta Plan consistent with Resolution 2018-0059.

2.3. Nothing in this MOU is intended to modify or supersede the independent authority or discretion of any Party. Nothing in this MOU is intended to exercise, modify, or supersede the regulatory authority of any Party that is a regulatory agency or any subordinate agency of such a Party.

2.4. Nothing in this MOU is intended to be a pre-decisional commitment of resources. The Parties recognize that while this Memorandum of Understanding is the product of significant effort and collaboration to identify a proposed approach that the Parties believe will prove to be successful and consistent with all applicable regulatory and other obligations, any commitment to implement the flow and non-flow measures described in the Term Sheet is dependent on all necessary environmental review and regulatory approvals. Accordingly, the Parties acknowledge that nothing in this MOU or the attached Term Sheet can meaningfully foreclose any public agency's consideration of alternatives including not proceeding with any aspect of the flow and non-flow measures described herein. This MOU is not subject to CEQA consistent with CEQA Guidelines section 15004.

2.5. It is the intent of the Parties to encourage the possibility that additional entities, at a later date, will sign this MOU to offer contributions that would enhance the effectiveness of the VA Program described in the Term Sheet. A tributary or other water user group not party to the MOU should notify the Parties if it proposes to make contributions of flow, habitat and/or funding that are additive to the VA Program and commensurate with contributions by the original Parties. If appropriate, the entity shall sign this MOU as a separate counterpart, and the additive contributions shall be incorporated into the Term Sheet.

2.6. This MOU may be executed in separate counterparts, each of which when so executed and delivered will be an original. All such counterparts will together constitute but one and the same instrument.

2.7 The MOU expresses the mutual agreement of the Parties to advance the VA Program as reflected in the attached Term Sheet for consideration by their respective decisional bodies, if required.

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

CALIFORNIA NATURAL RESOURCES AGENCY

3/29/22

By: Wade Crowfoot

Date

Secretary of the Natural Resources Agency

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

March 29, 2022

By: Jared Blumenfeld

Date

Secretary for Environmental Protection

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Karla Nemeth

3-29-22

By: Karla Nemeth

Date

Director

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

CH Bonham

March 29, 2022

By: Charlton Bonham

Date

Director

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

YUBA WATER AGENCY

______________________________ 3/29/22

By: Willie Whittlesey
Its: General Manager

Date

SIGNATORY PARTIES TO THE
MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

GARDEN HIGHWAY MUTUAL WATER COMPANY

Nicole Van Vleck ____________________ 3/29/22

By: Nicole Van Vleck
Its: Vice President

Date

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

______________________________ 3-29-2022

By: Adel Hagekhalil — Date

Its: General Manager and Chief Executive Officer

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

RIVER GARDEN FARMS

[signature] 3-29-2022

By: Roger Cornwell
Its: General Manager

Date

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

STATE WATER CONTRACTORS

______________________________ 3/29/22

By: Jennifer Pierre Date

Its: General Manager

SIGNATORY PARTIES TO THE
MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

SUTTER MUTUAL WATER COMPANY

William Henle ______________________ March 29, 2022
By: William Henle Date
Its: Board President

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

GLENN-COLUSA IRRIGATION DISTRICT

MARCH 29, 2022

By: Thaddeus Bettner
Its: General Manager

Date

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

WESTLANDS WATER DISTRICT

Thomas W Birmingham ______________________ 3/29/2022

By: Thomas Birmingham Date

Its: General Manager

SIGNATORY PARTIES TO THE
MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

REGIONAL WATER AUTHORITY

_______________________________ 3/29/22
By: Michelle Banonis Date
Its: Manager of Strategic Affairs

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

KERN COUNTY WATER AGENCY

[signature] 3/29/22

By: Thomas McCarthy — Date

Its: General Manager

SIGNATORY PARTIES TO THE
MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

U.S. BUREAU OF RECLAMATION – CALIFORNIA-GREAT BASIN REGION

_______________________________ 3/29/2022

By: Ernest Conant
Its: Regional Director

Date

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

WESTERN CANAL WATER DISTRICT

Ted Tr

By: Ted Trimble

Its: General Manager

3/29/2022

Date

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

SAN LUIS & DELTA-MENDOTA WATER AUTHORITY

________________________ 6/16/2022

By: Federico Barajas Date

Its: Executive Director

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

FRIANT WATER AUTHORITY

______________________________ 6-17-2022

By: Jason Phillips
Its: Chief Executive Officer

Date

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

TEHAMA-COLUSA CANAL AUTHORITY

Jeffrey Sutton ______________________ 6-26-22 __________

By: Jeffrey Sutton
Its: General Manager

Date

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

SOLANO COUNTY WATER AGENCY

By: Roland Sanford
Its: General Manager

June 21, 2022
Date

ADDITION OF SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

East Bay Municipal Utility District agrees to the Recitals and Understandings set forth in the MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS (March 29, 2022) (MOU), subject to the following amendments pursuant to MOU section 2.5:

1. The addition of new footnotes to, and revision of, the "Mokelumne" and "PWA Water Purchase Program, Market Price" Appendix 1 Flow Tables, Table 1a: New Contributions to Tributary Flow and Delta Outflows in Thousand Acre Feet, to read:

	C (15%)	**D (22%)**	**BN (17%)**	**AN (14%)**	**W (32%)**
Mokelumne[i]	0	~~10~~ 5	~~20~~ 5	~~45~~ 7	0
PWA Water Purchase Program, Market Price[ii]	0	45 (+5)	45 (+15)	45 (+38)	0

[i] EBMUD will operate to the tributary flows proposed in Appendix A5 of the Memorandum of Understanding dated March 1, 2019 ("Mokelumne River Proposal" or "2019 MRP"). Modeled flows in the 2019 MRP were above the existing requirements in EBMUD's D-1641/Joint Settlement Agreement (JSA) year types. EBMUD will present modeling, consistent with the VA flow accounting procedures, to demonstrate average long-term contribution of new flows from the Mokelumne, and if a shortfall is determined relative to the flows stated in modified Table 1a above for a given Sacramento River index year type EBMUD will commit to funding the purchase of any remaining volume difference when that Sacramento year type occurs during the 8-year term of the agreement. The VA Parties will endeavor to achieve fair and equitable pricing for all VA water purchases.

[ii] EBMUD commits to coordinating and prioritizing possible water purchases from the Mokelumne River system to the extent feasible and practical and acceptable to EBMUD. And, consistent with footnote 11 of Appendix 1 Flow Tables, Table 1a: *The VA's governance program will be used to determine the use of available funding to provide additional outflow in AN, BN, or W years. If DWR is called upon to provide the water by foregoing SWP exports, such call will be handled through a separate agreement between DWR and its contractors*.

2. The deletion of an entry and associated footnote "Refill (Mokelumne)" in Appendix 1 Flow Tables, Table 1b: Supporting Details for New Flow Contributions (Table 1a) and Year 8 Water Storage:

	C (15%)	**D (22%)**	**BN (17%)**	**AN (14%)**	**W (32%)**
~~Refill (Mokelumne)~~[14]	~~0~~	~~9~~	~~18~~	~~13.5~~	~~0~~

~~[14]Requires refill commitments or mutually agreeable operational agreement. Refill commitments are not included in tabulation of additive flows since they serve to ensure tributary flow contributions are protected as outflow without injury to other users.~~

3. The modification of the following entries in Appendix 3, Costs of Implement VAs:

~~Total Estimated Cost Refill~~	~~$25~~	~~Estimated cost on Mokelumne (Potential to Operate around and avoid this cost)~~
~~Mokelumne AN Water Purchase (30 taf)~~ Additional PWA Water Purchases	~~$13~~ $20	

4. The addition of a new entry and associated footnote to, and modification to the Habitat on Mokelumne line item in Appendix 3, Table 4 Funding for VAs' Framework:

Water Agencies	Habitat on Mokelumne	~~$17~~ $1.5	Water agency contribution to habitat on Mokelumne per Planning Agreement
Water Agencies	Water Revolving Fund	$20[1]	Generated by $10/AF diversion charge. Hydrology dependent.

[1]Dollars made available by $10/af charge on diversions over the 8-year agreement term, plus immediate collection of self-assessment for up to 2 years as part of early implementation, consistent with commitments from other similarly situated PWAs. Totals in this and the subsequent row are based on historical deliveries on a long-term average. Actual dollars may vary.

East Bay Municipal Utility District intends to work with the Mokelumne River Parties, (including North San Joaquin Water Conservation District, Amador Water Agency, Calaveras County Water District, Calaveras County Public Utility District, Jackson

Valley Irrigation District, Woodbridge Irrigation District, and San Joaquin County) as potentially covered parties who may ultimately become signatories to the Mokelumne Implementing Agreement.

East Bay Municipal Utility District

______________________________ August 11, 2022

By: Clifford Chan Date

Its: General Manager

With the concurrence of:

CALIFORNIA NATURAL RESOURCES AGENCY

______________________________ ______________

By: Wade Crowfoot Date

Secretary of the Natural Resources

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

______________________________ ______________

By: Jared Blumenfeld Date

Secretary for Environmental Protection

Valley Irrigation District, Woodbridge Irrigation District, and San Joaquin County) as potentially covered parties who may ultimately become signatories to the Mokelumne Implementing Agreement.

East Bay Municipal Utility District

______________________________ ________________

By: Clifford Chan Date

Its: General Manager

With the concurrence of:

CALIFORNIA NATURAL RESOURCES AGENCY

______________________________ 8/11/2022

By: Wade Crowfoot Date

Secretary of the Natural Resources

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

______________________________ ________________

By: Jared Blumenfeld Date

Secretary for Environmental Protection

Valley Irrigation District, Woodbridge Irrigation District, and San Joaquin County) as potentially covered parties who may ultimately become signatories to the Mokelumne Implementing Agreement.

East Bay Municipal Utility District

______________________________ ______________
By: Clifford Chan Date
Its: General Manager

With the concurrence of:

CALIFORNIA NATURAL RESOURCES AGENCY

______________________________ ______________
By: Wade Crowfoot Date
Secretary of the Natural Resources

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

______________________________ 8/11/22
By: Jared Blumenfeld Date
Secretary for Environmental Protection

CALIFORNIA DEPARTMENT OF WATER RESOURCES

8/11/2022

By: Karla Nemeth
Director

Date

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

By: Charlton Bonham
Director

Date

CALIFORNIA DEPARTMENT OF WATER RESOURCES

______________________________ ________________

By: Karla Nemeth Date
Director

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

DocuSigned by:
Chuck Bonham
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8/11/2022

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By: Charlton Bonham Date
Director

SIGNATORY PARTIES TO THE

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

CONTRA COSTA WATER DISTRICT

[signature]

By: Marguerite Patil
Its: Assistant General Manager –
Policy and External Affairs

September 15, 2022
Date

ADDITION OF SIGNATORY PARTIES TO

MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS

Tuolumne Parties San Francisco Public Utilities Commission, Modesto Irrigation District and Turlock Irrigation District agree to all Recitals and Understandings set forth in the MEMORANDUM OF UNDERSTANDING ADVANCING A TERM SHEET FOR THE VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN, AND OTHER RELATED ACTIONS (March 29, 2022) (MOU), subject to the following amendments pursuant to MOU section 2.5:

1. The addition of a new entry and footnotes to Appendix 1 Flow Tables, Table 1a: New Contributions to Tributary Flow and Delta Outflows in Thousand Acre Feet, to read:

	C (15%)	D (22%)	BN (17%)	AN (14%)	W (32%)
Tuolumne River downstream of the La Grange Dam[1, 2, 3, 4]	**86(17)**	**140(40)**	**127(98)**	**138**	**138**
Additional Maximum Tuolumne Flows [5, 6]	**16**	**19**	**30**	**8**	**0**

[1]Tuolumne Parties flow contributions, additive to average January-June minimum instream flow requirements on the Lower Tuolumne River, as set-forth in the current FERC license for the Don Pedro Project and measured at the USGS gage downstream of La Grange Dam. Values in parenthesis apply in critical, dry, and below normal year following a critical, dry or below normal year.

[2]Tuolumne Parties are releasing or bypassing flow contributions at their lowest point of control, which is La Grange Dam. This is the point at which the State Water Board will have authority to enforce the flow measures as contemplated by Term Sheet section 7.2.

[3]Modeling done by the State predicts that with implementation of the Tuolumne VA that Tuolumne River flows as measured at the Modesto gage, on average by water year type, will exceed the average January-June flows in the base case (flow resulting under current conditions with the 1995 FERC Settlement Agreement in effect). The modeling projects the following resultant flows at Modesto Gage that will be protected as Delta outflows.

	C (15%)	D (22%)	BN (17%)	AN (14%)	W (32%)
Resultant Tuolumne River flows at the Modesto Gage	***37***	***62***	***78***	***27***	***0***

Consistent with Term Sheet Section 8.3 these flows will be protected in the Tuolumne River as VA flows that implement the native fishes water quality objective and will be protected as Delta outflow. Term Sheet Section 8.1 anticipates that the State Water Board will use its legal authorities to protect VA flows and obligates VA parties to support the State Water Board in its proceedings to protect VA flows. The Tuolumne Parties will assist and partner in this endeavor consistent with section 8.1 of term sheet. The resultant flows at Modesto gage are not flow commitments that will be enforceable against the Tuolumne Parties pursuant to Term Sheet Section 2.2(C).

[4] The State and Tuolumne Parties understand these flows will be included in the systemwide assessment as specified in Footnote 3 in Appendix 1 Flow Tables, Table 1a: "*An assessment based on the accounting procedures to be developed pursuant to Term Sheet section 8.4 will be conducted prior to year 8 of VA to determine if the flows in this table have materialized on average above baseline by water year type. The VA parties acknowledge that, if this analysis does not demonstrate that flows have materialized as shown in this table, then the VAs will be subject to Term Sheet provisions of Section 7.4(B)(ii) or (iii).*"

[5] Tuolumne Parties will work collaboratively with DWR, Reclamation, and other VA parties to set the terms and conditions (e.g., additional flows will only occur when the Delta is in balanced conditions, etc.) of providing additional flow contributions consistent with Sections 8.1 and 8.3 of the Term Sheet.

[6] Real-time hydrology dependent. The Tuolumne Parties will work collaboratively with DWR, Reclamation, and other VA Parties in each year where Tuolumne VA Flows are provided to determine the total volumetric need for these additional flows. The Tuolumne's additional flow contribution shall equal 1/3 of this agreed upon volume, or the Additional Maximum flow contribution, whichever is less. These volumes, when provided will provide instream flow benefits, but will not be subject to flow protection below La Grange Dam.

2. The addition of a new entry and footnotes to Appendix 2 <u>Minimum Additive Contributions to Habitat Restoration</u>:

Area	**Total Acres**
Tuolumne[1]	1. 75,000 tons of new gravel between river mile (RM) 52 and RM 39 and approximately 25,000 tons of new gravel between RM 39 and RM 24.5 to create additional spawning/rearing habitat. 2. 77 acres of newly-constructed rearing/floodplain habitat which will be inundated at the proposed Tuolumne VA flows.

[1] Tuolumne Parties will work to define the habitat projects below in collaboration with the California Department of Fish and Wildlife – that were drawn from the prior 15-year VA habitat list – that will be funded by the Tuolumne Parties and implemented, subject to and depending on obtaining applicable requirements for project-specific environmental review or regulatory approval, within the 8-year term of the agreement:

///

REF	PROJECT NAME	CAPITAL COST	O&M COST
1	Riffle A2 Rehabilitation	$0.6 M	$0.13 M
2	Riffle A3 Rehabilitation	$0.8 M	$0.13 M
3	Riffles 3A and 3B	$3.2 M	$0.13 M
4	Gravel Cleaning	$1.2 M	$2.85 M
5	Lower Tuolumne River Habitat Improvement Program	$19 M	$7.5 M
6	Riffle A5	$1.5 M	$0.13 M
7	Riffle A6	$1.8 M	$0.13 M
8	Basso Pool	$2.2 M	$0.13 M
9	Large Woody Debris	$3.7 M	$0.3 M
10	Infiltration Galleries	$13 M	$0.6 M
11	Riffle A3/A4 Gravel Augmentation	$0.6 M	$0.13 M
12	Fish Counting and Barrier Weir	$12 M	$1.2 M
13	Predator Control	$0.2 M	$1.0 M
14	Reduce Redd Superimposition (seasonal weir)	$4.2 M	$0.2 M
15	Tuolumne Partnership Advisory Committee	$0.1 M	$2.9 M
	TOTAL	**$64.10**	**$17.46**

3. The addition of the following entries in Appendix 3, Costs of Implement VAs:

Costs to Implement VAs	**$ Million (M)**	**Notes**
Habitat Restoration on the Tuolumne	$ Self Funded	

4. The addition of the following entries to Appendix 3, Table 4 Funding for VAs' Framework:

Funding Source	**Use of Funds**	**$ million (M)**	**Notes**
Tuolumne Parties	Habitat restoration	$ Self Funded	

Tuolumne parties recognize a need to avoid temperature degradation from implementation of the VA water commitments and will continue work on a suitable temperature term to include in the Tuolumne VA Implementing Agreement, and which will not be enforceable against the Tuolumne Parties pursuant to Term Sheet Section 2.2(C), and which will be included as a metric to be measured in Term Sheet Appendix 4.

The Tuolumne Parties and State Parties recognize that the State Water Board has previously adopted 2018 Amendments to the Bay-Delta Plan, including a water quality objective and program of implementation applicable to the Tuolumne River, and the intent of the parties is to present for State Water Board consideration revisions to the 2018 Bay-Delta Plan that would authorize a Voluntary Agreement implementation pathway for the Tuolumne Parties consistent with this Memorandum of Understanding and the Term Sheet it advances. The resolution of pending litigation concerning the 2018 Bay-Delta Plan and 401 water quality certifications that implement the 2018 Bay-Delta Plan will be the subject of future negotiations consistent with MOU section 1.3(B), as explained in the “401 WQC & Litigation” bullets of the Tuolumne VA Principals’ Deal Points (Aug. 31, 2022).

With the concurrence of:

CALIFORNIA NATURAL RESOURCES AGENCY

Wade Crowfoot

By: Wade Crowfoot
Secretary of the Natural Resources

November 9, 2022
Date

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

A. Yana Garcia

By: Yana Garcia
Secretary for Environmental Protection

November 9, 2022
Date

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Karla A Nemeth

By: Karla Nemeth
Director

November 9, 2022
Date

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

CM Bonham

By: Charlton Bonham
Director

November 9, 2022
Date

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SAN FRANCISCO PUBLIC UTILITIES COMMISSION

[signature]

By: Dennis Herrera
General Manager

11/9/22
Date

MODESTO IRRIGATION DISTRICT

By: Ed Franciosa
General Manager

Date

TURLOCK IRRIGATION DISTRICT

By: Michelle Reimers
General Manager

Date

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

By: Dennis Herrera
General Manager

Date

MODESTO IRRIGATION DISTRICT

By: Ed Franciosa
General Manager

11/09/2022
Date

TURLOCK IRRIGATION DISTRICT

By: Michelle Reimers
General Manager

11/09/2022
Date

TERM SHEET FOR VOLUNTARY AGREEMENTS TO UPDATE AND IMPLEMENT THE BAY-DELTA WATER QUALITY CONTROL PLAN

March 29, 2022

Parties signatory to the attached "Memorandum of Understanding" (MOU) propose this "Term Sheet (Term Sheet) for the Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan" (Bay-Delta Plan).

1. Purpose.

1.1. Subject to Section 13, this Term Sheet states the essential terms that the Parties will use to finalize the Voluntary Agreements (VAs). The VAs will consist of three types of agreements described in Section 2.2 below.

1.2. The VAs will state actions, together with other measures in the Bay-Delta Plan, necessary to implement two water quality objectives in the plan related to protection of native fishes.

A. These objectives are: (1) the existing narrative objective that provides for water quality conditions, together with other measures in the watershed, to achieve doubling of the reference salmon population (1967-1991) (Narrative Salmon Objective); and (2) a new narrative objective to achieve the viability of native fish populations (Narrative Viability Objective).

B. The Parties propose that the State Water Resources Control Board (State Water Board) adopt the following Narrative Viability Objective:

"Maintain water quality conditions, including flow conditions in and from tributaries and into the Delta, together with other measures in the watershed, sufficient to support and maintain the natural production of viable native fish populations. Conditions and measures that reasonably contribute toward maintaining viable native fish populations include, but may not be limited to, (1) flows that support native fish species, including the relative magnitude, duration, timing, temperature, and spatial extent of flows, and (2) conditions within water bodies that enhance spawning, rearing, growth, and migration in order to contribute to improved viability. Indicators of viability include population abundance, spatial extent, distribution, structure, genetic and life history diversity, and productivity.* Flows provided to meet this objective shall be managed in a manner to avoid causing significant adverse impacts to fish and wildlife beneficial uses at other times of the year.

* The actions the State Water Board and other agencies expect to take to implement this objective are described in section [insert number] of this Plan's Program of Implementation."

C. The commitments in the VAs will provide the participating parties' share, during implementation of the VAs, to contribute to achieving the Narrative Salmon Objective by 2050.

1.3. The VAs will include new flow and other measures, including habitat restoration, subject to adaptive management pursuant to the Governance and Science Programs stated in Sections 9 and 10 below.

1.4. The Parties will request that the State Water Board consider and approve an updated Bay-Delta Plan that includes the VAs as a pathway within the Program of Implementation that, along with other measures required in the plan, implements the Narrative Salmon Objective and Narrative Viability Objective.

A. This Term Sheet will be submitted to the State Water Board pursuant to Resolution 2018-0059 (Ordering Paragraph 7), which states:

"The State Water Board directs staff to provide appropriate technical and regulatory information to assist the California Natural Resources Agency in completing a Delta watershed-wide agreement, including potential flow and non-flow measures for the Tuolumne River, and associated analyses no later than March 1, 2019. State Water Board staff will incorporate the Delta watershed-wide agreement, including potential amendments to implement agreements related to the Tuolumne River, as an alternative for a future, comprehensive Bay-Delta Plan update that addresses the reasonable protection of beneficial uses across the Delta watershed, with the goal that comprehensive amendments to the Bay-Delta Plan across the Delta watershed may be presented to the State Water Board for consideration as early as possible after December 1, 2019."

B. The Parties request that the Program of Implementation in the updated Bay-Delta Plan include the VAs as a pathway to implement the Narrative Salmon Objective and Narrative Viability Objective, on a finding that the VA pathway in conjunction with the regulatory pathway described in section 1.4(C) will provide reasonable protection of the associated beneficial uses as documented in the SED. The Parties further request that the State Water Board consider the VAs as an alternative to be analyzed in the Substitute Environmental Document (SED) as described in Resolution 2018-0059.

C. The Parties understand that the State Water Board will include in the Program of Implementation an additional pathway to implement the Narrative Salmon Objective and Narrative Viability Objective. This pathway will apply to tributaries, or persons or entities, not covered by a VA. In this pathway, the State Water Board will use its legal authorities and public processes to establish conditions to require flows and other measures by persons or entities not covered by a VA to provide reasonable protection of beneficial uses associated with the Narrative Salmon Objective and Narrative Viability Objective. The Parties request that the Program of Implementation provide an opportunity for water right holders not covered by a VA to, at a later date, commit to contributions to implement the Narrative Salmon Objective and Narrative Viability Objective under the VAs, as approved by the State Water Board.

D. The Parties further request that the Program of Implementation include:

(i). A summary of the VAs as reflected by this Term Sheet, including a summary of any early implementation before the Effective Date of the VAs (defined in Section 7.1);

(ii). A Strategic Plan for implementation of the VAs, including adaptive management of flow and habitat restoration measures, pursuant to Section 9.3;

(iii). Obligations of the State Water Board, the Parties and others to implement their commitments, pursuant to Section 2.2 and Water Code section 13247;

(iv). A Governance Program including Annual and Triennial Reports pursuant to Section 9;

(v). A Science Program pursuant to Section 10; and

(vi). Procedures for renewal, modification, and extension of the VAs pursuant to Sections 7.4 through 7.5.

2. Structure.

2.1. The parties that sign the attached MOU are "VA Parties" for the purpose of this Term Sheet.

2.2. The VAs will consist of three types of agreements. These are:

A. Global Agreement that will describe the VAs' structure, funding, Science Program, and Governance Program, to be signed by all VA Parties;

B. Implementing Agreements, each of which will state in detail the measures for a participating tributary, the Sacramento River mainstem, or the Delta, as applicable, each to be signed by those VA Parties with responsibility for implementation of that agreement, including the California Department of Fish and Wildlife (CDFW) and the California Department of Water Resources (CDWR); and

C. Government Code Section 11415.60 Agreements, each of which will state the specific obligations of those VA Parties responsible for implementation of an Implementing Agreement, along with related regulatory enforcement mechanisms related to flows, habitat restoration and other assurances, each to be signed by such VA Parties and the State Water Board. Each agreement will specify any contingencies outside the reasonable control of the responsible VA Party related to performance of a measure.

2.3. The VAs will incorporate flow measures (including any refill criteria and other accounting provisions) as stated in Appendix 1, habitat restoration measures as stated in Appendix 2, funding as stated in Appendix 3, and expected outcomes and metrics as stated in Appendix 4.

3. **Relationship to Prior Proposed Agreements.** This Term Sheet supersedes all previously proposed VA agreements, VA frameworks and/or VA planning documents.[1]

4. **Additional Delta Outflows, Tributary Flows, and Habitat**.

4.1. The VA flows described in Appendix 1 will be additive to the Delta outflows required by Revised Water Rights Decision 1641 (Revised D-1641) and resulting from the 2019 Biological Opinions, although the 2019 Biological Opinions may be modified, including to resolve litigation concerning those opinions.

4.2. The habitat restoration measures described in Appendix 2 will be additive to physical conditions and regulatory requirements existing as of December 2018, when the State Water Board adopted Resolution 2018-0059. Implementation of such measures by Parties after that date, but prior to execution of the VAs, will be considered as contributing towards implementation of the Narrative Salmon Objective and Narrative Viability Objective.

5. **Contributions of Tributary Flows, Delta Outflows, and Habitat Restoration.** The VAs will result in flow and non-flow measures as shown in Appendices 1 and 2 respectively.

5.1. With respect to tributary flows and Delta outflows shown in Appendix 1:

A. These flows may be shaped in timing and seasonality, to test biological hypotheses and respond to hydrologic conditions while reasonably protecting beneficial uses. Such shaping will occur through the Governance Program stated in Section 9 below, and subject to the Implementing Agreements and applicable regulatory requirements. The Parties agree a portion of the volumes of water in Appendix 1 will be managed with a priority of providing increased flows in the months of April and May in D, BN, and AN water years to replicate average outflow resulting from the I/E ratio in the 2009 salmonid BiOp as modeled.

[1] The State signatories stand by the funding commitments contained in the March 2019 Proposed Action as scaled to reflect an 8-year VA term, see Appendix 3.

B. Such shaping will occur through the Governance Program stated in Section 9 below, and subject to the Implementing Agreements and applicable regulatory requirements.

C. Flow measures described in Appendix 1 as "Water Purchase Program" or other water purchases will be obtained through a free-market program for single-year transfers, subject to applicable law. The Parties acknowledge that, if the water purchases do not occur, then the VAs will be subject to the provisions of Section 7.4(B)(ii) or (iii).

5.2. The Global Agreement and Implementing Agreements will include appropriate provisions that VA Parties (including regulatory agencies) will expedite and coordinate permitting of flow and non-flow measures, consistent with applicable laws.

A. Each Party acknowledges that a metric for success in the voluntary agreements would be the completion of identified restoration projects.

B. CDFW will apply innovative uses of its Lake and Streambed Alteration and California Endangered Species Act authorities to expedite permitting of these restoration projects.

C. The Parties anticipate that the State Water Board will complete and employ its proposed general order for Clean Water Action section 401 Water Quality Certification and waste discharge requirements for restoration projects to expedite permitting of these restoration projects.

D. The United States Fish and Wildlife Service and National Marine Fisheries Service will use regulatory tools for restoration to expedite permitting of these restoration projects.

E. California will establish a multi-disciplinary restoration unit of 8 full-time specialists to track, permit and implement these restoration projects. This team will regularly report to Secretaries for Environmental Protection and Natural Resources.

F. The relevant state and federal agencies involved in implementation of these restoration projects will convene with other VA Parties as part of the governance to update on project delivery.

G. The relevant state and federal agencies involved in implementation of the VAs' restoration projects will update the California Governor's Office regularly on status of permitting these projects.

6. **Funding**. The VAs will include the funding commitments shown in Appendix 3. Those commitments will include appropriate assurances of performance, as provided in the Global Agreement. Any Global Agreement executed by the U.S. Fish and Wildlife Service, the U.S Bureau of Reclamation or National Marine Fisheries Service will be subject to appropriations.

7. **Effectiveness, Enforcement, Assurances, and Termination or Renewal.**

7.1. The VAs will become effective on the date the Government Code section 11415.60 Agreements are executed. The VAs will remain in effect for a term of 8 years after the Effective Date. For purpose of this Term Sheet, a numbered "Year" refers to the year after the Effective Date.

A. The Parties with permitting authority recognize their affirmative obligation to move as expeditiously as possible to complete permitting processes prior to Year 1.

B. The Parties will request and expect the State Water Board include in the Program of Implementation a process for the Executive Director to recognize unanticipated permitting delays prior to Year 1 and to defer review and performance milestones within the Program of Implementation accordingly to better align the VA implementation with State Water Board's processes. In considering any adjustments under this paragraph, the delay must result from actions or inactions that were beyond the control of the Parties.

7.2. The State Water Board will have authority to enforce the flow and non-flow measures relying on Water Code authorities, as provided in the Government Code Section 11415.60 Agreements. The agreements will specify responsible parties and conditions precedent for implementation and related liability for enforcement. The Parties will be accountable to secure their individual funding commitments specified in Appendix 3, as provided in the Global Agreement. It is anticipated that neither the U.S.

Fish and Wildlife Service, nor the U.S. Bureau of Reclamation, nor National Marine Fisheries Service will be participating through a Government Code 11415.60 Agreement.

7.3. Through the Government Code Section 11415.60 Agreements, the State Water Board will provide assurances that the VAs state the total obligations of the VA Parties to implement the Narrative Salmon Objective and Narrative Viability Objective for the term of the VAs, subject to Section 7.4.

7.4. The Parties propose that, in Year 6, the State Water Board will initiate the process to evaluate and determine the implementation pathway for VA parties after Year 8. The Parties also propose that the Program of Implementation include a process to incorporate consideration of the following information:

- The VA science program's synthesis of the most current science and analyses of the effects of the VAs' implementation, consistent with Appendix 4;
- Past, present, and probable future beneficial uses of water;
- Environmental characteristics of the Bay-Delta watershed, including the quality of water available thereto;
- Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the Bay-Delta watershed; and
- Economic considerations.

At Year 8, the State Water Board will consider potential amendments to the Program of Implementation under the "green"-"yellow"-"red" structure described in Section 7.4.B, which will be informed by the consideration of the scientific analysis and information submitted pursuant to section 7.D. If under the "red" option in Section 7.4B(iii), the VA Parties may present new agreements to fulfill the purpose stated in Section 1.4(B), or the State Water Board will begin implementing the Bay Delta Plan through the additional pathway described in Section 1.4(C).

A. In Year 6, the State Water Board will issue a notice to initiate the process. It will hold a public informational workshop, at which time the VA Parties will present on their second Triennial Reports and Strategic Plan for Years 6-9. Based on these reports and the information gathered by the VA Science Committee (as described in Appendix 4), the VA Parties, through the Systemwide Governance Committee, will recommend to the State Water Board whether the VAs should continue for another term with limited modification or if more significant changes to the VA terms are needed. The State Water Board will consider the Systemwide Governance Committee's recommendation and all public comments on the progress of VA implementation, technical information, and the implementation pathway in Year 8.

B. Following the workshop and after consideration of all comments, the State Water Board will distribute a draft proposed pathway to be implemented for VA Parties after Year 8. In summary form, it will select from three options:

(i). **Green** – The VAs are substantially achieving the required metrics as described in Appendix 4; and the ecological outcomes analysis described there supports the conclusion that continuing the VA, together with other actions in the Bay-Delta Plan, will result in attainment of the narrative objectives. If so, the VA Parties will continue implementation of VAs without any substantial modification in terms, except for necessary changes to provide for funding and other measures necessary to continue the VAs. Necessary updates to the VA terms (if any) will be determined and the process to renew the VAs will be initiated so that renewed VAs are in place at Year 9.

(ii). **Yellow** – The VAs are meeting a significant number of metrics as described in Appendix 4; and the ecological outcomes analysis as described there supports the conclusion that continuing the VAs, together with other actions in the Bay-Delta Plan, will result in attainment of the narrative objectives, but some modifications are needed. If so, the VA Parties will continue implementation with substantive modification in terms. The process to modify the VA terms to address deficiencies will be initiated. Concurrently, the State Water Board will consider alternative means to address deficiencies in achieving the metrics as described in Appendix 4.

(iii). **Red –** A new pathway is required because VAs are not achieving required metrics as described in Appendix 4; and the ecological outcomes analysis as described there does not support the conclusion that continuing the VAs, together with other actions in the Bay-Delta Plan, will result in attainment of the narrative objectives. New agreements will be negotiated, or the Bay-Delta Plan's Program of Implementation will be implemented through the State Water Board's regulatory authorities and the VA Parties reserve all rights to fully participate in the related regulatory processes, and potential remedies related thereto.

C. Factors the State Water Board will consider in selecting one of the three options from subsection (B), will include, but not necessarily be limited to:

(i). Whether permits required for implementation were pursued and available within a reasonable timeframe.

(ii). Whether VA Parties timely and fully performed VA flow asset commitments.

(iii). Whether the Triennial Reports analyze progress across the Delta watershed, provide considerations for updating the Strategic Plan, include considerations for updating the VA flow and non-flow measures, and are timely submitted to the State Water Board to inform its triennial review process.

(iv). Whether the guidance as set forth in the Strategic Plan for the initiation and construction of habitat projects has been achieved.

(v). Whether VAs were fully funded through Year 8;

(vi). Whether the Triennial Reports or other sources of reliable information indicate that factors outside of the VAs are impairing the relevant fish species;

(vii). Whether flows have been adequately protected pursuant to Section 8; and (viii). Whether additional funds are available to continue the VA program.

D. Prior to selecting one of the three options from subsection (B), the State Water Board will:

(i). Hold appropriate hearings to review and receive input on the scientific reports, analysis, information, and data generated by the VA Science Program and other sources and receive recommendations on the anticipated effectiveness of continuing or modifying VAs or implementing the regulatory pathway described in Section 1.4(C); and

(ii). Conduct a Delta Independent Science Board review to receive input and recommendations on the scientific rationale for continuing or modifying the VAs.

E. In Year 8, the VA Parties will submit their final Annual Report. The State Water Board will distribute any proposed amendments to the Bay-Delta Plan's Program of Implementation, which will be informed by the consideration of factors in Section 7.4(C), to be implemented after Year 8.

F. If, by the end of Year 8, no new agreements have been adopted or State Water Board has not yet assigned responsibility for implementing the Bay-Delta Plan through a regulatory pathway described in amendments to that Bay-Delta Plan's Program of Implementation, the original VAs (and their terms concerning water-user funding for flow contributions) will continue, but unless otherwise negotiated, those obligations will not extend beyond 15 years.

G. In the Government Code section 11415.60 Agreements, the VA Parties and the State Water Board will establish a procedure for timely and effective referral of disputes that arise during any update to the Bay-Delta Plan's Program of Implementation described in Section 7.4. The procedure will promptly involve executive leadership (across the VA Parties) in resolution of disputes that, if unresolved, would involve significant risk of delay in final action.

7.5. The Government Code section 11415.60 Agreements will authorize an extension of the VAs beyond Year 8 to continue until new VAs are adopted or the State Water Board adopts a pathway as described in Section 7.4(B). VA Parties that are water agencies will reserve remedies specified in these agreements.

8. Protection of Flows.

8.1. The Parties propose to, and anticipate that, the State Water Board will use its legal authorities to protect all flows generated by actions identified in Appendix 1 against diversions for other purposes for the term of the VAs. The VA Parties will support the State Water Board in its proceedings by assisting with developing technically and legally defensible methods to provide these protections. During administrative proceedings, the VA Parties will support the developed protections, provided the VA Parties agree with the authority cited by the State Water Board for the proceedings, the scope of proceedings, and the technical methodology. Prior to the potential adoption of VAs by the State Water Board, the Parties agree to collaboratively identify and resolve any redirected adverse impacts resulting from the implementation of flow contributions identified in Appendix 1.

8.2. The Parties anticipate that State Water Board will report annually on what actions the State Water Board has taken to protect these flows from unauthorized uses.

8.3. All San Joaquin River watershed flows required as a result of implementing the 2018 Bay Delta Plan Update or VAs will be protected as Delta outflows to the maximum extent feasible, and prior to the State Water Board's adoption of an action to protect the new Delta outflows, the Parties agree to discuss the protection of these flows and collaboratively identify and resolve any redirected adverse impacts to water supply in excess of Appendix 1 contributions resulting from the protection of these flows as Delta outflow.

8.4. In coordination with the State Water Board and other Parties, the Department of Water Resources, and the U.S. Bureau of Reclamation will develop accounting procedures to assure that flows and habitat restoration provided under the VAs are additional contributions as stated in Section 4. These procedures will be incorporated into the Implementation

Agreements, as appropriate, and will be subject to approval by the State Water Board.

9. **Governance Program.** The VAs will establish a Governance Program to direct flows and habitat restoration, conduct assessments, develop strategic plans and annual reports, implement a science program, and hire staff and contractors.

9.1. **Governance Entities.** VA Parties will formally establish the following entities to govern implementation of the VAs unless a comparable governance entity already exists. Each governance entity will adopt a charter that is consistent with the Global Agreement and applicable Implementing Agreement.

A. The Systemwide Governance Committee will make recommendations related to deployment of flow and non-flow measures as provided in its charter, oversee Triennial Reports in Years 3 and 6 (and potentially Years 9 and 12, if the VAs are renewed), regarding implementation and effects, any revision to the Strategic Plan in Year 6 (and potentially 12, if the VAs are renewed), and overall coordination of the VA Program. Through the Strategic Plan and otherwise, this committee will assure that implementation is consistent with the terms of applicable Implementing Agreements. This committee may include members from appropriate stakeholders who are not VA Parties.

B. The Tributary/Delta Governance Entities will be responsible for implementation of Implementing Agreements for which that entity is responsible, including deployment of flow and nonflow measures as specified in those Implementing Agreements, and preparation and submittal of associated Annual Reports to the Systemwide Governance Committee. Each such entity will include VA Parties subject to the applicable agreement.

9.2. **Governance Procedures for Flow Measures.**

A. Tributary flow measures will be subject to implementation in accordance with the recommendation or request of the Systemwide Governance Committee, consistent with rules set forth in the Implementing Agreements. A Tributary Governing Entity may consent but is not required to agree to a recommendation for implementing a measure in a manner that would be inconsistent with its Implementing Agreement.

B. Delta flow measures will be subject to implementation in accordance with the recommendation or request of the Delta Governance Entity consistent with rules that will define the scope that the measure is available to be adaptively managed. Such implementation will be coordinated with the Systemwide Governance Committee.

9.3. Strategic Plans.

A. The VA Parties will propose an initial Strategic Plan for approval in the update to the Bay-Delta Plan, along with other elements of the VAs. The plan will provide multi-year guidance for the implementation of flow and other measures, set priorities to guide the Science Program, and establish reporting procedures related to implementation and effects. The Strategic Plan will be consistent with applicable terms of Implementing Agreements.

B. The Parties will request that the State Water Board approve the initial Strategic Plan as an element of the Program of Implementation.

C. The Systemwide Governance Committee may revise the initial Strategic Plan for the purpose of Years 3 and 6, and subsequently as applicable, subject to the State Water Board's review and approval of any adaptive management outside of the limits established in the initial Strategic Plan.

9.4. Annual and Triennial Reports.

A. The Tributary/Delta Governance Entities will prepare Annual Reports of their implementation of the VAs in the preceding year. The Systemwide Governance Committee will compile and integrate these reports for annual submittal to the State Water Board.

(i). Reports will inform adaptive management.

(ii). Reports will be technical in nature, identify actions taken, monitoring results, and milestones achieved.

(iii). Reports will document status and trends of native fish.

(iv). Reports will document whether commitments for VA asset deployments are being met. Commitments will be documented using a State approved accounting methodology and validated to be true and correct by a third party independent registered professional engineer.

(v). Reports will document progress toward completion of VA habitat restoration projects. Each report will document permit success in terms of applications submitted, processing timelines, and permits obtained.

(vi). Reports will document efforts to seek new funding to support program.

B. In Years 3 and 6, and subsequently as applicable, the Systemwide Governance Committee will prepare a Triennial Report to analyze progress across the Delta watershed and, in coordination with the Tributary/Delta Governance Entities, will submit these reports to the State Water Board.

C. The State Water Board will hold a public informational workshop on the VAs following receipt of each Triennial Report.

10. Science Program. The VAs will include a comprehensive Science Program.

10.1. The Science Program will serve the following purposes: (A) inform decision-making by the Systemwide Governance Committee, Tributary/Delta Governance Entities, and VA Parties; (B) track and report progress relative to the metrics and outcomes stated in Appendix 4; (C) reduce management-relevant uncertainty; and (D) provide recommendations on adjusting management actions to the Systemwide Governance Committee, Tributary/Delta Governance Entities and VA Parties.

10.2. The Science Program will be guided by the principles of best available science, efficiency, forward-looking perspective, shared risk in addressing uncertainty in data and analyses, transparency, collaboration, and timeliness.

10.3. The Science Program will include the following elements.

A. Implement specific experiments. The science program will adopt a "safe to fail" experimental approach to maximize learning.

B. Test hypotheses. The program will identify and test key hypotheses/assertions, especially/even if conflicting, about how the ecosystem functions and what measures will be most effective at achieving desired outcomes.

C. Learn from the experiments. Ensure that each measure is designed and implemented in a manner that maximizes learning.

D. Design the experiments to test specific outcomes.

E. Facilitate a collaborative process. All parties will be engaged in the development and implementation of the science program.

F. Facilitate a transparent process. All parties will facilitate a transparent process through collaboration, reporting, and open data.

G. Monitoring. The Science Program will ensure one or more monitoring regimes are developed that will allow the parties to collect data on target species and their habitats necessary to assess the efficacy of flow and non-flow measures

10.4. For purposes of adaptive management, the Science Program will include structured decision-making processes to determine or adjust flow and non-flow measures, direct science efforts, and incorporate outcomes of the testable hypotheses to continue to inform decision-making, consistent with applicable provisions of the Governance Program.

11. Resolution of Litigation and Other Related Regulatory Proceedings. The Parties understand the VA contributions, to the maximum extent allowable under law, will be recognized in the resolution of other related regulatory proceedings, including during the pending consultation on ongoing CVP and SWP operations and/or application for a new or amended incidental take permit for operations. As provided in Section 1.3.B of the MOU, the VA Parties will address appropriate resolution of litigation pertaining to other regulatory actions, interim operations in 2023 and 2024, and other regulatory proceedings that relate to the actions described in the Term Sheet.

12. **Early Implementation.** State agencies will work with the VA Parties to implement the following measures before the State Water Board's approval of the VAs in the Program of Implementation, subject to applicable environmental review:

12.1. Dedication of water that can be made available without the establishment of revolving or water purchase funds;

12.2. Dedication of water that can be made available through an identified funding source; and

12.3. Advanced planning and/or implementation of habitat restoration projects that have funding and necessary regulatory approvals, including that available through the $70M appropriated from Proposition 68.

13. **Environmental Review**. The Parties request that the State Water Board consider this Term Sheet, including Appendices 1 through 4, as a proposal in the SED to support the update of the Bay-Delta Plan.

13.1. The Parties will develop a plan for all necessary environmental review for all VA-related implementation actions, including but not limited to use of the programmatic discussion in the State Water Board's SED consistent with applicable law.

13.2. This Term Sheet is not a contract and does not represent a commitment by any Party to approve or implement any project or alternative or otherwise bind any Party to a definite course of action.

Appendix 1.
Flow Tables

Table 1a: New Contributions to Tributary Flow and Delta Outflows in Thousand Acre Feet[1,2,3]

Source	**C (15%)[4]**	**D (22%)**	**BN (17%)**	**AN (14%)**	**W (32%)**
San Joaquin River Basin					
Minimum Placeholder Contributions [5]	*48*	*145*	*179*	*112*	*0*
San Joaquin Basin Portion of Gap		*11*	*2*	*10*	
Friant	0	50	50	50	0
Sacramento River Basin[6]					
Sacramento[7]	2	102	100	100	0
Feather	0	60	60	60	0
Yuba	0	60	60	60	0
American[8]	30	40	10	10	0
Mokelumne	0	10	20	45	0
Putah[9]	7	6	6	6	0
CVP/SWP Export Reduction[10]	0	125	125	175	0
PWA Water Purchase Program					
Fixed Price (see Table 1b)	3	63.5	84.5	99.5	27
Market Price[11]	0	45	45	45	0
Permanent State Water Purchases[12]	65	108	9	52	123
Year 1 New Outflow Above Baseline (Low Target)	***155***	***825.5***	***750.5***	***824.5***	***150***

Table 1b: Supporting Details for New Flow Contributions (Table 1a) and Year 8 Water Storage

	C (15%)	**D (22%)**	**BN (17%)**	**AN (14%)**	**W (32%)**
PWA Fixed Price Water Purchase Program					
Sac Valley NOD		10	10	10	
CVP SOD		12.5	24.5	35	
WWD SOD [13]	3	6	15	19.5	27
Add CVP SOD [13]		5	5	5	
SWP SOD		30	30	30	
Refill (Mokelumne)[14]	0	9	18	13.5	0

New Water Projects (Before Year 8)[15]					
Chino Basin	0	50	50	0	0
Kern Fan	0	18	18	0	0
Willow Springs Conjunctive Use	0	19	29	0	0

[1] This table reflects status of negotiations as of the date of this Framework. Prior "global gap" to meet adequacy are now reflected as Permanent State Water Purchases.

[2] Outflows additive to baseline and will be provided January through June. A portion of the VAs' flows can be flexibly shaped to other times of year to test biological hypotheses while reasonably protecting beneficial uses. Such shaping will be subject to VAs' governance program. Flows made available through reservoir reoperations will be subject to accounting procedures described in term sheet and all flows will be verified as a contribution above baseline using these accounting procedures.

[3] An assessment based on the accounting procedures to be developed pursuant to Term Sheet section 8.4 will be conducted prior to year 8 of VA to determine if the flows in this table have materialized on average above baseline by water year type. The VA parties acknowledge that, if this analysis does not demonstrate that flows have materialized as shown in this table, then the VAs will be subject to Term Sheet provisions of Section 7.4(B)(ii) or (iii).

[4] C year off-ramps subject to negotiation, but flows in this table must reflect average C year contributions over the term of the VA.

[5] Minimum placeholder contribution for the SJR tributaries equivalent to what would have been provided under the VA. Additional flows above minimum placeholder values will be required in certain year types to satisfy current water quality objectives.

[6] The new flow contributions from the Sacramento River Basin identified in this Table 1a, plus new flow contributions resulting from the below-referenced PWA Water Purchase Program, Permanent State Water Purchases, and PWA Fixed Price Water Purchase Program line items in Tables 1a and 1b, are not intended to result in idling more than 35,000 acres of rice land in the Sacramento River Basin.

[7] VA parties agree that the Sacramento River flow contribution of 100 TAF will be provided during the January through June period, except when it is recommended through the VA governance process that shifting the timing of a portion of this contribution would be in the best interest of the fishery. Recommendations by the VA governance group require approval from the following agencies: National Marine Fisheries Service, California Department of Fish and Wildlife, and the State Water Board.

[8] Contingent on funding groundwater substitution infrastructure to be completed by a subsequent year. These flows are included in the Year 1 subtotal.

[9] Consistent with the safe yield of the Putah Creek Accord (2000).

[10] If, in any year, this level of Exporter contribution would reduce supplies that would otherwise be provided to Exporters to protect M&I Public Health and Safety, then the Exporter contribution will be reduced to avoid reduction of M&I Public Health and Safety water, consistent with operations contemplated in D-1641 and the biological opinions for the coordinated operations of the CVP and SWP to protect health and safety water supplies.

[11] The VA's governance program will be used to determine the use of available funding to provide additional outflow in AN, BN, or W years. If DWR is called upon to provide the water by foregoing SWP exports, such call will be handled through a separate agreement between DWR and its contractors.
[12] State to permanently acquire 65TAF of water in all water year types to contribute to meeting the flow targets specified in row 27 of this table. After applying this 65TAF in all water years a gap of 43TAF will persist in D years and a gap of 58TAF will persist in W years; however, there will be a surplus of 56TAF in BN years and a surplus of 13TAF in AN years. D and W year gaps to filled by redistributing a portion of the PWA water purchase contribution from BN and AN years, and through additional State water purchases in W years.
[13] If flows are not obtained through this source, the equivalent volume would be obtained at market price or otherwise obtained through other mechanisms.
[14] Requires refill commitments or mutually agreeable operational agreement. Refill commitments are not included in tabulation of additive flows since they serve to ensure tributary flow contributions are protected as outflow without injury to other users.
[15] State funding to be secured, and projects to be phased-in, by Year 8.

Appendix 2.*
Minimum Additive Contributions to Habitat Restoration

Area	Total Acres[i]
Sacramento Basin	
Sacramento	137.5 (instream), 113.5 (spawning)
Sutter Bypass, Butte Sink, and Colusa Basin	20,000 (floodplain) [ii], 20,000 (fish food production) [iii] *Initial Targets per funding and permitting*
Feather	15 (spawning), 5.25 (instream), 1,655 (floodplain) [iv]
Yuba[v]	50 (instream), 100 (floodplain)
American	25 (spawning), 75 (rearing)
Mokelumne	1 (instream), 25 (floodplain)
Putah	1.4 (spawning)
North Delta Arc and Suisun Marsh	5,227.5 [vi]

**To expedite the completion of these projects, the State will commit to establish a new, multi-disciplinary restoration unit, with authority to coordinate and work collaboratively to obtain all permits required to implement the restoration activities. The unit will track and permit these projects and seek to: (1) encourage coordination between and among state and federal agencies, (2) avoid repetitive steps in the permitting process, (3) avoid conflicting conditions of approval and permit terms, and (4) provide an expedited path to elevate and resolve permitting challenges.*

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[i] This column represents the sum of habitat restoration commitments proposed in the Planning Agreement and habitat restoration acres identified in the State's VA Framework from February 2020 (modified to reflect the 8-yr VA term, State Team's discussion with participants, and modeling analysis).
[ii] Floodplain habitat will be generated via Tisdale Weir and other modifications. Subject to analysis showing that acreage meets suitability criteria.
[iii] Subject to analysis of effectiveness. Water will be pumped onto rice fields, held for a period of time to allow fish food production (e.g., zooplankton), and then discharged to the river for the benefit of native fishes downstream.
[iv] This consists of added instream habitat complexity and side-channel improvements.
[v] This constructed floodplain will be activated at 2,000 cfs.
[vi] This will be tidal wetland and associated floodplain habitats.

Appendix 3.
Costs to Implement VAs

Costs to Implement VAs	$ Million (M)	Notes
Costs in Planning Agreement		
Habitat Construction	$477	Estimated project costs throughout tributaries.
Voluntary Fallowing	$268	Upfront payments plus voluntary fallowing in Sacramento and Feather watersheds.
Water Purchases in Various Water Years	$125	Funding to purchase water from Yuba and upfront water purchase from American.
American River Recharge Project	$40	Project specified for funding in Planning Agreement.
Science and Adaptive Management Programs	$104	Estimated costs of science program across all tributaries ($1M/tributary/year) and Delta ($3M/year), and adaptive management ($5M/year).
Subtotal	**$1,014**	
Additional Costs to Achieve VAs as Described in this Framework		
Water Development Costs	$370	Projects that generate Delta outflow. Reflects State's share of awarded Prop 1 WSIP funding.
Additional Water Purchase on Market	$64	Funding deployed to secure additional flows in certain water years allocated per VA's Governance Program.
Additional Water Purchase with Fixed Price	$208	
Additional Habitat Restoration per this Framework	$381	Estimated cost to construct additional habitat identified in this Framework.
Adjusted Science and Adaptive Management Program	$24	Additional estimated science costs across all participating tributaries (+$0.5M/tributary/year) and Delta (+$0.5M/year).
Permanent State water purchases (no defined source)	$490	Estimated cost of water in various WYT's

Total Estimated Cost Refill	$25	Estimated cost on Mokelumne (Potential to Operate around and avoid this cost)
Mokelumne AN Water Purchase (30 taf)	$13	
Subtotal	**$1,575**	
Total VA Costs	**$2,589**	Aggregated costs from Planning Agreement plus additional costs to achieve commitments per this Framework.

Table 4.
<u>Funding for VAs' Framework</u>

Funding Source	**Use of Funds**	**$ million (M)**	**Notes**
Committed Funding in Proposed Framework (December 2018)			
Water Agencies	CVPIA Funding for VAs' Term	$80	Approximately $10M/year for 8 years.
Water Agencies	Water Revolving Fund	$217[1]	Generated by $5/AF charge on state and federal contractors and some other water agencies. Hydrology dependent. Portion required to stay within contributing tributaries.
Water Agencies	Habitat on Mokelumne	$17	Water agency contribution to habitat on Mokelumne per Planning Agreement
Water Agencies	Structural Science and Habitat Fund (SSHF)	$124	Generated by $1-2/AF charge on state and federal contractors and some other water agencies. Portion required to stay within contributing tributaries (Yuba and American).
Subtotal		**$438**	
State	Proposition 68	$165	Explicitly provided in Proposition 68 for water purchases, land fallowing, and habitat projects
State	Proposition 1 Water Storage Investment	$370	Funding generated by Proposition 1. Requires other funding match from

[1] Dollars in this and the subsequent row are based on historical deliveries on a long-term average. Actual dollars may vary.

	Program (WSIP) for Feather River		individual State Water Contractors (Chino, Kern, and Willow Springs).
Various	CVPIA and State funding allocated to VA habitat projects in March 2019 PD	$87	Funding from CVPIA, Prop 1, and other grants already allocated to projects identified in the March 2019 PD. Does not include Prop 68 funds.
Subtotal		**$622**	
Total Committed Funding		**$1,060**	From PWAs, State and Federal combined
Identified New Funding			
Water Agencies	Immediate collection of self-assessment	$100	Contribution to revolving fund two years prior to VAs' effective date. Any federal funding that is not available in these first two years due to appropriations constraints will be recouped through a surcharge over the 8-year term of the VAs. If federal funding is recouped through a surcharge, each PWA that pays a surcharge will receive credit in the amount of the surcharge paid. The credit shall be applied as soon as possible against a financial obligation the PWA assumes under the VAs.
Water Agencies	Additional funding for water purchases (Water Revolving Fund)	$130	Funding generated by an additional $3/AF self-assessment by PWAs.
Subtotal of New Funding from Water Agencies		**$230**	
New Funding from State (secured)		**$503**	$200 M from DWR for habitat restoration and $303 M from CNRA water resilience funds (which total $445 M)
New Funding from State (unsecured)		**$381**	
New Federal Funding (unsecured)		**$740**	New federal funding to support habitat restoration throughout tributaries, multi-

			benefit projects, and Sacramento Valley habitat projects.
Total of New Funding Commitments		**$1,854**	
Total Funding for VAs		**$2,914**	This total exceeds VA costs above because it includes federal funding which is needed for habitat restoration.

Appendix 4: Metrics, Monitoring, and Outcomes Framework for Assessing VA Effectiveness

This framework, including implementation criteria, habitat suitability and utilization criteria, and the final monitoring framework will be further developed collaboratively by the VA Parties (see Sections 2.1 and 5.2 of VA Term Sheet) in coordination with the State Water Board.

Implementation criteria: Quantitative metrics will be developed to ascertain whether VA commitments are met. Implementation criteria will be established to ensure actions are taken to provide (1) flow volumes by water year type above baseline as specified in Appendix 1, and (2) non-flow assets, including instream and floodplain habitat projects, that meet design criteria, acreage, and other targets. The implementation criteria answer the question: Did we implement the actions we committed to undertake? If not, why not? Consideration will be given for non-party caused implementation hurdles.

Habitat suitability and utilization criteria: Quantitative metrics will be developed for determining if constructed habitat meets predetermined: 1) project level suitability criteria (e.g. depth, velocity, duration); and 2) utilization criteria (e.g. fish presence, food production, juvenile fish movement, fish condition). The habitat suitability and utilization criteria answer the question: Are the constructed and restored habitats providing or likely to provide suitable habitat or food production for target species and life stages and are they being used as intended? Consideration will be given for non-party caused implementation issues and for the time it takes for restoration sites to "mature."

Monitoring: Before VA year 0, the VA Governance and Science Program will develop a monitoring framework (e.g. species and habitat) to test the specific hypotheses for each of the VA commitments. The framework will include habitat design, suitability, and utilization criteria, which will be subject to approval by DFW, in consultation with USFWS and NMFS, and adopted by the SWB as part of the overall VA. Project specific monitoring plans will be developed through the VA Governance and Science Program. In coordination with the SWB and other VA Parties, CDWR and the U.S. Bureau of Reclamation will develop accounting procedures to assure that flows and habitat restoration provided under the VAs are additional contributions above baseline conditions as defined in Section 4 of this Term Sheet. These procedures will be incorporated into the Implementation Agreements and subject to approval by the State Water Board. Early implementation projects will follow monitoring protocols developed during permitting/granting process, and adjust, as appropriate, once VA governance has developed a framework. The framework will require SWB approval.

Sufficient monitoring of target species and flow and habitat assets deployed over the initial term of the VA will be key to informing the scientific basis and rationale for continuing the VA beyond year 8. Monitoring approaches will vary geographically and by habitat type but should be hypotheses driven and supported by recent data from the watershed or geographic region in question. The goal of this monitoring effort is to ensure species and habitats are monitored correctly and sufficiently to answer the hypotheses as described in the habitat monitoring framework. An illustrative example is provided below:

Habitat Type	Objective	Hypothesis	Monitoring Metrics
Tributary Spawning	• Increase abundance of fry	Increase in suitable spawning habitat area increases number of redds and successfully hatched eggs.	• Number of redds • Egg→Fry survival • Abiotic parameters

Ecological outcomes analysis: Prior to year 7 of the VA, a report from the VA governance program will be submitted to the SWB synthesizing the scientific data and information generated by the VA science program, primarily based on the Years 3 and 6 Triennial Reports. The governance and science programs will include, but not be limited to, members of all represented parties in the development of reports and synthesis analysis. This report will document the hypotheses tested and the results, and will demonstrate the scientific basis and rationale for continuing the VA beyond year 8. This report will also synthesize available information and extrapolate from the VA hypothesis testing the expected ecological outcomes from continuing the VA, including quantifying how the continuation of the VA will improve species abundance, ecosystem conditions, and contribute to meeting the WQCP Objectives. The analysis will be informed by a variety of approaches, including monitoring data and models developed over the initial 8-year term of the VA. Sufficient monitoring of target species and flow and habitat assets deployed over the initial term of the VA will be key to informing the scientific basis and rationale for continuing the VA beyond year 8. The ecological outcomes analysis could answer the key questions: What have we learned from flow and non-flow actions implemented under the VA, what combination of flow and non-flow assets maximize ecological benefits, are changes needed to VA assets after Year 8, and how will continuation of the VA effect the overall ecosystem at the population level for target species? Consideration will be given for actions or circumstances outside the control of the VA parties.

Appendix B

Draft Governance Program

Draft VA Governance Program

Contents

Preface

Document Purpose

This document is a preliminary draft of the Governance Program which, in final form, will be content for Exhibit D to the Global Voluntary Agreement (VA). The VA Parties provides this draft to the State Water Resources Control Board for information, as the Board prepares its Staff Report to update the Bay-Delta Plan. The VA Parties will update this document as necessary following the public review process, including to address comments received.

Consistent with the VA Governance Principles of inclusiveness, collaboration, transparency, accountability to outcomes, consensus-seeking, and informed decision making, the VA Parties strongly welcome the involvement of California Native American tribes and non-governmental organizations (NGOs) to further refine the development of the VA Governance Description.

1 Draft VA Governance Program

A Voluntary Agreements (VA) Governance Program will be established to direct Systemwide Measures, make recommendations regarding the deployment of Tributary/Delta Measures, conduct assessments, update the strategic plan, develop annual reports, implement a systemwide science program, and hire staff and contractors, consistent with applicable provisions of the VA. The "VA" will be a series of legal agreements, including a Global Agreement, Implementing Agreements, and Enforcement Agreements. These agreements (defined further in the Strategic Plan) will establish the measures, rights, and obligations with respect to the VA Program.

1.1 VA Governance Principles

Participants agree to keep the following principles in the forefront to guide how the VA Governance Program is developed and implemented:

- Inclusiveness and Collaboration
- Transparency
- Accountability to Outcomes
- Respecting Rights, Authorities and Obligations
- Certainty and Adaptability
- Consensus-seeking
- Science-based Decision Making
- Efficiency

Inclusiveness and Collaboration
The VA Governance Program will be inclusive, involving Participants in all aspects of planning and implementation. The Participants commit to working together in good faith, with integrity and a spirit of collaboration. They recognize each others' constraints, acknowledge the need to address capacity limitations and the inherent uncertainty of biological outcomes, and will work together in a manner that acknowledges both their shared and individual interests and the purpose of the Bay-Delta Plan to provide for the reasonable protection of all beneficial uses.

Transparency
Transparency, on multiple fronts, will be a key means of building trust among the Participants and integrity in the VA Governance Program. Transparency will be reflected in all aspects of the VA Governance Program – decision making, science, budgeting and accounting. With respect to decision making and science activities, transparency means that information is accessible to the public with respect to: (1) decision-making processes, (2) the information or evidence used to inform decisions, and (3) the rationale for decisions. California Native American tribes shall have full control regarding the use and disclosure of cultural, traditional, proprietary, ecological knowledge, or any other tribal information they deem sensitive. In the VA Governance Program's budgeting and accounting activities, transparency means that information is accessible to the public on: (1) who contributes to VA funds, (2) who receives VA funds, and (3) the use of the funds and current balance of unused funds.

Accountability to Outcomes
Participants acknowledge that time is of the essence and they are committed to achieving ecologically relevant outcomes to help halt and reverse the decline of native fish and wildlife, and contribute towards achieving viable populations of native species. The VA Governance Program will be action-oriented with a focus on deploying the portfolio of Flow and Non-flow Measures over the 8-year term of the VA to

contribute to the Bay-Delta Plan's Narrative Salmon Objectives and the proposed Narrative Viability Objective.

Respecting Rights, Authorities, and Obligations

The VA Governance Program will be consistent with all discretionary and administrative authority. Nothing in the VA Governance Program will be interpreted as requiring the Federal Parties, California Native American tribes, the State agencies, or any other entity to implement any action that is not authorized by, or is in conflict with, applicable law, State or federal regulation, or where sufficient funds have not been appropriated or provided for that purpose. The VA Parties expressly reserve all rights not granted, recognized, or relinquished in this agreement.

Certainty and Adaptability

The VA is intended to provide assurance and certainty to the VA Parties regarding Bay-Delta Plan regulatory obligations over the 8-year VA term. This certainty is coupled with a commitment of Flow and Non-flow Measures to be adaptively managed within the scope and terms of the VA and the Bay-Delta Plan, and according to defined planning and decision-making processes. A formal process for learning and adaptation over time is expected to lead to better, innovative, long-term solutions and outcomes for native fish and wildlife.

Consensus-seeking

Building on the principle of collaboration, the VA governance processes will be consensus-seeking, recognizing that consensus among the Participants facilitates implementation of management actions to contribute to the Bay-Delta Plan's Narrative Salmon Objectives and the proposed Narrative Viability Objective.

Science-based Decision Making

All plans and decisions in the VA Governance Program will be guided by the best available science and technical information on how to deploy Flow and Non-flow Measures to contribute to the Bay-Delta Plan's Narrative Salmon Objectives and the proposed Narrative Viability Objective.

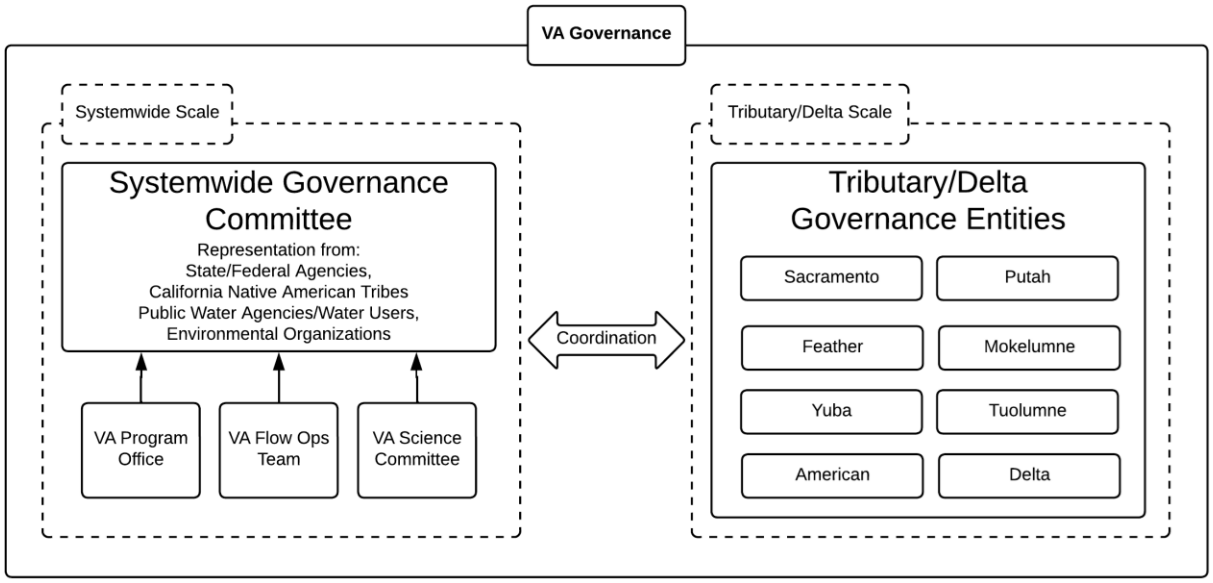
Efficiency

Broadly, being efficient means achieving the greatest benefit with the resources available, making timely decisions and avoiding duplication of effort. The Participants acknowledge that there are numerous existing entities across the Bay-Delta Watershed that have planning processes and science programs in place. To the extent possible, the VA Governance Program will coordinate with existing entities to avoid duplication and be resource efficient.

1.2 Systemwide and Tributary/Delta Governance Entities

VA Participants will establish a Systemwide Governance Committee to implement the VA Governance Program. In addition, the parties to each Tributary/Delta Specific Agreement will establish or identify a Tributary/Delta Governance Entity (Figure 1). The Systemwide Governance Committee will be supported by a Program Office, Flow Operations Team, and a Science Committee. The roles and responsibilities for the Systemwide Governance Committee, the Trib/Delta Governance Entities, and other entities are described further in the following sub-sections.

Figure 1: VA Governance Structure



1.2.1 Implementing Entities and Responsible Parties

Implementing Entities are the entities that commit to implement VA Flow or Non-flow Measures, as shown in the relevant Implementing Agreements.

The Implementing Entities will vary depending on the measure being deployed. VA Parties that will be Implementing Entities for Flow and Non-flow Measures include: the U.S. Bureau of Reclamation, the California Department of Water Resources, and other Public Water Agencies or water purveyors with legal authority to implement measures and that have signed an Implementing Agreement.

Responsible Parties are a subset of Implementing Entities that have signed Enforcement Agreements and thus have regulatory obligations to implement specified measures.

1.2.2 Systemwide Governance Committee

The primary responsibilities of the Systemwide Governance Committee will be:

- **Decision Making:**
  - Manage the VA Science Program and Systemwide Measures, consistent with the terms of applicable Voluntary Agreements.
  - Make recommendations to Responsible Parties for deployment of Tributary/Delta Measures.
  - Make administrative decisions regarding the Program Office (e.g., Executive Director hiring, Program Office budgets).
- **Reporting:** Oversee Triennial Reports every 3 years beginning in Year 3 as provided in Section 1.4.
- **Strategic Planning:** Update the Strategic Plan on the deployment of Flow and Non-flow Measures and science priorities and provide oversight for the implementation of the Strategic Plan.
- **Coordination:** Provide a venue for the overall coordination of the VA Governance Program.
- **Consistency:** Assure that implementation of the VA Governance Program is consistent with the terms of applicable Voluntary Agreements.

Systemwide Measures, Tributary/Delta Measures and Systemwide Planning

Systemwide Measures are Flow and Non-flow Measures that are not tightly constrained, and therefore can be deployed for the greatest overall benefit as assessed at the scale of the Bay-Delta Watershed by the Systemwide Governance Committee. Tributary/Delta Measures are the Flow and Non-flow Measures that can be implemented at the discretion of the VA Party that committed the measures as long as that implementation is consistent with the Enforcement Agreements.

The Systemwide Governance Committee will focus evaluation and deliberation on those measures and science activities that are appropriate for planning at the systemwide-scale (i.e., Systemwide Measures and science, and any Tributary/Delta- Measures that are being offered for planning at the systemwide-scale) and are necessary for accomplishing systemwide metrics and outcomes.

The Systemwide Governance Committee does not have the authority to direct actions inconsistent with the Enforcement Agreements, which will establish the enforceable obligations of specific VA Parties.

A Charter for the Systemwide Governance Committee will be developed. This Charter will, among other things, (a) identify the goals and objectives of the VA Governance Program, (b) describe the membership of the Committee, (c) establish procedures for adding and removing members, (d) establish meeting guidelines, a schedule, and other related content, (e) identify the Tributary/Delta Measures for which the Systemwide Governance Committee will make recommendations, and (f) define voting procedures.

Consistent with the VA Governance Principles of inclusiveness, collaboration, transparency, accountability to outcomes, consensus-seeking, and informed decision making, a wide range of VA Parties, California Native American tribes, non-governmental organizations, and other interested parties will be eligible for membership in the Systemwide Governance Committee.[1] The State Water Board will designate a representative to participate in the Systemwide Governance Committee as an advisory resource but will not be a voting member.[2]

Membership on the Systemwide Governance Committee will not trigger or otherwise cause a delegation of authority or obligation from a member of the Systemwide Governance Committee to the Systemwide Governance Committee or any member of the Systemwide Governance Committee. The specific roles and level of involvement in implementing actions are defined either by existing statutory or regulatory authorities of each member or by provisions set out in the Voluntary Agreements. The Systemwide Governance Committee will not have legally enforceable responsibility for implementation.

1.2.3 Tributary/Delta Governance Entities

The parties to each respective Tributary/Delta Voluntary Agreement will establish its governance structure. The primary responsibilities of each respective Tributary/Delta Governance Entity with responsibility for implementing a VA will be:

- **Implementation:** Implement the Voluntary Agreement(s) or any portion thereof for which that entity is responsible.
- **Reporting:** Provide reports annually to the Systemwide Governance Committee and the State Water Board as provided in Section 1.4. Reports may also be provided directly to the State Water Board as it

[1] The specific process for determining who is eligible to become a member will be defined in the Systemwide Governance Charter.
[2] State Water Board oversight and enforcement of the Voluntary Agreement is as described in the Plan of Implementation and through the Government Code Agreement.

pertains to specific permits or requirements for that tributary separate from VA implementation and commitments.

- **Decision making:** Participate actively in the Systemwide Governance Committee and provide background and status of resources and projects to inform and improve overall strategic planning and systemwide decision making.

Tributary/Delta Governance Entities will coordinate with the Systemwide Governance Committee as necessary. The structures of the Tributary/Delta Governance Entities will vary as summarized in Table 1 and each Tributary/Delta Governance Entity will exercise varying degrees of influence over how each Responsible Party will deploy the Flow and Non-flow Measures it controls. Some of these entities are existing entities that will expand their current scope of activities to include implementation of the Voluntary Agreements.

Tributary/Delta governance entities will not have legally enforceable responsibility for implementation.

Table 1. Tributary/Delta Governance Entities

Tributary/Delta	Current Status of Tributary/Delta Governance Entity
Sacramento River	On the Sacramento River, there are several different organizations that are engaged and active, however, none of those currently have broad representation and decision making structure. The Sacramento River Settlement Contractors (SRSC) have been working toward formation of a governance body that would include water users, government agencies and interested parties.
Feather River	Upon issuance of the FERC license for the Oroville Facilities, DWR will be required to create a Feather River Operations Group (FROG) that will be composed of representatives from at least DWR, NMFS, USFWS, and CDFW. One objective of the FROG is to provide recommendations for coordination of Feather River flows, flows with fish releases, and flows for green sturgeon. The FROG could function as an appropriate forum to make release recommendations for the VA Flow Measures. However, a governance body would still need to be formed to include water users and interested parties and to implement VA Non-flow Measures, consistent with VA governance principles.
Yuba River	For the Tributary Specific Agreement Flow Measures, the Yuba Accord provides the background framework for planning, management, and verification of Yuba River flows. The Tributary Specific Agreement structure and process will be consistent with the Yuba Accord Water Purchase Agreement accounting and coordination provisions, with the primary parties being the Yuba Water Agency (YWA) and CDWR. YWA, CDWR and CDFW will establish a management team for Tributary Specific Agreement Non-flow Measures. A Yuba River Habitat group may be created to provide advice regarding implementation of the VA.
American River	For the American River, VA implementation will involve the existing Water Forum governance, which was established with the Water Forum Agreement (2000). The Water Forum makes decisions through a quad-cameral supermajority of their Water, Environmental, Public, and Business Caucuses.
Putah Creek	For the Tributary Specific Agreement Flow and Non-flow measures, the Solano County Water Agency (SCWA) is the Responsible Party and will serve as the Tributary Governance Entity. Flow measures will be deployed above to the Putah Creek Accord of 2000 (Accord) baseline flow regime to protect and enhance regional system functional flow needs. SCWA will recommend VA flow deployment regimes

Tributary/Delta	Current Status of Tributary/Delta Governance Entity
	based on real-time conditions and consider recommendations for VA flow deployment requested through the Systemwide Governance Committee. SCWA is the lead agency for CEQA and permitting for implementation of Putah Non-flow measures. The Lower Putah Creek Coordinating Committee (LPCCC) was formed by the settlement parties in 2000 to administer the terms of Accord. Non-flow measures will be implemented by SCWA as funding becomes available and issuance of necessary implementation permits, with logistical support of the LPCCC.
Mokelumne River	For the Tributary Specific Agreement, implementation will involve governance under the existing Mokelumne River Partnership established under the Mokelumne Joint Settlement Agreement (1998). The Partnership includes EBMUD, CDFW, and USFWS, with input from NMFS. It consists of a three tiered system for technical collaboration and consensus-based decision making and signatory authority .
Tuolumne River	Upon issuance of a FERC license for the Don Pedro and La Grange Projects, MID and TID will form the Tuolumne River Partnership Advisory Committee (TRPAC) which shall include USFWS, CDFW, SFPUC, MID and TID as initial members; other resource agencies will be invited to actively participate. The TRPAC will provide advice regarding the selection and design of individual habitat projects and the management of spill to benefit salmonids. The TRPAC could function as an appropriate forum for implementing the Tuolumne River VA, including consideration of recommendations from the Systemwide Governance Committee.
Sacramento-San Joaquin Delta	The Collaborative Science and Adaptive Management Program's (CSAMP) Collaborative Adaptive Management Team (CAMT) is one potential Delta Governance Entity for the VA. CAMT includes water users, agencies, and interested parties, and currently supports science and structured decision-making activities.

1.2.4 Science Committee

The primary role of the Science Committee will be to guide and support the implementation of the Systemwide Governance Committee's science and technical priorities. The Science Committee will report to the Systemwide Governance Committee. The Science Committee will be composed of technical and science representatives of all Systemwide Governance Committee members and will form subcommittees or technical task teams as needed.

The primary responsibilities of the Science Committee in connection to the Systemwide Governance Committee will be:

- **Strategic Planning**: Provide scientific and technical analysis support to the Systemwide Governance Committee's strategic planning activities and Tributary/Delta Governance Entity planning processes as applicable.
- **Science Program**: Under the direction of the Systemwide Governance Committee, and in close coordination with the Program Office, plan and coordinate the systemwide science activities in the VA Science Program in accordance with the Strategic Plan, Tributary/Delta science plans, and in coordination with existing entities.
- **Reporting**: Coordinate and synthesize all systemwide monitoring and research under the VA Science Program, assess progress relative to implementation metrics and habitat suitability and utilization metrics, review and synthesize results to inform ongoing adaptive management and Strategic Plan updates.

1.2.5 Flow Operations Team

The Flow Operations Team will be composed of water operational staff from each of the Implementing Entities with a role in implementing or coordinating Systemwide Flow Measures. The Flow Operations Team will report to the Systemwide Governance Committee.

The Flow Operations Team's primary responsibilities will be:

- **Planning:** Provide advice to the Systemwide Governance Committee and the Tributary/Delta Governance Entities on the feasibility, options and risks of possible deployments of Systemwide Flow Measures based on water supply conditions and system operations constraints.
- **Coordination:** Support coordination of Systemwide Flow Measures in real-time operations, and provide support with accounting and documenting of Systemwide Flow Measure deployment on an annual basis.

1.2.6 State Water Board

The State Water Board will be signatory to Enforcement Agreements, which establish the enforceable obligations for implementation.

State Water Board staff will participate in the Systemwide Governance Committee but will not be a voting member. State Water Board staff will also provide technical staff to participate in the Science Committee and the Flow Operations Team. The role of State Water Board staff will be to provide advice on compliance with the Bay-Delta Water Quality Control Plan.

The State Water Board will incorporate the annual and triennial reporting and the Strategic Plan developed by the Systemwide Governance Committee into their triennial review to meet requirements of the Federal Clean Water Act (33 U.S.C., § 1313, subd. (c)(1)) and Water Code section 13240, the Central Valley Regional Water Quality Control Board (Regional Water Board).

1.2.7 Program Office

The Program Office will report directly to the Systemwide Governance Committee and will be a neutral entity responsible for the ongoing implementation and administration of the systemwide VA Governance Program. The Program Office will have an Executive Director who has the authority to hire staff as necessary, subject to budget limitations as set by the Systemwide Governance Committee. The Program Office will also have a Science Manager who will support the Science Committee to implement the VA Science Program. Other supporting staff positions could be developed as required.

The primary responsibilities of the Program Office will be:

- **Strategic Planning:** Coordinate development of the Strategic Plan and provide guidance to the Systemwide Governance Committee, with Science Committee support, on science and adaptive management. Coordination on plans, permitting for non-flow measures and activities will be needed across Tributary/Delta Governance Entities and the VA Science Program.
- **Systemwide Governance Committee Meeting support:** Provide administrative and facilitation services for all Systemwide Governance Committee meetings, including meetings of Systemwide Governance Committee's sub-committees/teams (e.g., Science Committee, Flow Ops Team) and any other meetings/workshops convened by the Systemwide Governance Committee.
- **Work planning and financial administration:** Develop Program Office annual work plans and budgets for Systemwide Governance Committee approval and administer the Program Office's budget to implement work plans, including managing staff and contracts.

- **Reporting:** Develop consolidated annual and triennial reports incorporating input from the Tributary/Delta Governance Entities for Systemwide Governance Committee approval and for submittal to the State Water Board.
- **Issue Management:** Document systemwide issues constraining schedule and effective implementation of Systemwide Measures, for use in making recommendations to the Systemwide Governance Committee.

1.3 Governance Procedures

1.3.1 Systemwide Governance Committee Consensus-seeking Procedures

The Systemwide Governance Committee will be consensus-seeking for all decisions and recommendations. Consensus-seeking means that the Systemwide Governance Committee members will strive for, but not require, unanimous agreement. The Systemwide Governance Committee members acknowledge that there are tough choices to be made and that full agreement may not always be possible. Systemwide Governance Committee members will first and foremost work in good faith to reach full agreement. If full agreement is not reached after reasonable effort, alternative decision-making processes will be used that are described in Section 1.3.2 and are consistent with existing legal rights, authorities, and obligations.

The Program Office will play a critical role in facilitating consensus through presenting proposals or options to the Systemwide Governance Committee that incorporate the viewpoints of all members and through iteratively improving proposals/options to better address competing interests.

The Systemwide Governance Committee will engage in two types of decision making: (1) recommendations on Tributary/Delta Measures (e.g., recommendations to Tributary/Delta Governance Entities and/or Responsible Parties); and (2) decisions related to Systemwide Measures In either type of decision making, or when appropriate, the Systemwide Governance Committee will seek to build consensus on a preferred course of action among all members. Proposals to the Systemwide Governance Committee for how to deploy Flow and Non-flow Measures will originate in the VA Science Committee or through the Tributary/Delta Governance Entities.

1.3.2 Systemwide Governance Committee alternative decision-making procedures in the event of non-consensus

The expectation is that non-consensus will be rare because Systemwide Governance Committee members will participate in accordance with the governance principles that emphasize inclusiveness, collaboration, consensus-seeking and informed decision making. However, if after reasonable effort, consensus on a decision cannot be reached, the Systemwide Governance Committee will undertake the alternative decision-making processes. “Reasonable effort” means that the Systemwide Governance Committee members have made honest and earnest attempts, commensurate with the magnitude of the decision, to address the specifically identified deficiencies of a proposal relative to the underlying interests of all members. Usually this requires some degree of iteration through identification of the interests, development of solutions to better address them, and re-assessment of the proposal.

The alternative decision-making procedure will occur within 7 business days of the failure to reach consensus. The alternative decision-making procedure used depends on the nature of the proposal. If an agreement cannot be reached for:

- **Recommendations on Proposals for Tributary/Delta Measures** → proposals will go back to the Responsible Party without a recommendation. The Program Office will document the perspectives of the Systemwide Governance Committee and provide the information to the Responsible Party to inform their decision-making process.

- **Decisions on Proposals for Non-flow Measures funded through alternative funding sources** → decision goes back to entity(ies) that is/are provider of funding. The Program Office will document the perspectives of the Systemwide Governance Committee and provide the information to the funding entity(ies) to inform their decision-making process.
- **Decisions on Proposals for Systemwide Flow and Non-flow Measures, Science and Habitat Fund and All Other Systemwide Decisions** → decisions will go to a vote by the Systemwide Governance Committee to determine whether the proposal is accepted. The specifics and requirements of the voting procedure will be defined in the Systemwide Governance Committee Charter.

1.3.3 Resolution of Disputes between Systemwide Governance Committee and Responsible Parties for Systemwide Measures

For the purposes of this section, a "dispute" shall be deemed to have arisen when a disagreement between the Systemwide Governance Committee and Responsible Party still exists related to Systemwide Measures after they have attempted to resolve the disagreement through the standard decision-making procedures. In the event of such a dispute, the following process will be employed to resolve the dispute.

The Dispute Resolution process will in no way limit any legal or equitable processes or remedies otherwise available to the parties. The Dispute Resolution process will in no way bind or limit the discretion afforded to any party by law, internal resolution, or policy.

When a Responsible Party determines it cannot implement a Systemwide Measure consistent with the recommendation of the Systemwide Governance Committee, the Responsible Party shall notify the Systemwide Governance Committee, which shall convene a meeting of appropriate representatives. At the meeting, the participants shall identify options to resolve the matter. If no resolution is found, then the respective parties may jointly consult the State Water Board or other regulatory agency for guidance.

If the regulatory agency responsible for the obligation provides guidance that the Systemwide Measure cannot be implemented as recommended by the Systemwide Governance Committee without affecting compliance by the Responsible Party, then the direction of the Systemwide Governance Committee will not be implemented.

If the regulatory agency with authority over the obligation provides guidance that the Systemwide Governance Committee's recommendation can be implemented without affecting compliance, then the Responsible Party will implement the measures unless it disputes the guidance.

1.4 Annual and Triennial Reports

The Tributary/Delta Governance Entities will prepare Annual Reports of their implementation of the VAs in the preceding year. The Systemwide Governance Committee will compile and integrate these reports for annual submittal to the State Water Board.

The annual reports will:

- inform adaptive management.
- be technical in nature, identify actions taken, monitoring results, and milestones achieved.
- document status and trends of native fish.

- document whether commitments for VA Flow and Non-flow measures are being met. Commitments will be documented using a State approved accounting methodology and validated to be true and correct by a third party independent registered professional engineer.
- document progress toward completion of VA habitat restoration projects. Each report will document permit success in terms of applications submitted, processing timelines, and permits obtained.
- document efforts to seek new funding to support program.

In Years 3 and 6, and subsequently as applicable, the Systemwide Governance Committee will prepare a Triennial Report to analyze progress across the Delta watershed and, in coordination with the Tributary/Delta Governance Entities, will submit these reports to the State Water Board.

The State Water Board will hold a public informational workshop on the VAs following receipt of each Triennial Report.

Appendix C

Draft Science Plan

Draft Voluntary Agreement Science Program

Contents

Preface

Document Purpose

This document is a preliminary draft of the Science Plan which, in final form, will be content for Exhibit E to the Global Voluntary Agreement. The Systemwide Governance Committee provides this draft to the State Water Resources Control Board for information, as the Board prepares its Staff Report to update the Bay-Delta Plan. The purpose of the Draft Science Plan is to provide the framework and specific approach for evaluating the outcomes of the Flow and Non-flow Measures and ultimately to inform the State Water Board's assessment in Year 8 of the VA Program as described in the March 29, 2022, MOU and Term Sheet. The VA Parties will update this document as necessary following the public review process, including to address comments received.

Voluntary Agreement Draft Science Program

1 Introduction and Background

The Voluntary Agreements (VA or VAs) Program, described in the March 29, 2022, Term Sheet, is an alternative Program of Implementation for the Sacramento River, Delta, and Tributary update to the San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan. The scientific rationale for the VA approach of providing both environmental flows and habitat improvements for native fishes is described in the 2023 Draft Scientific Basis Report Supplement in Support of Proposed Voluntary Agreements for the Sacramento River, Delta, and Tributaries Update to the San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan (2023 Draft Scientific Basis Report Supplement), and the forthcoming Draft Scientific Basis Report for the Tuolumne River.

1.1 Voluntary Agreement Science Program and Governance

The VAs include formation of a VA Science Program, guided by the VA Science Committee. The VA Science Program is a coordinated collective of tributary- and Delta-focused monitoring and research programs relevant to understanding the outcomes of VA implementation that has several high-level functions:

- To inform decision-making by the Systemwide Governance Committee, Tributary/Delta Governance Entities, and VA Parties;
- To track and report progress relative to the metrics described in Section 2 of this document;
- To reduce management-relevant uncertainty; and
- To provide recommendations on adjusting management actions to the Systemwide Governance Committee, Tributary/Delta Governance Entities and VA Parties.

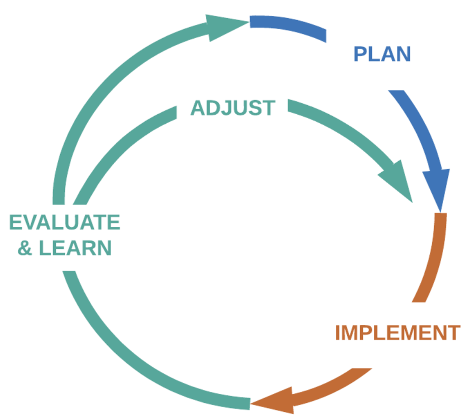
Individual tributary and Delta science programs will play a key role in generating the base of information necessary to support these functions. Tributary and Delta-specific science plans will provide the detailed guidance for monitoring VA actions by leveraging existing tributary monitoring networks. The primary role of the VA Science Program will be to work toward increasing consistency over time in how these tributary- and Delta-focused programs track progress relative to metrics described in this Plan, to enable a broad and synthetic understanding of the outcomes of VA actions. The VA Science Committee will play a key role in building this consistency by advising on project- and tributary-specific science and monitoring plans, and by directing VA funding (through recommendations to the Systemwide Governance Committee) into specific improvements in the monitoring network. For example, the VA Science Committee will review project-specific science and monitoring plans and will recommend changes to ensure that priority management-relevant uncertainties (i.e., those that are most relevant to informing implementation of VA Flow and Non-flow Measures) are appropriately evaluated, and that the data are collected in a way that facilitates a consistent dataset across watersheds. This consistency will in turn enable a system-wide evaluation of the ecosystem response to similar habitat enhancement or flow actions taken in different tributary systems. This broader geographic scale of evaluation will inform the triennial reports in Year 3 and Year 6 required in the VA Term Sheet. Additionally, consistent data collection practices across systems will provide robust empirical data needed to enhance predictive modeling tools, such as life cycle models, which are necessary for simulating the effect of future management actions and informing adaptive management of VA actions.

As described in the Term Sheet, the State Water Board will, in Year 8 of the Program, assess whether to continue or modify the VA Program in consideration of a range of factors related to progress on implementation of VA commitments, availability of required permitting and funding, and protection of flows. In addition, and most relevant to the Science Program, the State Water Board will also consider whether synthesis reports and analyses produced by the VA Science Program support the conclusion that continuation of the VA Program, together with other actions in the Bay-Delta Plan, will result in attainment of the Narrative Objectives. Information collected by the VA Science Program on the biological and ecological outcomes of the VA actions will be instrumental to supporting the State Water Board's assessment of the effects of the VA Program but will not solely determine success or failure of the VA program.

The purpose of this Science Plan is to provide the framework and specific approach for evaluating the outcomes of the flow and non-flow measures and for addressing several important and broad-scale ecosystem management questions, described in the next section. The hypotheses and associated monitoring described in this Science Plan are intended to be thorough to describe a full range of potential approaches to assessing the biological and environmental outcomes; however, it is not anticipated that every flow and non-flow action will address each relevant hypothesis. Instead, this document is intended to provide guidance to the VA Science Committee as it develops recommendations for priority areas of focus for additional monitoring, active experiments, decision support modeling, and data analyses needed to fill knowledge gaps, assess the outcomes of the suite of VA measures, and inform ongoing and future decision making.

1.2 Adaptive Management and Decision Support for VA Flow and Non-Flow Measures

Figure 1. Adaptive management cycle



The VA Parties are committed to learning and adaptation over time with the goal of developing better, innovative, and long-term solutions and outcomes for native fish and wildlife. As such, the VA Parties are committed to learning from the implementation of VA flow and non-flow measures over the 8-year term of the VA Program and using this knowledge to inform future decisions about VA actions. Prior to the end of the 8-year term, the knowledge gained through the implementation of the VAs is expected to inform either a renewal of the VA Program and/or a Bay-Delta Plan update.

Adaptive management in the VA Science Program describes an approach to testing priority hypotheses related to the effects of the suite of VA measures and applying the resulting information to improve future management and regulatory decisions. The foundation of the VAs approach to adaptive management is articulated in a set of spatially nested Big Questions, which include:

- **Big Question 1**: Will implementation of individual VA flow and non-flow measures have the intended physical and biological effects at the site scale – and if not, why not?
- **Big Question 2**: Will the combination of VA flow and non-flow measures within a tributary result in improved tributary-level outcomes for native fish (e.g., juvenile production)?
- **Big Question 3**: Will changes in fish outcomes at the tributary scale result in improved population-level outcomes in support of the State Water Board's Narrative Objectives?

Collectively, these Big Questions articulate a bottom-up approach to understanding the aggregated effects of site-specific actions that VA Parties have taken in support of the Narrative Objectives. Section 2 elaborates on these questions further in Sections 2.2 through 2.4 of this Science Plan, which articulate specific hypotheses about the expected changes in key metrics relative to relevant pre-action baselines or reference sites. Observed or modeled changes relative to these metrics (summarized in Table 1) will be the primary means through which the VA Science Committee assesses progress relative to the core objectives of the VA Program and informs decisions both within and at the end of the term of the VA about whether and how to modify implementation. A variety of methods including monitoring, modeling, and field experimentation (e.g., mesocosm experiments) will enable assessment of the effectiveness of the VA actions in achieving the anticipated ecological and biological effects.

It is anticipated that through testing hypotheses and assessing progress relative to metrics described in this plan and synthesizing learning across tributaries, the VA Science Committee will contribute to:

- Improved understanding of the ecological response to the suite of VA actions at multiple spatial scales, in recognition of (a) the longer time required for restoration actions to mature, and (b) the relatively long lifecycles of some native fish species (e.g., Chinook salmon and Central Valley white sturgeon) relative to the term of the VA;
- Recommendations to modify VA Flow and Non-flow Measures within the term of the VA, in light of observed effects, to improve outcomes; and
- Refinement of existing and/or development of new decision support models to enable predictions of the effects of continued or modified VA actions in support of the State Water Board's assessment process near the end of the VA term and/or related decision making by VA Parties.

1.3 General Description of Proposed VA Actions

In general terms, the VA Program includes new flow and non-flow measures (including habitat restoration), to support the Narrative Objectives and implement the Bay-Delta Plan. This section briefly describes the nature of the flow and non-flow actions. More detail on the flow measures, including the default flow schedule, is provided in the Flow Measures Description; similarly, further detail on the non-flow measures, including descriptions of the kinds of projects and the implementation schedule, is provided in the Non-Flow Measures Description. The general descriptions below are intended to provide context for the following sections and aid the reader's understanding of the connection between the VA measures and the predicted effects.

1.3.1 Flow Measures

New flows will be provided with two main categories of intended benefits:

- **Flow actions for improved salmonid outcomes in the tributaries:** These flows are intended to provide a range of improved habitat conditions for fish populations in the tributaries by activating constructed spawning and rearing habitats, improving upstream and/or downstream migration conditions, and reducing pressures from both physical (e.g., depth, velocity), and non-physical habitat conditions such as pathogen loads. Timing of these flow actions varies by tributary. Specific anticipated benefits vary by tributary and are related to the anticipated timing of flow.
- **Flow actions for managed species benefits in the Delta:** Flows from tributaries and reduced Delta exports are provided with the intent to increase Delta outflow January to June (dependent on water year type), and during April and May in particular, to benefit a range of species and ecosystem processes. Flow actions may also include targeted provision of enhanced Delta outflow for specific Delta regions with a goal of improving habitat conditions for species of interest, such as Delta and Longfin Smelt.

1.3.2 Non-Flow Measures

A wide variety of non-flow measures have been proposed by Tributary and Delta Entities to augment the provision of flows in line with the comprehensive approach taken by the VA Program.

- **Tributary Chinook salmon spawning habitat restoration:** Restoration actions for enhancing Chinook salmon spawning habitat involve provision of additional spawning gravel in areas accessible to adult salmon, as well as adjustments to river morphology to create riffles typical of spawning areas. Restoration efforts will include improvements to existing spawning areas, and/or maintenance of previously restored areas.
- **Tributary Chinook salmon in-channel rearing habitat restoration:** Restoration actions for enhancing Chinook salmon rearing habitat in the channel involve the creation and enhancement of perennially inundated side-channel and other low-velocity habitats to provide improved and diversified rearing conditions.
- **Tributary Chinook salmon floodplain rearing habitat restoration:** Restoration actions for enhancing Chinook salmon rearing habitat on floodplains involve providing access to improved and diversified rearing habitats on a seasonal basis.
- **Fish passage improvements:** Fish passage improvements can reduce migration delay or improve access to habitat for both juvenile and adult migratory fishes. Actions to improve fish passage can include improvements to high priority instream structures such as dams, weirs, or culverts, screening of surface water diversions, or channel morphology adjustments to improve critical riffle depth for adult passage.
- **Predator management:** Actions to reduce the impact of predators on target species include physical restrictions on predator access (e.g., weirs), eliminating predator refugia, and direct removal of predators through seining or other collection methods.
- **Delta/Bypass floodplain restoration and seasonal flooding of agricultural land**: Restoration actions for floodplain habitats in the Bypasses and in the Delta involve providing access to improved and diversified rearing habitat conditions on a seasonal basis for a wide variety of native fish species. In addition to providing a greater area with suitable physical conditions for target native fish species, these actions are also intended to support improved ecosystem processes (e.g., zooplankton production) that support a suite of native aquatic species.
- **Tidal wetlands restoration:** Restoration actions for tidal wetlands in the Delta include a suite of actions to improve shallow-water habitat for native fish spawning and rearing, and to restore ecosystem function including increased production of zooplankton and macroinvertebrate taxa that support growth of native fishes.

2 Hypotheses, Metrics, and Baselines for Evaluating Outcomes of Voluntary Agreement Actions

2.1 General Framework for Hypotheses

The VA Science Plan is based on hypotheses that state the expected outcome of VA actions. To set into motion an adaptive management cycle, the hypotheses must be accompanied by metrics, which can be evaluated to assess whether the intended benefits are being realized in the ecosystems and native species populations of the VA tributaries and Delta. Given that the flow and non-flow actions of the VAs occur at varying spatial scales, and that target species (e.g., Chinook salmon) have multi-year generation times, hypotheses must also reflect the various spatial and temporal scales of the intended benefits. To this end, hypotheses are developed at three basic spatial and temporal “tiers” (Figure 2):

- **Local Tier: Effects of Non-flow Habitat Improvement Actions**. These hypotheses will test: (1) implementation of proposed habitat enhancements (i.e., whether the habitat improvement was implemented according to design); (2) whether it is providing improved habitat conditions with respect to both biotic and abiotic conditions; and (3) whether the site is being utilized by native fishes (Chinook salmon, Delta Smelt, Longfin Smelt, as well as other native species) in a way that is consistent with predictions. These sets of hypotheses are organized by the specific type of habitat project undertaken (e.g., Chinook Salmon spawning habitat, fish passage improvements, tidal wetlands). These hypotheses are evaluated at a sub-annual or annual scale.

- **Full Tributary and Delta Tier**: These hypotheses are developed to test predictions of how flow actions in the tributaries and the Delta will benefit native species. Additional hypotheses at this tier address how flow and non-flow actions in aggregate will contribute to changes in productivity of juvenile Chinook salmon within tributaries. For salmon, hypotheses are limited to the juvenile life stages, because these life stages reflect biological responses within the "zone of influence" of VA actions on the tributaries; that is, the species responses evaluated at this tier do not yet involve out-of-basin influences. Flow-specific hypotheses are generally evaluated at an annual scale. However, trends in the productivity of tributaries for juvenile salmon must be evaluated over several years.
- **Population-level Tier:** These hypotheses prompt evaluation of general population trends at both the tributary and system-wide (Sacramento and San Joaquin Valleys, and full Central Valley) spatial scales. At this tier, the VA parties recognize that population-level responses may not be observed during the term of the VAs because the non-flow actions will be incrementally implemented over the proposed eight-year period, and that time frame may not be sufficient to observe population-level responses. Furthermore, the occurrence of stochastic events or inter-annual variability in abiotic conditions could obfuscate trends in biological responses over the relatively short time frame. Additionally, out-of-basin factors that include ocean conditions, climate-induced changes to air temperature and hydrology, non-native species, and hatchery and harvest practices, can all influence population-level responses and these factors are outside of the control of VA parties. For these reasons, metrics provided at population-level tier are intended for tracking purposes regarding the narrative objectives. Because these hypotheses and metrics involve the full life span of native species, trends in these metrics will be reviewed on a temporal scale of 3 or more years.

Throughout the hypotheses (at all tiers), essential covariates are noted that must be tracked (e.g., water temperature) to analyze their potential impact on biological responses. These covariates are generally outside the control of the VA parties but may influence the success of the VA actions. If VA actions are not achieving predicted outcomes, covariate data may help explain the reason. Trends in covariate data as well as statistical models utilizing covariate data along with the data required for evaluating the metrics for predicted responses to VA actions will be reported in VA Science Program products, including the Triennial reports planned for Years 3 and 6 of VA implementation. These analyses will be evaluated in adaptive management processes, including prioritization of further investment in flow and non-flow actions.

The hypotheses are not written for specific VA actions and shall not be the sole metric for determining VA success; instead, the VA Science Plan hypotheses provide a generalized framework for how each action should be assessed, including specific metrics to be used. Identified VA actions will have their own specific monitoring and science plans that are responsive to the VA Science Plan framework and VA participants may propose to add, modify, or exclude hypotheses for specific VA actions. For example, additional details on an appropriate range of gravel sizes for spawning Chinook salmon habitat restoration actions may be based on the tributary-specific historical data of gravel sizes associated with active spawning and/or hydrogeomorphic conditions in each tributary, and this range may differ across tributaries. Action-specific monitoring and science plans will be provided as appendices to the Science Plan as they become available. The VA Science Plan hypotheses and metrics are written from a western science perspective, but the VA Science Committee hopes to support ongoing dialogue on interweaving western science and traditional and tribal knowledges that can inform Tribal-non-Tribal partnerships in restoration and management activities.

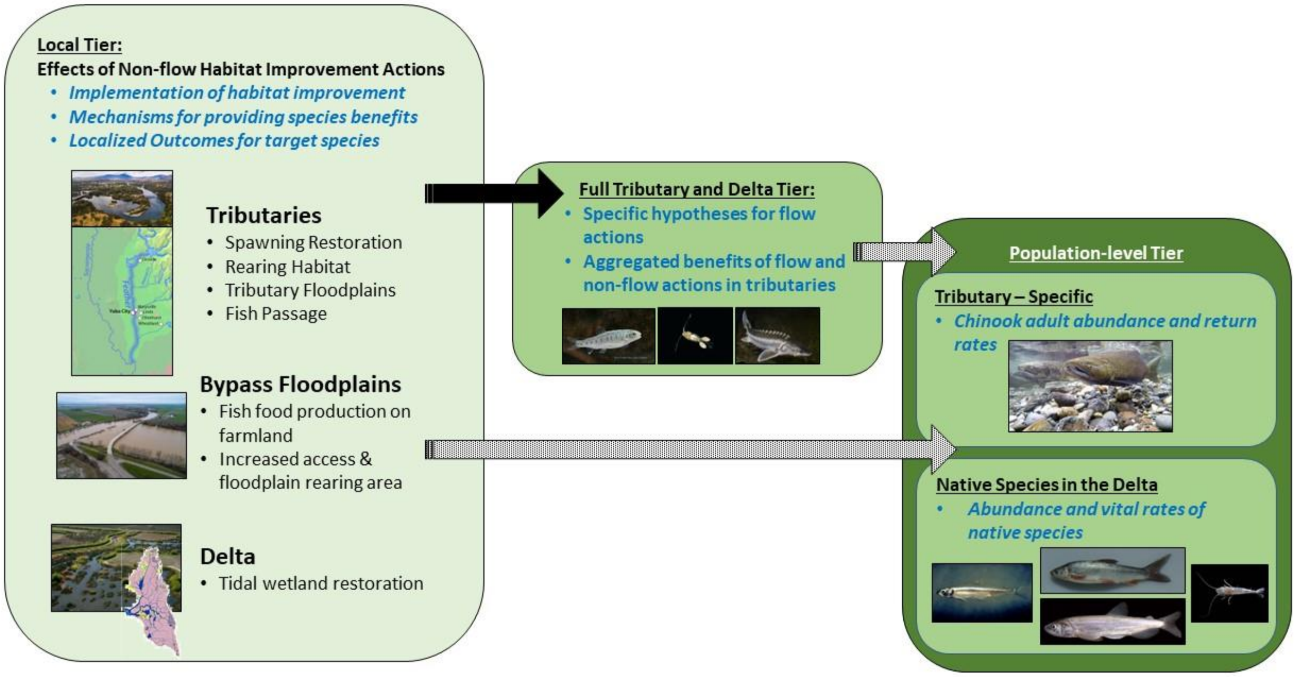


Figure 2 Tiered framework for hypothesis structure of the VA Science Plan. Local hypotheses will help inform the Full Tributary and Delta Tier hypotheses, as indicated by the black arrow. The gray arrows between the Local, Full Tributary and Delta, and Population-Level Tiers indicate increased uncertainty in population-level outcomes on the timeframe of the VAs.

Specific metrics are provided for each hypothesis and at all three tiers. To enable synthesis efforts to evaluate a suite of VA actions of a certain type (e.g., spawning habitat enhancements across multiple sites), where practicable it is important that the metrics, and the methods by which data are collected to produce the metrics, are consistent across monitoring efforts. Action-specific monitoring and science plans will identify how metrics (i.e., modeled or observational data) can be incorporated for testing hypotheses as part of decision support models evaluation of VA actions across local, tributary and Delta, and population-level tiers. Identification of metrics also facilitates the next portion of the VA Science Plan, which identifies where existing monitoring and science efforts provide the needed information, and where data gaps exist.

Finally, to guide analyses, it is necessary to set a baseline that will serve as a reference for understanding the impact of habitat improvements and/or flow deployments. Therefore, hypotheses and metrics are accompanied by a baseline that will guide analyses. Where appropriate, the 2023 Draft Scientific Basis Report Supplement is referenced for the baseline. In other cases, it is more appropriate to gather pre-project or reference site data for the needed metric.

Table 1. Summary of Voluntary Agreement Science Program Hypotheses, Metrics, Comparisons, and Covariates for Local, Full Tributary and Delta, and Population-Level Tiers. All hypotheses are explained in detail in Section 2 Hypotheses, Metrics, and Baselines for Evaluating Outcomes of Voluntary Agreement Actions**. Hypothesis ID subscripts indicate the Hypothesis Tier described in Figure 2 (**Subscripts of A, R, TribFP, Bypass FP, and TW **= Local Tier for Non-Flow Measures;** Subscripts of TribFlow, TribWide, and DeltaFlow **= Full Tributary and Delta Tier;** Subscripts of TribPop and SWPop **= Population-level Tier). *Indicates an Implementation Metric as described in Section 4.1.**

Action Type	Hyp. ID	Metric	Prediction	Basis for Comparison	Covariates
Spawning Habitat	H_{S1}	Spawning habitat acreage*	↑	Existing suitable habitat acreage, based on depth and velocity criteria from DEMs and hydraulic models	Flow, water temperature, and dissolved oxygen
Spawning Habitat	H_{S2}	Salmon redd density (#/unit area)	↑	Non-project, proximal reference sites measured concurrently	Flow, water temperature, and dissolved oxygen
Rearing Habitat	H_{R1}	Rearing habitat acreage*	↑	Existing suitable habitat acreage, based on depth and velocity criteria from DEMs and hydraulic models	Flow, water temperature and dissolved oxygen
Rearing Habitat	H_{R2}	Biomass density of secondary productivity (g/volume)	↑	Non-project, non-enhanced proximal reference sites measured concurrently	N/A
Rearing Habitat	H_{R3}, H_{R4}	Juvenile Chinook salmon densities (#/unit area)	↑	Proximal project and non-project reference sites measured concurrently	N/A
Tributary Floodplain	$H_{TribFP1}$	Tributary floodplain acreage subject to inundation*	↑	Existing floodplain acreage	Water temperature, dissolved oxygen, and flow
Tributary Floodplain	$H_{TribFP2}$	Biomass density of drift and benthic macroinvertebrates (g/volume)	↑	(1) Avg. densities for in-channel locations from historical record (2) In-channel locations measured concurrently with project areas	Water temperature, dissolved oxygen, water velocity, and indices of primary productivity
Tributary Floodplain	$H_{TribFP3}$	Juvenile salmon presence and densities (#/unit area or #/volume)	↑	Non-project, proximal reference sites measured concurrently	Water temperature and dissolved oxygen
Tributary Floodplain	$H_{TribFP4}$	Growth rate of juvenile salmon	↑	Derived through experimental work using caged fish	Water temperature, secondary productivity
Tributary Floodplain	$H_{TribFP5}$	Number of stranded juvenile salmon as a proportion of the tributary juvenile production estimate (JPE)	↔	(1) Historical estimates of stranding (2) Total population impact based on tributary JPE	N/A
Tributary Floodplain	$H_{TribFP6}$	Prevalence of native fish community (relative catch of	↑	Historical period of record for fish community sampling (seining, electrofishing, rotary screw traps)	N/A

Action Type	Hyp. ID	Metric	Prediction	Basis for Comparison	Covariates
		native fishes compared to non-native fishes)			
Fish Passage	H_{Pass1}	Water velocity at surface water diversions	↓	Pre-project water velocities Pre- and post-project velocities compared with NMFS 1997 criteria for fish passage	N/A
Fish Passage	H_{Pass2}	anadromous fish passage efficiency	↑	Pre-project passage efficiency data	N/A
Bypass Floodplain	$H_{BypassFP1}$	Acreage of shallow flooded ag land for invertebrate production and export (thru March 31)*	↑	Pre-project flooded acreage	N/A
Bypass Floodplain	$H_{BypassFP2}$	Zooplankton and macroinvertebrate densities (# and weight/unit volume)	↑	Adjacent riverine sites; upstream and downstream of field drainage locations	Dissolved oxygen in drained waters and the presence and concentrations of potential contaminants (i.e., pesticide residue, methylated mercury) in drainage water and in invertebrates
Bypass Floodplain	$H_{BypassFP3}$	Sulfur and carbon isotopic signature in diet, otoliths and/or eye lenses of juvenile Chinook salmon	↑	Experimental work using caged juvenile salmon exposed to varying levels of food items sourced from flooded ag land	N/A
Bypass Floodplain	$H_{BypassFP4}$	(1) Acreage of Bypass floodplain habitat* (2) Frequency of MFEs	↑	(1) Pre-project acreage (2) MFE frequency on historical record in SWRCB 2023 Sci Basis Draft Suppl Report	Water temperature, dissolved oxygen, and flow
Bypass Floodplain	$H_{BypassFP5}$	(1) Hydrologic connectivity with enhanced bypass floodplains (2) Juvenile salmon and native fish densities near bypass entry points	↑	(1) Estimated duration and frequency of hydrological connectivity before project implementation (2) Historical data on juvenile salmon densities during inundation	Water temperature, dissolved oxygen, turbidity, and predator (aquatic & avian) densities
Bypass Floodplain	$H_{BypassFP6}$	Number of stranded juvenile salmon as a proportion of the upstream JPEs	↔	(1) Historical estimates of stranding (2) Total population impact based on Sacramento Valley JPE (combined from tributary JPEs) – *pending modeling effort to produce this estimate.*	N/A

Action Type	Hyp. ID	Metric	Prediction	Basis for Comparison	Covariates
Bypass Floodplain	$H_{BypassFP7}$	(1) Number of adult anadromous fish observed to pass through major passage structures (2) Number of stranded adult anadromous fish observed at the base of major weir structures	↑	(1) Fish surveys for period of record for each major bypass (Yolo and Sutter). (2) Experimental, targeted studies examining behavior at weir modifications.	N/A
Tidal Wetlands	H_{TW1}	Tidal wetland habitat acreage*	↑	Modeled existing acreage of tidal wetland habitat, as described in the SWRCB 2023 Sci Basis Draft Suppl Report	Water temperature, turbidity, specific conductivity, pH, water residence time, and presence of CyanoHABs.
Tidal Wetlands	H_{TW2}	Densities of beneficial secondary production for native fish diets (zooplankton, epiphytic, and benthic invertebrates)	↑	Pre-project secondary production densities	Estimated quantity of water filtered by invasive clams
Tidal Wetlands	H_{TW3}	Community composition of native fish diets reflective of their sampled habitat	↔	Diet composition of native fish in proximate, non-project sites in pelagic and/or littoral habitat.	N/A
Tidal Wetlands	H_{TW4}	Condition factor and growth rate of native fishes	↑	Experimental studies using caged fish between tidal wetland and pelagic habitats	N/A
Tidal Wetlands	H_{TW5}	Presence of native fish	↑	Pre-project predator densities and/or non-project reference sites	Coverage of submerged and floating aquatic vegetation at entry/exit points of restored areas, density and movements of predators.
Tributary Flow Pulses	$H_{TribFlow1}$	Adult Chinook salmon fall upstream migration (spawner abundance/week)	↑	Weekly abundance estimates immediately before and after flow action	Water temperatures and dissolved oxygen
Tributary Flow Pulses	$H_{TribFlow2}$	Juvenile salmon outmigration rate	↑	Outmigration rates prior to flow action, same year	Fry density, fish size, turbidity, day length, PAR (sunlight), and temperature
Tributary Flow Pulses	$H_{TribFlow3}$	Juvenile salmon survival and travel time during outmigration	↑	Survival of acoustically tagged salmon during and outside of pulse flows	Water temperature, turbidity, and dissolved oxygen
Tributary Flow Pulses	$H_{TribFlow4}$	(1) *C. shasta* spore density (#/volume)	↓	Spore densities and infection rates two weeks prior to flow pulses, same year	Water temperature and dissolved oxygen

Action Type	Hyp. ID	Metric	Prediction	Basis for Comparison	Covariates
		(2) Clinical infection rate of *C. shasta* in juvenile salmon			
Tributary Juvenile Salmon Production	$H_{TribWide1}$	Trend # estimated outmigrating juveniles / female spawner (≥ 3 years)	↑	Annual values in historical data record prior to VA implementation	Flow, water temperatures and dissolved oxygen
Tributary Juvenile Salmon Production	$H_{TribWide2}$	Condition factor of emigrating Chinook salmon	↑	Available historical data for each tributary	N/A
Tributary Juvenile Salmon Production	$H_{TribWide3}$	Coefficient of variation in emigration timing and body size	↑	Available historical data for each tributary prior to VA implementation	N/A
Increased Spring Delta Outflow	$H_{DeltaFlow1}$	Acreage of suitable spawning and rearing habitat for Delta and Longfin Smelt	↑	Modeled habitat area without implementation of VA flow measures as described in the SWRCB 2023 Scientific Basis Draft Report Supplement	N/A
Increased Spring Delta Outflow	$H_{DeltaFlow2}$	(1) Larval and juvenile Longfin smelt distribution (2) Estimated larval and juvenile longfin smelt entrainment at South Delta facilities	1. ↑ 2. ↓	(1) Longfin smelt catch in Smelt Larval Survey and special studies (2) Modeled estimates of larval and juvenile longfin smelt entrainment across variable flow conditions in historical years	Water temperature, turbidity, and distribution/abundance of longfin smelt spawning stock
Increased Spring Delta Outflow	$H_{DeltaFlow3}$	Delta and longfin smelt entrainment; estimated proportional loss of juvenile Chinook salmon to entrainment	↓	Estimates of entrainment risk in historical years with conditions similar to VA flow measures but with lower outflows.	Population abundance, distribution, regional hydrodynamics, water quality, and water temperature.
Increased Spring Delta Outflow	$H_{DeltaFlow4}$	(1) Travel time of outmigrating juvenile salmon in the Delta (2) Juvenile salmon Delta survival	1. ↓ 2. ↑	(1) Published studies on acoustically tagged juvenile salmon survival and travel times, associated with known outflow levels (2) Experimental comparison of acoustically tagged salmon with and without VA outflows	Water temperature, dissolved oxygen, turbidity, submerged aquatic vegetation coverage along migration routes, and predator densities at critical junctures

Action Type	Hyp. ID	Metric	Prediction	Basis for Comparison	Covariates
Increased Spring Delta Outflow	$H_{DeltaFlow5}$	Annual proportion of juveniles with isotopic signature of floodplain rearing and growth	↑	Period of record for available samples (otoliths and/or eye lenses) that can be associated with known levels of Bypass inundation	Water temperature, turbidity and the timing, magnitude, and frequency of floodplain inundation
Increased Spring Delta Outflow	$H_{DeltaFlow6}$	White sturgeon age-0 and age-1 year class indices	↑	Period of record for age-0 and age-1 year class indices	N/A
Increased Spring Delta Outflow	$H_{DeltaFlow7}$	Freshwater-associated zooplankton densities in Western Delta and Suisun Marsh regions	↑	Regional sampled densities and community assemblage across datasets collecting zooplankton samples	Phytoplankton biomass density and composition, salinity, water temperature, and turbidity
Increased Spring Delta Outflow	$H_{DeltaFlow8}$	(1) Frequency, magnitude, severity of Harmful Algal Blooms (2) Cyanotoxin concentrations	↔	Period of record of cyanoHAB visual observations during routine monitoring surveys, and cyanotoxin data collected in special studies	Water temperature, turbidity, salinity, and nutrient concentrations/ratios, and Delta outflow
Tributary Adult Chinook Population	$H_{TribPop1}$	Isotopic signature of floodplain rearing in adult population, evident in otoliths and/or eye lenses	↑	Period of record of archived samples across a variety of flow conditions, including years with known Bypass inundation	N/A
Tributary Adult Chinook Population	$H_{TribPop2}$	Natural origin adult Chinook salmon population estimates by tributary, and trend in abundance (harvest plus escapement)	↑	(1) Tributary adult abundance estimates from AFRP Doubling Goal years (1967 – 1991) (2) Tributary adult abundance since 2010	N/A
Tributary Adult Chinook Population	$H_{TribPop3}$	Trend in the tributary Cohort Replacement Rate (CRR) for natural origin fish	↑	(1) Trend in the natural origin CRR in the period of record for each tributary (2) CRR since 2010	N/A
Systemwide Chinook Population	H_{SWPop1}	Annual Chinook salmon escapement and harvest for Sacramento and San Joaquin Valleys	↑	(1) Escapement + Harvest for AFRP Doubling Goal years (1967 – 1991) (2) Escapement + Harvest since 2010	N/A
Systemwide Chinook Population	H_{SWPop2}	Trend in CRR for natural origin fish for Sacramento and San Joaquin Valleys	↑	(1) CRR for AFRP Doubling Goal years (1967 – 1991) 2) CRR for Central Valley since 2010	N/A

Action Type	Hyp. ID	Metric	Prediction	Basis for Comparison	Covariates
Native Delta Species Populations	**H_{SWPop3}**	Distribution and population estimates for native species (California Bay shrimp, Sacramento splittail, longfin smelt, Delta smelt)	↑	Species abundance indices from 2023 Draft Scientific Basis Report Supplement.	N/A
Native Delta Species Populations	**H_{SWPop4}**	Estimated number of Longfin smelt larvae per number of spawning adults	↑	Period of record in historical data in years with consistently sample habitat area, associated with Delta outflow	N/A

2.2 Local Tier Hypotheses: Effects of Non-flow Habitat Improvement Actions in Tributaries and the Delta

2.2.1 Chinook Salmon Spawning Habitat Enhancement on Tributaries

Augmentation of spawning habitat on several tributary systems is expected to result in an increased number of redds in restored areas. The following hypotheses pertain to suitability of improved spawning habitat and the Chinook salmon response to increased habitat area.

H_{S1}: The area of suitable spawning habitat, conforming to specified depth and velocity criteria, will increase in habitat enhancement areas, at design flows.

The **metric** for this hypothesis will be the acreage of spawning habitat with suitable water depths and velocities, and sizes of spawning gravel. Spawning habitat criteria, including depth, velocity, and target spawning substrate size will be defined in the specific VA action science and monitoring plan and associated design documents. The suitable gravel size for spawning habitat will be a range and distribution of spawning substrate sizes specific to the spawning population and hydrogeomorphic conditions in each tributary.

Covariates to measure for a comprehensive assessment of the effective suitability of restored spawning habitat will include flow, water temperatures and dissolved oxygen to ascertain whether they are in an appropriate range for spawning and egg incubation throughout the applicable time periods for each tributary. Water temperature and dissolved oxygen will be measured concurrently at the project locations and in nearby reference sites used by Chinook salmon for spawning.

The **baseline** for this hypothesis evaluation will be the quantification of the existing spawning habitat area within the project area boundary (polygon). This quantification will be accomplished by using available (or newly developed) topographic mapping (digital elevation model, or DEM), and applying available hydraulic (preferably 2D) models to calculate water depths and velocities within each computational pixel within the project area boundary. Spawning habitat area according to water depth, velocity, and substrate criteria at design flows test the implementation of the VA actions for increasing spawning habitat, and the methodology for evaluating the total area of this habitat is detailed further in Section 3.1.4 of the Strategic Plan for the Proposed Agreements to Support Healthy Rivers and Landscapes on "Methods for Assessing VA Non-flow Measure Completion."

H_{S2}: The density of Chinook salmon redds will increase in habitat enhancement areas compared to proximate, non-enhanced areas.

The **metric** for this hypothesis will be the number of Chinook salmon redds per unit area in habitat enhancement project areas, while also accounting for the potential for redd superimposition.

The **baseline** for this hypothesis will be the redd density and superimposition rate at habitat enhancement locations compared to adjacent areas within the same reach, measured concurrently along with water quality criteria. In systems where redd mapping has been conducted consistently at both project locations and adjacent, non-enhanced locations, historical data can also be leveraged to examine trends and changes in redd density after the enhancement action.

2.2.2 Habitat enhancements for in-channel and floodplain habitat on tributaries

Enhancement of in-channel rearing habitat for juvenile salmon in tributaries is expected to result in increased secondary productivity and increased utilization of rearing habitats. Hypotheses include the mechanisms through which this outcome for juvenile salmon are expected. Additional habitat enhancement actions in the tributaries include increased availability of floodplain areas and improvement of habitat access by resolving known barriers to anadromous fish passage. These latter actions are expected to benefit juvenile salmon as well as other native species.

2.2.2.1 Chinook Salmon In-channel Rearing Habitat

H_{R1}: The area of juvenile rearing habitat within channels and in side-channels that conforms to specified water depth and velocity criteria will increase in habitat enhancement areas, at design flows.

The **metric** for this hypothesis will be the acreage of in-channel and side channel rearing habitat conforming to water depth and velocity criteria. Rearing habitat criteria, including depth and velocity will be defined in the specific VA action science and monitoring plan and associated design documents.

Covariates to measure for a comprehensive assessment of the effective suitability of enhanced rearing habitat will include water temperature, dissolved oxygen, and flow to ascertain whether they are in an appropriate range for juvenile Chinook salmon rearing through the applicable time periods for each tributary and its relevant Chinook salmon runs. Water temperature and dissolved oxygen will be measured concurrently at the project locations and in nearby reference sites used by juvenile Chinook salmon for rearing.

The **baseline** for this hypothesis evaluation will be the quantification of the existing rearing habitat area within the project area boundary (polygon). This would be accomplished by using available (or newly developed) topographic mapping (DEM) and applying available hydraulic (preferably 2D) models to calculate water depths and velocities within each computational pixel within the project area boundary. Rearing habitat area according to water depth and velocity criteria test the implementation of the VA actions for increasing rearing habitat, and the methodology for evaluating the total area of this habitat is detailed further in Section 3.1.4 titled "Methods for Assessing VA Non-flow Measure Completion" of the Strategic Plan for the Proposed Agreements to Support Healthy Rivers and Landscapes.

To represent the existing (pre-project) suitable habitat, quantification will be based on the hydraulic (depth, velocity) suitability criteria. However, recognizing that the addition of cover elements within or near hydraulically suitable habitat results in higher quality rearing habitat, the combination of hydraulic and cover suitability will be addressed by a separate hypothesis (see H_{R3}).

H_{R2}: Enhanced rearing habitat will have higher biomass density of secondary productivity (e.g., drift and benthic macroinvertebrates) compared to adjacent sites.

The **metric** for this hypothesis will be biomass density (weight of invertebrates per unit volume sampled) of secondary productivity per unit of habitat in restored sites, both in-channel and in newly constructed side channels for rearing, compared to adjacent, non-enhanced sites.

The **baseline** for this hypothesis will be biomass density of secondary productivity per unit of habitat in adjacent, non-enhanced sites.

The two following hypotheses are devoted to the expected outcome of increased juvenile Chinook salmon densities at restored areas. H_{R3} addresses the change in density resulting specifically from the addition of cover elements (e.g., large woody debris) to enhanced in-channel habitat. Understanding this response will help guide design of future rearing habitat enhancements. H_{R4} addresses the expected change in juvenile Chinook salmon densities more generally. **Covariates** to measure for a comprehensive assessment of the utilization (e.g., juvenile densities) of enhanced rearing habitat identified in H_{R1} are applicable to these two hypotheses.

H_{R3}: Adding cover elements to hydraulically suitable habitat (based on water depth and velocity) will result in increased densities of juvenile Chinook salmon utilizing habitat enhancement project areas.

The **metric** for this hypothesis will be juvenile Chinook salmon densities (expressed as the number of individuals per unit area) where cover elements are incorporated within the project boundary compared to locations where cover is limited or absent.

The **baseline** for this hypothesis will be juvenile salmonid density measured concurrently at: (1) specific locations within the project boundary where cover elements are not incorporated into constructed habitat; and/or (2) nearby reference sites where cover is limited or absent.

H_{R4}: Enhanced rearing habitat areas will have increased juvenile salmon densities compared to channel areas outside of project location.

The **metric** for this hypothesis will be juvenile Chinook salmon density (expressed as number of individuals per unit area) in habitat enhancement project locations.

The **baseline** for this hypothesis will be juvenile salmonid density at nearby tributary locations where enhancement measures have not been conducted, measured concurrently with juvenile salmonid densities at project locations.

2.2.2.2 Tributary floodplain restoration

The anticipated outcomes of tributary floodplain restoration are increased rearing habitat availability and suitability for juvenile salmon, and increased secondary productivity, which will be beneficial for salmon and other native fishes. These outcomes are hypothesized to occur through the following mechanisms.

$H_{TribFP1}$: The area of tributary floodplain habitat appropriate for native fish rearing will increase through floodplain enhancement actions.

The **metrics** for this hypothesis will be the acreage of floodplain habitat subject to inundation during periods of Chinook salmon rearing. Tributary floodplain habitat criteria, including water depth, velocity, and values for cover (e.g., as described in SJRRP 2012) will be defined in the specific VA science and monitoring plan and associated design documents for individual actions.

Covariates to measure for a comprehensive assessment of the effective suitability of inundated floodplain habitat include water temperature, dissolved oxygen, and flow in order to evaluate how tributary floodplain habitats restoration responds to different climate and hydrology scenarios. Inundation of tributary floodplain habitats may be dependent in some years on deployment of VA flow measures in tributaries. To inform best practices for flow deployments to achieve adequate inundation of tributary floodplain habitat, the area of inundated habitat will be tracked along with flow.

The **baseline** for this hypothesis will be the existing acreage of floodplain habitat.

$H_{TribFP2}$: Biomass densities and/or bioassessment indices of secondary productivity will be higher on tributary floodplains compared to adjacent riverine habitats.

The **metric** for this hypothesis will be the biomass density (measured in weight per unit water volume sampled) of drift and benthic macroinvertebrates sampled on tributary floodplains compared to the densities measured in adjacent riverine habitats. This hypothesis is best measured by targeted sampling occurring during the period of inundation of tributary floodplains.

Covariates for this hypothesis include water temperature, dissolved oxygen, and water velocity, indices of primary productivity (e.g., chl-*a)* as all these factors influence local densities of secondary productivity.

The **baseline** for this hypothesis will be the average sampled densities during the period of record for in-channel locations, where a tributary system maintains a sampling program for drift and benthic macroinvertebrates. An additional basis for comparison will be sampled densities of secondary productivity in in-channel locations, measured concurrently with densities in enhanced tributary floodplain locations. These in-channel locations may be upstream, adjacent to, and downstream of enhanced floodplain areas. If floodplain project areas are contributing food resources for in-channel rearing, biomass densities of secondary productivity will be higher in adjacent and downstream locations compared to locations upstream of project areas.

$H_{TribFP3}$: Juvenile salmon will utilize enhanced tributary floodplains, as measured by presence/absence, fish density, and relative densities between tributary floodplains and in-channel rearing locations.

The **metrics** for this hypothesis will be the sampled presence of juvenile salmon in restored areas and the density of fish per unit of area or water volume sampled. To account for annual variation in overall densities of juvenile salmon, the metric can be standardized as the ratio of juvenile salmon densities between floodplain habitats and in-channel rearing habitats.

Covariates to measure for a comprehensive understanding of the use of inundated floodplain habitat include water temperature and dissolved oxygen.

The **baseline** for this hypothesis will be the densities of juvenile salmon in non-restored, in-channel locations. The ratio of densities in floodplains to in-channel locations greater than 1 indicates rates of utilization than in-channel rearing locations. While it is difficult to compare fish densities across years because there are many confounding factors (hydrologic conditions, fish numbers, etc.), data from prior years may provide valuable context.

$H_{TribFP4}$: Growth of juvenile salmon in tributary floodplain restoration sites will be faster than growth of juvenile salmon rearing in in-channel locations.

The **metric** for this hypothesis will be the growth rate of juvenile salmon on restored tributary floodplains compared with the growth rate in in-channel locations, measured concurrently.

Covariates to measure to evaluate this hypothesis include water temperature and density of invertebrates serving as a food resource for juvenile salmon (e.g., drift invertebrates), as these are important controlling factors for juvenile salmon growth.

The **basis for comparison** for this hypothesis will involve experimental work potentially using caged fish, as it is difficult to assess individual, habitat-specific growth rates within tributaries on free-ranging juvenile salmon. Additionally, it is desirable to assess the minimum duration of time needed for rearing and habitat inundation to achieve growth differences between restored tributary floodplain and in-channel rearing, as this duration is a current area of uncertainty. Experimentation can provide empirical data on the differentiation of growth rate and the period of floodplain rearing needed to achieve a size benefit; this empirical data can subsequently be used to inform predictive modeling tools developed to simulate anticipated outcomes from further restoration actions across different climate and hydrology scenarios.

$H_{TribFP5}$: Enhanced tributary floodplain areas will not contribute to stranding of juvenile salmon at levels significant to the estimated annual production estimate for the

tributary after flows recede and floodplain areas are no longer connected to the mainstem.

The **metric** for this hypothesis will be the number of fish sampled in floodplain enhancement project areas in outstanding isolated pools after connectivity with the mainstem of the tributary system has ceased. In addition to field surveys, it may be possible to investigate the potential for stranding with a mapping exercise in ArcGIS using a high-resolution LiDAR layer to examine the density of potential entrapment areas and the distance to wetted areas connected to the mainstem. The combination of a mapping study and field surveys may serve to develop an estimate of the likely population of juveniles that are unable to emigrate due to isolation from the main migration corridor. It will be important to evaluate this metric in the context of the estimated annual juvenile production estimate for the tributary. Over multiple years of collecting data (and utilizing historical data on stranding where possible), it may be possible to model an estimate of the proportion of the juvenile population, across different hydrology conditions, that does not emigrate from tributaries because of isolation and determine whether this is a significant population impact.

The **baseline** for this hypothesis will be densities of apparently stranded Chinook salmon in historical studies that have aimed to estimate the number of fish remaining in isolated pools. The comparison will not be whether the estimate of total stranded fish has increased, but how much observed stranding contributes to significant population impact based on annual juvenile production estimates. The ability to make these comparisons is dependent on the availability of relevant sampling in floodplain enhancement areas, particularly the availability of sampling data after elevated flows have receded. If juvenile salmon sampling efforts have not typically occurred in the vicinity of the project area, it is possible that no baseline information will be available for this hypothesis. In these cases, the estimate of total stranding can still be compared to the annual juvenile production estimate for the tributary.

$H_{TribFP6}$: Increased inundation of tributary floodplain habitat will be associated with increased prevalence of juvenile native fishes (e.g., native minnows, juvenile salmon) during early spring months.

The **metric** for this hypothesis will be the catch frequencies of native fish species (e.g., Sacramento splittail, hitch, Sacramento blackfish, Sacramento pikeminnow, Chinook salmon, Sacramento sucker) in routine surveys (community composition in beach seine, snorkel surveys, backpack electrofishing, and/or RST catch). Previous studies and the natural history of native Central Valley fishes indicate that the above listed species utilize tributary floodplain habitats as young-of-the-year for rearing habitat, typically during the early spring months (Moyle et al. 2007). Introduced species (e.g., black bass, common carp, mosquitofish) also utilize tributary floodplain habitats but are more prevalent in later spring months (e.g., May and June).

The **baseline** for this hypothesis will be native fish species catch during the period of record for each tributary system, compared to the period of VA implementation when tributary floodplains are inundated. While it is difficult to compare catch rates across years because there are many confounding factors (hydrologic conditions, fish numbers, etc.), data from prior years may provide valuable context.

2.2.2.3 Fish passage improvements

Addressing barriers to fish passage on tributaries is expected to result in improved access and accessibility of both spawning habitat and rearing habitat such that there is increased connectivity between quality habitats. Passage rates and efficiency at target locations should increase. For juvenile salmon moving downstream during outmigration, survival at specific locations where diversions were previously unscreened, is expected to increase. The hypotheses below describe the mechanisms for these outcomes.

H_{Pass1}: Screening surface water diversions in accordance with National Marine Fisheries Service passage criteria will reduce entrainment potential for juvenile salmonids.

The **metric** for evaluating screening actions will be the observed water velocity at the diversion point. To determine velocity suitability, the observed water velocity should be in conformance with NMFS screening criteria (NMFS 1997), and to relevant literature on juvenile salmon physiology to assess whether screens are effectively reducing risk of entrainment and impingement.

The **basis for comparison** for this hypothesis will be the NMFS criteria for water velocities at diversion points. Pre-project velocities, if measured, can also be a baseline to determine the change in velocity post-project.

H_{Pass2}: Improvements to dams, weirs, and culverts will improve adult fish passage past the areas of improvement and reduce anadromous fish migration delays.

The **metric** for this hypothesis will be the passage efficiency past fish passage improvement projects (proportion of fish approaching that successfully pass the project area (Bunt et al. 2012)) over the range of expected flows during migration periods for Chinook salmon, white and green sturgeon, and Pacific lamprey. Improvement projects should follow NMFS guidelines for fish passage facilities (NMFS 2023).

If **baseline** data on adult anadromous fish passage rates are available for specific project areas, then fish passage rates before the improvement action will provide the baseline. While it is difficult to compare passage rates across years because there are many confounding factors (hydrologic conditions, fish numbers, etc.), data from prior years may provide valuable context. In some cases, there may not be baseline data available as adult fish passage data requires active counting and/or video capture of adult fish movements at target locations.

2.2.3 Delta/Bypass floodplain restoration and seasonal flooding of agricultural land

Floodplain enhancement in the Delta region (Yolo Bypass) and in the Sacramento River system at Sutter Bypass has two general approaches. The first approach involves managed flooding of agricultural fields to provide shallow-water habitat for increased productivity of invertebrates, which can then be re-directed into riverine habitats to support fish growth. The first set of hypotheses in this section addresses uncertainties on the ability of food-rich water from flooded agricultural fields to provide a growth benefit to juvenile salmon rearing in the mainstem of the Sacramento River.

The second floodplain enhancement approach involves weir modifications and other improvements to increase the frequency and magnitude of floodplain activation and increase accessibility of floodplain habitats to native fishes. Previous research on floodplain ecology, particularly in Yolo Bypass, has provided ample evidence that beneficial invertebrate taxa for juvenile salmon and other native fishes are present in higher densities on flooded Bypasses than adjacent, riverine channels and that juvenile salmon growth is faster in floodplains than in the river mainstem (Sommer et al. 2001; Takata et al. 2017; Cordoleani et al. 2022). Because food web and growth benefits are well established, hypotheses on these factors are not included in this second section of hypotheses. Instead, hypotheses are focused on uncertainties regarding the efficacy of weir improvement efforts to increase accessibility for juveniles and provide safe passage for adult Chinook salmon and sturgeon that navigate flooded bypasses in the course of their upstream migrations.

Implementation of other actions to create salmon rearing habitat by actively managing water in or across multiple agricultural fields through the use of water control structures, berms or levees, may also be included in some floodplain enhancement projects and these will be evaluated by the VA science committee/program based on data from previous, ongoing, and future research (Katz et al. 2017; Corline et al. 2017; Sommer et al. 2020; Holmes et al. 2021).

2.2.3.1 Seasonal flooding of agricultural land to support production of zooplankton and drift/benthic macroinvertebrates for export to riverine rearing habitats to provide increased food resources for fish

$H_{BypassFP1}$: The amount of shallow-water area in acres in seasonally flooded agricultural land that is suitable for production of zooplankton and macroinvertebrates appropriate for juvenile salmon consumption will increase.

The **metric** for this hypothesis will be acreage of shallow water areas that are inundated and meet duration and water temperature suitability criteria for zooplankton and macroinvertebrate production (Corline et al. 2017).

The **baseline** for this metric will be the amount of inundated area available and suitable for secondary production before managed flooding action occurs.

$H_{BypassFP2}$: Densities of beneficial zooplankton and macroinvertebrates for juvenile salmon will increase in seasonally flooded agricultural land compared to riverine habitats and will also increase in proximate, suitable riverine habitats after flooded agricultural fields are drained.

The **metric** for this hypothesis will be the sampled densities (# or weight per unit volume) of food taxa (e.g., cladocerans, copepods, insects, amphipods) in proximate suitable habitat, with suitability defined by water depth, velocity, and temperature zooplankton and macroinvertebrates in targeted inundation areas as well as adjacent riverine habitats after flooded fields are drained. Sampled densities will be compared between flooded agricultural fields and adjacent riverine sites. In addition to sampled densities, evaluation of this hypothesis can explore the potential for modeling drift densities using particle tracking models to estimate the full footprint of subsidizing food densities through this action of draining highly productive waters from flooded agricultural fields.

Covariates to measure to assess whether there may be unintended impacts of agricultural field drainage include dissolved oxygen in drained waters and the presence and concentrations of potential contaminants in drainage water and in invertebrates. Contaminants to track include pesticide residue and methylated mercury.

The **baseline** for this hypothesis will be the comparisons between flooded agricultural fields and adjacent riverine sites, as well as riverine locations that are upstream of field drainage sites.

$H_{BypassFP3}$: Juvenile salmon consuming zooplankton and macroinvertebrates derived from seasonally flooded agricultural land will bear an isotopic signal of these items in their diet and in their eye lenses and otoliths.

The **metric** for this hypothesis will be the isotopic signature in juvenile salmon diet, eye lenses and/or otoliths that were exposed to food items derived from seasonally flooded agricultural land. Recent studies already demonstrate that floodplain rearing is evident through sulfur ($\delta^{34}S$) and carbon ($\delta^{13}C$) isotopes measured in otoliths (Bell-Tilcock et al. 2021), and the mechanism for this signature occurs through floodplain-sourced food. A current uncertainty is whether fish consuming food from seasonally flooded agricultural land but that are not rearing directly on floodplains, also bear this isotopic signature. Confirming that isotopic tools can be used to detect a floodplain-sourced diet is useful for potential future analyses seeking to quantify the extent to which food subsidy benefits from seasonally flooded agricultural lands contribute to the Chinook salmon population. A second uncertainty is whether, if the food subsidy is detected in Chinook salmon, if it is distinguishable from the isotopic signature present in juveniles rearing on Bypass floodplain habitat.

The **basis for comparison** for this hypothesis will be experimental work in which juvenile Chinook salmon are raised in cages with varying degrees of exposure to food sourced from seasonally flooded agricultural land. The isotopic signatures in these caged fish can also be compared with those of juvenile salmon rearing directly on Bypass floodplain habitat, in years where both food subsidy actions and floodplain inundation are occurring.

2.2.3.2 Floodplain enhancement actions that target increased rearing habitat to be used directly by native Central Valley fishes

$H_{BypassFP4}$: The acreage of floodplain habitat appropriate for native fish rearing and the frequency of meaningful floodplain events (MFEs) will increase through Bypass floodplain enhancement actions.

The **metrics** for this hypothesis will be the acreage of floodplain habitat subject to inundation during periods of Chinook salmon rearing, and the frequency of flood events that meet suitability criteria for MFEs. The suitability criteria for MFEs will regard the magnitude, inter-annual and intra-annual frequency, and duration of inundation deemed to provide biologically meaningful benefits for native fishes rearing in floodplain habitat. These criteria will be consistent with those provided in the 2023 Scientific Basis Draft Supplement Report (SWRCB 2023).

Covariates to measure for a comprehensive assessment of the effective suitability of inundated floodplain habitat include water temperature, dissolved oxygen, and flow.

The **baseline** for this hypothesis will be the average acreage and duration of flooded bypass lands before the flow action (either targeted flooding of agricultural lands or delay of draining after a natural flood event) for the 1922 – 2015 time series (as described in the 2023 Scientific Basis Draft Supplement Report, SWRCB 2023).

$H_{BypassFP5}$: Weir modifications in Bypass locations will increase the duration of hydrologic connectivity and utilization of floodplain habitat by juvenile salmon.

The **metric** for this hypothesis will include the duration of hydrologic connectivity (e.g., # days with flows passing through weir notches) of enhanced bypass floodplains with migration corridors for Chinook salmon during periods of active migration. Additional metrics will include the presence of juvenile salmon or other native fishes on inundated bypass floodplains, including sampled fish densities in the local vicinity of entry points to enhanced bypass floodplains, particularly where weirs or other structures have been modified to support access.

Covariates for this metric include water quality (water temperature, dissolved oxygen, turbidity) on floodplain habitats, as well as predator densities (both predatory fishes and avian species) near weir structures.

The potential **baselines** for this hypothesis will be the estimated duration and frequency of hydrologic connectivity during outmigration periods in the historical timeseries, dates and frequency of observed Chinook salmon presence in project locations during inundation events in the historical timeseries, where data are available. If juvenile salmon sampling has not typically occurred in the vicinity of the project area, it is possible that no baseline information will be available for presence or density metrics.

$H_{BypassFP6}$: Increased access to Bypass floodplains will not result in detrimental impacts to juvenile Chinook salmon populations, including the potential for stranding and predation while on the floodplain.

The **metrics** for evaluating this hypothesis will be the number of juvenile salmonids remaining in flooded areas after drainage is complete and there is no more connectivity with the Sacramento mainstem. This metric will be evaluated in the context of the estimated risk to significant population impact based on the annual juvenile production estimates of upstream tributaries. Over multiple years of collecting data (and utilizing historical data on stranding where possible), it may be possible to model an estimate of the proportion of the juvenile population of the Sacramento Valley, across different hydrology conditions, that does not emigrate from Bypass because of isolation and determine whether this is a significant population impact.

The **baseline** for this hypothesis will be densities of apparently stranded Chinook salmon in historical studies (e.g. Sommer et al. 2005) that have aimed to estimate the number of fish remaining in isolated pools. The comparison will not be whether the estimate of total stranded fish has increased, but how much observed stranding contributes to significant population impact based on annual juvenile production estimates. However, there is no long-running historical record of stranding events on bypass floodplains and stranding numbers are likely to vary across years due to variation in total population sizes and hydrologic conditions. Therefore, this hypothesis may be best evaluated through targeted sampling of floodplain areas at the end of the drainage period.

$H_{BypassFP7}$: Weir modifications and/or removal of existing passage barriers will result in improvements in passage for adult anadromous fish (Chinook salmon, white sturgeon, lamprey).

The **metric** for this hypothesis will be the number of adult anadromous fish observed to pass through major passage structures (e.g., at Fremont Weir). A second metric will be the number of adult anadromous fish observed at the base of major weir structures after connectivity with the main riverine channel has ceased. The number of stranded fish should be contextualized by the estimated annual adult abundance for each species.

Covariates for this hypothesis include water depth, velocity, and water temperature during periods of anadromous fish presence and passage or attempted passage at weir structures.

The **baseline** for this hypothesis will be the period of record of stranded adult fish surveys for each major Bypass (Yolo and Sutter). Data on adult fish stranding (both Chinook salmon and green and white sturgeon) are typically collected as part of fish rescue operations (e.g., CDFW 2019). In addition, as weir modifications are implemented, special, targeted studies may also be useful to assess their impacts on adult fish passage. These studies could include acoustic tagging of adult fishes in Yolo or Sutter Bypasses to determine response to weir modifications (e.g., Johnston et al. 2020).

2.2.4 Tidal wetlands

The expected outcomes of tidal wetland restoration for native fishes are twofold: 1) tidal wetland restoration will provide an increase in the density and abundance of food for native fishes; and 2) tidal wetlands will provide viable and suitable juvenile rearing habitat for native estuarine and migratory fish species, including Longfin smelt, Delta smelt, Chinook salmon, tule perch, Sacramento sucker, hitch, among others. Hypotheses below describe the mechanisms through which these outcomes will occur.

2.2.4.1 Tidal wetland support for beneficial food web processes

H_{TW1}: Tidal wetland habitat acreage will increase in proposed locations with tidal inundation depths and frequency of inundation according to project objectives, with assessment to include water quality suitability criteria.

The **metric** for this hypothesis will be the area (in acres) of tidal wetland habitat according to project design criteria for water depth and inundation at specific tidal stages.

Covariates to measure for a comprehensive assessment of the suitability of water quality conditions in tidal wetlands for native species benefit will include monitoring for water temperature, turbidity, specific conductivity, and pH, and comparing observed values to suitability criteria for Delta smelt, Longfin smelt, Chinook salmon and other native species of interest. These criteria should be consistent with the 2023 Scientific Basis Draft Supplement Report (SWRCB 2023). Additional factors that are important to track to comprehensively assess suitability include the presence of phytoplankton taxa that may contain toxins and are associated with cyanobacterial harmful algal blooms (cyanoHABs), such as *Microcystis, Anabaena*, and *Dolichospermum,* and for presence of toxins. CyanoHABs are often associated with conditions of high water residence time, vertical stratification, and warmer temperatures (Kudela et al. 2023). An existing uncertainty is the extent to which construction of new tidal wetlands may or may not be associated with cyanoHABs, and when these events do occur, their toxicity levels.

The **baseline** for this hypothesis is the modeled acreage of tidal wetland habitat as described in the 2023 Scientific Basis Draft Supplement Report (SWRCB 2023).

H_{TW2}: Invertebrate food densities representing beneficial taxa for native fish species diets will increase at restored tidal wetland sites and within their tidal footprints.

The **metrics** for this hypothesis will include sampled densities of zooplankton (such as copepods and cladocera) as well as epiphytic and benthic invertebrates (insects, amphipods, and isopods) that present beneficial food items for native fishes. These metrics will include the geographic scope of the tidal footprint of the restored area and will not be restricted to boundaries of the restoration site. Monitoring will at a minimum occur during times of the year with the highest likelihood of native species presence.

Metrics for this hypothesis may also include production rates of zooplankton and macroinvertebrates in the tidal footprint of restored sites compared with reference (i.e., pelagic) areas. These metrics are labor-intensive to obtain and are not reflected in routine monitoring programs, therefore if chosen as the most appropriate metrics, they will be obtained through targeted, special studies.

Covariates to measure include an assessment of the impact of filter-feeding, invasive clams. *Potamocorbula amurensis* and *Corbicula fluminea* on the assemblage and abundance of zooplankton food resources in the Estuary at large which could detract from increased productivity in restored tidal wetlands. From observations of clam densities, their biomass and potential filter-feeding rate can be modeled. To fully evaluate this hypothesis for zooplankton, the impact of filter-feeding clams should be estimated and compared with estimates for productivity.

The **baseline** for this hypothesis will be the invertebrate and zooplankton densities measured at reference sites and during pre-project monitoring activities as part of the CDFW Fish Restoration Program (Hartman et al. 2018).

H_{TW3}: Beneficial taxa for native fish diets (zooplankton and benthic or epiphytic invertebrates) will be present in native fishes sampled in restored tidal wetland sites.

The **metric** for this hypothesis will be the community composition of the diets of native fishes sampled in restored tidal wetland sites. The diet composition can be compared with the community composition of zooplankton and invertebrate taxa sampled at the sites to assess whether the fish community is likely to be sourcing its diet from secondary productivity in restored areas. Assessing fish diets may include use of genetic techniques to sample the full suite of taxa found in sampled fish, as traditional, visual methods may not be able to sample the full assemblage of diet items (Schreier et al. 2016).

This **basis of comparison** for this hypothesis will be the diet composition of native fishes of the same species sampled outside of restored tidal wetland areas, in different habitat types (shoreline or pelagic). The analysis of diet samples will address whether the community composition of native fish diets reflect their habitat (tidal wetland or at comparison locations).

H_{TW4}: Growth rate and condition of target fish species will be higher in or adjacent to tidal wetland habitat compared to pelagic habitats.

The **metrics** for this hypothesis will include direct measurements of growth rates or estimated growth rates (such as via laboratory examination of otoliths) of target fish species (Delta smelt, Longfin smelt, Chinook salmon, or other native fishes), as well as other indicators of fish condition and growth such as condition factor or gut fullness. Condition metrics will be derived from fish sampled on or near restored areas. To determine growth rate and confidently relate it to specific habitats, experimental studies using hatchery-sourced Chinook salmon or cultured Delta smelt can be used to compare growth rates between restored tidal wetland habitats and reference locations.

While growth rates of many native fishes have been published in the scientific literature, they are generally not habitat-specific (except for juvenile salmon growth on floodplains compared to riverine channels, (e.g., Takata et al. 2017)), so there is no clear temporal baseline for this hypothesis. For this reason, the effect of restored habitat on growth rate will be best addressed through special studies that leverage a spatial comparison between measured growth rates across habitat types, such as via cage studies.

2.2.4.2 Restored tidal wetlands as rearing habitat for native fishes

H_{TW5}: Target fish species presence and density will increase in restored tidal wetland habitat sites and the area of their tidal footprint.

The **metric** for this hypothesis will be the presence of targeted fish species (Delta smelt, longfin smelt, Chinook salmon, and resident Delta natives such as tule perch, Sacramento blackfish, Sacramento suckers, and hitch) in restored tidal wetland habitat. Presence may be measured by sampling conducted through traditional methods such as beach seines, newly developed technologies to visualize species presence (e.g. Cramer Fish Science Sampling Platform), or by positive species identification through environmental DNA (e.g., as in Schreier et al. 2016; Nagarajan et al. 2022).

Covariates to measure for this hypothesis will be the coverage of submerged and floating invasive aquatic vegetation at entry/exit points of restored areas, and the density and movements of predators (Striped bass, Largemouth bass or other *Micropterus* species, or Sacramento pikeminnow) at these locations. Predators along migration routes and dense aquatic vegetation can all limit native fish access to restored areas and may elevate predation risk to native fishes. Tracking aquatic vegetation coverage, predator densities, and evaluating predation risk are especially relevant to juvenile Chinook salmon during their outmigration period because restored tidal wetlands may provide beneficial rearing habitat but late migrating fish are commonly subject to high predation rates as temperatures increase (Nobriga et al. 2021). Predator concentrations and flux in and out of a wetland can be using imaging sonar technology such as DIDSON (Boswell et al. 2019; Bennett et al. 2021). Predation risk can be assessed and compared across habitat types through tethering approaches using Predation Event Recorders, which are designed to record the exact time and location of a tethered, anchored fish being predated (Michel et al. 2020). Coverage of submerged and floating invasive aquatic vegetation can be expressed as the percent coverage in the vicinity of entry/exit points (e.g., using a 50m buffered area around the entry/exit location).

Notably, an uncertainty with this hypothesis is the thresholds of predator densities and invasive aquatic vegetation coverage above which survival of native fish species is impaired or at which they will avoid shallow water habitat. Piscivores and invasive aquatic vegetation are prevalent in the Delta and will be present to some extent near shallow-water habitat. It will be beneficial in evaluation of this hypothesis to assess whether increases in predator densities or vegetation coverage result in reduced utilization of the restored habitat or a notable decrease in survival, and these questions will be best addressed through targeted experimental work rather than continuous monitoring efforts. Finally, comprehensive evaluation of increased predation risk near restored sites should include assessments of water quality, as relative risk of predation varies with turbidity (Ferrari et al. 2014) and water temperature (Nobriga et al. 2021). If thresholds of predators and invasive aquatic vegetation that cause avoidance of restored areas can be determined, this information could be used to inform the degree or control of these factors that is needed to maintain the potential for restored areas to be used by target species, and the feasibility of performing predator or vegetation control at the level required. Such threshold information may also be useful for prioritization and decision-making processes that must weigh the likelihood of realizing benefits to native fishes with the required resource investment.

In addition to measuring predator densities and coverage of invasive aquatic vegetation at and near restored areas, the ability of outmigrating juvenile salmon to access these sites can also be investigated using release of tagged fish (likely coded-wire-tag, or CWT, releases to achieve large release numbers) upstream of potential tidal wetland rearing locations, and then checking for the presence of these fish in restored areas.

The **baseline** for this hypothesis will be sampled fish densities measured at reference sites and during pre-project monitoring activities conducted by the CDFW Fish Restoration Program (Hartman et al. 2018). Historical data on fish assemblage and frequency of native species detection can also be obtained from the US Fish & Wildlife Service Delta Juvenile Fish Monitoring Program, which has collected data on juvenile fish communities in the Delta since 1976 (Speegle et al. 2022).

2.3 Full Tributary and Delta Tier Hypotheses: Effects of environmental flow in Tributaries and the Delta, and tributary responses to flow and non-flow measures

2.3.1 Tributary-wide Hypotheses, Metrics, and Outcomes

Hypotheses at the scale of full tributaries regard flow actions specifically and their benefits to target species and the tributary ecosystem, as well as predictions for how the aggregate of both flow and non-flow actions within tributaries will affect productivity, condition, and life history diversity of juvenile Chinook salmon. Specific hypotheses for benefits of flow actions are presented first, followed by hypotheses for how the population of juvenile salmon will change as a result of both flow and non-flow VA measures.

2.3.1.1 Tributary flow increases to enhance salmon survival and migration

Flow releases in tributaries can be used to improve migration and survival in multiple ways in addition to inundation of floodplain habitats and provision of suitable instream habitats for rearing and spawning. Fall pulse flows in selected tributaries (Mokelumne, Putah) have been observed to improve adult upstream migration by providing migration cues, reduce straying of adult Chinook salmon away from their natal streams, and thereby improve overall spawning stock escapement. Spring pulse flows can be beneficial in transporting juvenile Chinook salmon through the tributaries while conditions remain suitable and when conditions are most suitable for survival in downstream migratory pathways. Analysis of historical data and previously published studies that relate juvenile outmigration to elevated flow events may be helpful for designing the shape and necessary magnitude of pulse flow events to cue downstream migration. Additionally, spring pulse flows may contribute to reduced water temperatures and may improve conditions for juvenile fall-run Chinook salmon by reducing thermal physiological stress and reducing parasite and disease/pathogen load. Seasonal pulse flows on the Sacramento River may improve thermal conditions for multiple runs and life-stages of Chinook salmon.

$H_{TribFlow1}$: Fall pulse flows in selected tributaries (e.g., Mokelumne, Putah) will provide migratory cues for adult Chinook salmon upstream migration, resulting in an increased rate of adult migration to spawning habitats.

The **metrics** for this hypothesis will be rates of upstream migration (i.e., estimates of upstream migrant abundance over a specified time period – e.g., weekly) of adult fall-run Chinook salmon. The timeframe for calculation of the migration rate metrics would be the week encompassing the pulse flow release, as well as 1 week subsequent to the release to capture potential lag-phasing of response. Migration rates will be calculated using direct observation where available (e.g., spawner surveys, VAKI Riverwatcher photogrammetric systems, video documentation at counting weirs) and/or special studies using acoustic tags.

Covariates to be measured for a comprehensive evaluation of the effectiveness of pulse flows will include water temperatures and dissolved oxygen to ensure they are suitable for adult fall-run Chinook salmon upstream migration. These variables should be measured before and during flow pulses to enable an assessment of whether they contributed to reduced water temperatures, which may be possible unless there are confounding factors (e.g., storm events) that preclude a robust comparison of before vs. after conditions.

The **baseline** for this hypothesis will be the weekly rates of upstream migration of adult fall-run Chinook salmon, prior and subsequent to fall pulse flow releases, during the annual periodicity of upstream migration.

$H_{TribFlow2}$: Pulse flows provided during spring months will provide outmigration cues for downstream migration of juvenile Chinook salmon, as indicated by an increase in the rates of juvenile outmigration associated with pulse flow releases.

The **metrics** for this hypothesis include rates of juvenile outmigration (i.e., estimates of outmigrant abundance over a specified time period – e.g., weekly). The timeframe for calculation of the migration rate metrics will be the week encompassing the pulse flow release, as well as one week subsequent to the release to capture potential lag-phasing of response. It is anticipated that migration rates will be calculated using rotary screw trap (RST) capture data. Secondarily, a retrospective analysis to help evaluate this hypothesis after the outmigration period is over would involve examination of whether spikes in juvenile Chinook salmon catch at RSTs (relatively high percentages of total catch for the season) are associated with VA pulse flows. This hypothesis may also be tested using a paired release design, in which batches of hatchery-origin juvenile salmon tagged with coded-wire-tags are released concurrently with a flow pulse and outside of a flow pulse window. The rate of tagged fish detected at downstream RSTs can then be compared between flow conditions.

Covariates to be measured for a comprehensive evaluation of the effectiveness of pulse flows include fry density, fish size, turbidity, day length, PAR (sunlight), lunar phase, and temperature.

The **baseline** for this hypothesis will be the weekly rates of juvenile outmigration for up to 2 weeks prior to spring pulse flow releases and after elevated flows due to the flow release have subsided.

$H_{TribFlow3}$: Pulse flows provided during spring months will increase survival of downstream migrating juvenile Chinook salmon, as indicated by an increase in the survival rate of juvenile outmigration associated with pulse flow releases.

The **metrics** for this hypothesis will be travel times and survival rates of juvenile salmon outmigrating from tributaries, as measured by acoustically tagged juvenile salmonids of hatchery origin. The timeframe for calculation of the survival rate metrics will be the weeks during and subsequent (approximately 1-2 weeks) to the pulse flow release. It is anticipated that survival rates will be calculated using acoustic telemetry data. The study design for evaluating this hypothesis may include tagged fish releases with and without flow pulses to compare both travel time and survival under different flow conditions within the same season. If pulse flows are designed to vary with respect to both magnitude and duration, it may be possible and desirable to develop an experimental design in which the survival of tagged fish is compared across different pulse flow strategies (e.g., sustained flow release of lesser magnitude vs. brief flow release of larger magnitude), with a goal of identifying thresholds for producing a survival benefit. Some experiments along these lines are already being conducted to guide operations of the State Water Project and the Central Valley Project (described and analyzed in real-time CalFishTrack (noaa.gov)).

Covariates to measure to assess the suitability of conditions for downstream migration include water temperature, turbidity, and dissolved oxygen. As water temperatures decrease, Chinook salmon survival is likely to increase during outmigration (Smith et al. 2003; Nobriga et al. 2021). To assess the relationships between flow, water temperatures, turbidity and dissolved oxygen and migration travel times and survival rates, these parameters will be tracked before, during, and after flow pulses.

The **baselines** for this hypothesis are the travel times and survival rates of acoustically tagged juvenile outmigration during the periods before and after the spring pulse flow releases. In addition, analysis of historical data, migration survival models and previously published studies that relate juvenile outmigration to elevated flow events (Steel et al. 2020; Hassrick et al. 2022), may be helpful for assessing the effectiveness of these actions.

$H_{TribFlow4}$: Flow increases during spring months will result in reduced pathogen density in the water column and reduced rates of clinical infection (i.e., disease) in Chinook salmon juveniles in tributaries.

The **metrics** for this hypothesis will be: (1) the number of spores per liter of *Ceratomyxa shasta:* and (2) the rate of clinical infection (disease) in Chinook salmon juveniles, based on USFWS methodologies for assessing disease compared to infection (Foott et al. 2021).

Covariates that may affect the impact of flow increases on *C. shasta* include water temperature and dissolved oxygen.

The **baseline** for this hypothesis will be existing spores per liter of *C. shasta* and rate of clinically infected Chinook salmon juveniles in tributaries up to 2 weeks before flow pulses occur. Where historical data are available, both *C. shasta* densities and clinical infection rates can be assessed for flow rates.

2.3.1.2 In-river juvenile salmon productivity, condition, and diversity

Generally, the suite of habitat enhancement measures for a tributary is expected to collectively result in biological responses for the population of juvenile salmon that outmigrate to the Delta. Tributary-specific in-river anadromous salmonid productivity is addressed through evaluation of trends in the annual ratio of the number of out-migrating fry and juveniles (collectively "juveniles") produced by a given number of spawners. Production of juveniles (expressed as number of outmigrants per spawning female) has been demonstrated to be a useful measure for evaluating in-river habitat conditions on salmon populations, and has been shown to be relatively immune to variations in year-to-year adult population abundances (Botkin et al. 2000). Tributary-specific juvenile anadromous salmonid life history diversity, which relates to population resiliency and is supported by increased habitat complexity and diversity (Herbold et al. 2018, Carlson and Satterthwaite 2011), is addressed through evaluation of trends in achieving variable distributions in the size and emigration timing of juvenile anadromous salmonid annual outmigrant populations.

$H_{TribWide1}$: The suite of VA measures implemented within a tributary will result in an increase in the rate of juvenile Chinook salmon productivity per spawning female adult.

The **metric** for this hypothesis is the trend in the annual ratio of the number of juvenile outmigrants per female spawner. The metric will be calculated from juvenile outmigrant data (# fish captured at RSTs) and adult biometric and spawning stock escapement data (e.g., carcass surveys, redd surveys, and/or direct observation such as video/VAKI Riverwatcher™/counting weirs). This metric will be evaluated as a trend over multiple years (e.g., >3).

Covariates to measure for a complete assessment of juvenile productivity will include flow, water temperatures and dissolved oxygen to ascertain whether they are in an appropriate range for spawning, egg incubation, and juvenile rearing prior to outmigration throughout the applicable time periods for each tributary. Water temperature and dissolved oxygen will be measured at locations used for spawning and juvenile rearing longitudinally distributed in each tributary. Overall escapement and redd superimposition are also important covariates to measure as they may affect estimates of the total number of eggs and fry.

The **baseline** for this hypothesis will be the trend in the annual values of the metric during the period of data availability prior to implementation of VA measures.

$H_{TribWide2}$: Increased habitat quality and associated primary and secondary production to support the base food web will result in improved condition of Chinook salmon emigrating from the tributaries.

The **metric** for this hypothesis will be the range and mean of the condition factor (Fulton's condition factor (Nash et al. 2006)) of the population of Chinook salmon emigrating from tributaries into the Delta system.

The **baseline** for this hypothesis will be the condition factor of Chinook salmon of the emigrating population for the period of record for each tributary.

$H_{TribWide3}$: The suite of VA measures implemented within a tributary will result in an increase in life history diversity of outmigrating juvenile salmonids.

The **metrics** for this hypothesis will be the coefficients of variation in the timing and body size of the juvenile Chinook salmon emigrant population over the annual period of emigration. Increased life history diversity may be reflected in larger numbers of yearling-sized juvenile salmon exiting tributaries and increased temporal diversity of outmigration for any given body size emigrating from the systems. Life history diversity may also be reflected in increased spatial diversity of outmigrating juveniles of any size (e.g., number of systems with evidence for both fry and yearling outmigrants).

The **baseline** for this hypothesis will be coefficients of variation in the timing and body size of the juvenile Chinook salmon emigrant population over the annual period of emigration for those years when data is available prior to implementation of VA measures.

2.3.2 Flow actions for managed species and ecosystem health in the Delta

$H_{DeltaFlow1}$: Increased spring Delta outflow results in increased availability of suitable adult spawning and larval rearing habitat for Delta smelt and longfin smelt.

The **metric** for this hypothesis will be modeled acreage of suitable habitat in the North, Western, and Central Delta regions as well as Suisun Marsh with appropriate ranges of water temperature, turbidity, and salinity for Delta and Longfin smelt, following the suitability criteria and modeling approach described in the 2023 Draft Scientific Basis Report Supplement (SWRCB 2023). The basis for this hypothesis is that as spring flow increases, the low salinity zone moves seaward and salinity-based habitat indices increase (Kimmerer et al. 2013).

The **baseline** for this hypothesis will be the modeled habitat area without implementation of VA flow measures, 2023 Draft Scientific Basis Report Supplement (tiered approach to integrate CalSim and the RMA Bay-Delta Model, described in Figure 5-4).

$H_{DeltaFlow2}$: Increased Delta outflows in the spring will facilitate transport of larval and juvenile longfin smelt larvae to downstream rearing areas, thereby reducing entrainment risk.

The **metrics** for this hypothesis will be the distribution of sampled Longfin smelt larvae and juveniles (Eakin 2021), modeled estimates of larval Longfin smelt entrainment at the South Delta pumping facilities (Gross et al. 2022), and estimated entrainment of juvenile longfin smelt (>20mm in size) from the numbers collected at the South Delta fish collection facilities.

Covariates for this hypothesis will be water temperatures and turbidity during the larval and juvenile rearing season, and the distribution and abundance of spawning stock of longfin smelt in the preceding spawning period.

The **baseline** for this hypothesis will be the period of record of larval Longfin smelt catch in the Smelt Larval Survey as well as special studies conducted to investigate the life history and distribution of Longfin smelt (e.g., Lewis et al. 2020). To assess the relationship between entrainment risk and VA flows, the baseline will be the modeled estimate of larval longfin smelt entrainment across variable flow conditions (Gross et al. 2022) and the historical dataset for estimated juvenile longfin smelt entrainment at the South Delta pumping facilities (expanded from salvage numbers). These entrainment estimates will be compared between VA spring flow measure implementation and historical years for the same months but with lower outflow conditions.

$H_{DeltaFlow3}$: Increased Delta outflows during spring months will reduce risk of entrainment in the South Delta pumping facilities for Delta smelt and juvenile Chinook salmon.

The **metrics** for this hypothesis will be the estimated entrainment of Delta smelt adults in early spring months, and for Delta smelt larvae and juveniles, and the proportional loss of juvenile salmonids in all spring months. Entrainment for adult Delta smelt is estimated from the numbers of salvaged Delta smelt at South Delta fish collection facilities and through modeling that accounts for sampling efficiency at salvage operations and other factors (Kimmerer 2008; Kimmerer 2011; Smith 2019), or through behavior-driven movement models that are a combination of behavior and particle tracking models (Korman et al. 2021). Entrainment of Delta smelt larvae is estimated through particle tracking modeling in which the transport of larvae as passive particles is simulated (Kimmerer and Rose 2018). Entrainment of juvenile Chinook salmon is estimated through an expansion of the number of juveniles salvaged at fish collection facilities (Kimmerer 2008). Estimated entrainment of juvenile salmonids will be considered within a population context given that previous studies have demonstrated that the highest entrainment rates are likely to occur at elevated diversion levels, but that the overall contribution of entrainment to mortality during outmigration may be low (Zeug and Cavallo 2014).

Covariates to measure for robust assessment of entrainment risk for Delta smelt include the population abundance estimate and its distribution during winter months prior to the spring outflow period, regional hydrodynamics (i.e., calculated flows in DAYFLOW for the San Joaquin River, exports, Sacramento River), and water quality (e.g., turbidity) (Grimaldo et al. 2021).

Covariates to measure for robust assessment of juvenile salmon entrainment risk also include local South Delta hydrodynamics, the overall abundance estimate of juvenile salmonids for each run entering the Delta, Delta Cross Channel gate operations, and water quality parameters such as water temperature.

The **baseline** for this hypothesis will be modeled estimates of entrainment risk for Delta smelt and juvenile salmonids in prior years over a range of hydrologic conditions, including outflow levels comparable to those achieved through implementation of VA flow measures, and outflow levels lower than those levels. Previously published studies can also serve as a basis for comparison (Kimmerer 2008; Smith 2019; Grimaldo et al. 2021; Korman et al. 2021).

$H_{DeltaFlow4}$: Increased Delta outflow during spring months reduces travel time and increases survival through the tidal region of the Delta for outmigrating juvenile salmonids.

The **metric** for this hypothesis will be the travel time and survival rate of juvenile anadromous salmonids within the tidal Delta, from Delta entry points from both the Sacramento and San Joaquin Valleys, as measured by acoustically tagged juvenile salmonids of hatchery origin (Perry et al. 2018; Hance et al. 2022).

Covariates to measure to assess possible factors contributing to travel time and survival through the Delta include water temperature, dissolved oxygen, turbidity, submerged aquatic vegetation coverage along migration routes, and (where possible) predator densities at critical junctures ("hotspots," Michel et al. 2020).

The **baseline** for this hypothesis will be the available published information on acoustically tagged juvenile salmon travel time and survival through the Delta (e.g., as described in Perry et al. 2018) during outflow conditions similar to those achieved through VA flow implementation and compared to lower outflow conditions. An experimental approach to evaluating this hypothesis is comparison of travel time and survival of acoustically tagged juvenile salmon with and without increased spring outflows, in the same year.

$H_{DeltaFlow5}$: In years where the magnitude, duration, and intra-annual frequency of a Meaningful Floodplain Event are achieved on Yolo and Sutter Bypasses, the population of juvenile salmon leaving the Delta will have a higher proportion of individuals with evidence of bypass floodplain rearing.

The **metric** for this hypothesis will be the annual proportion of juvenile Chinook salmon leaving the Delta bearing the signature of floodplain rearing and growth through isotopic analyses of otoliths and/or eye lenses (Bell-Tilcock et al. 2021). It is anticipated that samples for this analysis will be sourced through the USFWS Delta Juvenile Fish Monitoring Program (DJFMP), which trawls for juvenile salmon and other species at the confluence of the Sacramento and San Joaquin Rivers (Chipps Island Trawl, Speegle et al. 2022). As needed, other special studies can be used to increase sample size when floodplain conditions allow.

Covariates to measure to consider the various environmental factors that may influence the proportion of juvenile salmon utilizing floodplain rearing habitats include water quality variables in floodplain habitats and the riverine Delta migration routes (water temperature, turbidity), metrics of secondary productivity, as well as the timing, magnitude, and frequency of floodplain inundation for each year of samples.

The **baseline** for this hypothesis will be a comparison of the proportion of juvenile salmon utilizing floodplain habitats prior to exiting the Delta across years with different degrees of Bypass inundation (e.g., little to no inundation, to high levels of inundation through the juvenile salmon rearing period). The period of record for this comparison will be the time series for which salmon eye lenses are available (including in archived samples).

$H_{DeltaFlow6}$: Provision of spring flow pulses and increased spring Delta outflow will be associated with increased year class indices for age-0 and age-1 white sturgeon.

The **metric** for this hypothesis will be white sturgeon year class index strength measured through the San Francisco Bay Study conducted by the California Department of Fish and Wildlife. The number of larvae and juvenile sturgeon is positively correlated with Delta outflow during winter and early spring months (Fish 2010).

The **baseline** for this hypothesis will be the period of record for the San Francisco Bay Study. Analyses will leverage white sturgeon year class indices for Delta spring outflow levels similar to those achieved through implementation of VA flow measures and compared with years with lower outflows.

$H_{DeltaFlow7}$: Increased Delta outflow in the spring will result in transport of freshwater-associated zooplankton taxa (e.g., *Daphnia* spp. and *Pseudodiaptomus forbesi*) into the Western Delta and Suisun Marsh regions.

The **metric** for this hypothesis will be the average regional sampled densities of freshwater-associated zooplankton (using datasets described and integrated in Bashevkin et al. 2022a) in the Delta in the spring months during and after implementation of VA flow measures. Community composition of zooplankton is another useful metric for assessing whether assemblage changes across flow conditions. Increased Delta outflow is hypothesized to transport freshwater-associated zooplankton into the low salinity zone (Kimmerer et al. 2019) and increase their regional densities.

The composition of zooplankton taxa in turn affects habitat suitability for native fishes because zooplankton vary in their nutritional quality for fishes; for example, *Daphnia* spp and *Pseudodiaptomous forbesi* are taxa that are important food sources for Delta smelt (Slater and Baxter 2014). Other important taxa to examine for a relationship with Delta outflow include *Eurytemora affinis*, and mysid shrimp.

Covariates to measure to assess conditions influencing zooplankton community composition include phytoplankton biomass density and composition, salinity, water temperature, and turbidity.

The **baseline** for this hypothesis will be the regional sampled densities (regions as described in Bashevkin et al. 2022b) and assemblages of zooplankton in the historical dataset for similar outflow conditions as achieved through VA flow measure implementation and compared with the same months and regions for lower outflow conditions.

$H_{DeltaFlow8}$: Provision of increased spring outflows in the Delta will not be related to the prevalence of cyanoHABs or their toxicity during summer and fall months of the same year.

The **metric** for this hypothesis will be the frequency, magnitude, and severity of cyanoHABs in the Delta and Suisun Marsh region, as measured by consistent visual observations of *Microcystis* presence during routine Delta monitoring surveys, such as the Environmental Monitoring Program, Summer Townet Survey, and the Fall Midwater Trawl (Hartman et al. 2022b). CyanoHAB events in the Delta typically occur in summer and fall months (approximately July – November). While decreased retention time and lower water temperatures during the cyanoHAB season have been correlated with lower *Microcystis* abundance and reduced toxicity (Lehman et al. 2022), there is no evidence that increased outflows during the spring season as proposed by the VAs will affect the abundance of *Microcystis* or other cyanobacteria taxa and associated toxicity levels later in the same year.

Covariates to measure to evaluate this hypothesis include Delta outflow through the spring season when VA flows are implemented, as well as during the cyanoHAB season. Water temperature, turbidity, salinity, and nutrient concentrations and ratios (nitrate, ammonium) are also relevant to assessing the key factors contributing to the abundance of cyanoHAB taxa.

The **baseline** for this metric will be the period of record of cyanoHAB visual observations in routine surveys with corresponding Delta outflow calculations and similar temperatures. The evaluation of this hypothesis will involve an investigation of the relationship between spring outflow levels similar to those achieved through implementation of VA flow measures and the cyanoHAB observations later in the same year. This evaluation will need to be done for a range of spring outflow levels and temperatures to understand whether a relationship exists.

2.4 Population-level Tier Hypotheses: Trends in native species populations in tributaries, the Delta, and at the system-wide scale

Population-level considerations include tracking the status and trends in abundance and productivity of target fish species at the tributary-specific scale, within the Delta, and at the scale of the full Sacramento and San Joaquin Valleys. Temporal trends and annual variability in abundance and productivity provide measures of population status and viability. Population-level trends in abundance and productivity are important considerations regarding the narrative objectives of the SWRCB Bay-Delta Water Quality Control Plan.

At the full system-wide and population-level scale, a goal of the VA Program is that the aggregate of flow and habitat measures contribute to a trend of increased abundance. To this end, metrics of population abundance (listed below) will be tracked, and the VA Science Program will work to fill any gaps in the monitoring and science network to allow a comprehensive ability to track these metrics. As discussed above, it is important to acknowledge that many of the population-level outcomes are influenced by factors outside the control of VA Parties (e.g., climate-induced changes to hydrology and temperatures, ocean conditions, hatchery and harvest practices, among others). In addition, the multi-year life span of some target species mean that it will not be realistic to expect significant changes in trends to population-level metrics within the 8-year term of the VAs. For these reasons, metrics provided at population-level tier are intended for tracking purposes regarding the narrative objectives.

2.4.1 Tributary-Specific Chinook Salmon Population-level Response

The VA Program endeavors to provide population-level benefits for natural-origin Chinook salmon. However, there are five major hatcheries in the Central Valley for fall run Chinook salmon, releasing an average total of approximately 30 million juvenile salmon annually (Huber and Carlson 2015). While the hatchery production sustains the commercial and recreational fishery for Central Valley salmon, hatcheries and their release practices influence life history diversity and cause increased straying of adults to tributaries other than their natal system (Sturrock et al. 2019). Since 2007, Central Valley hatcheries have implemented the Central Valley Constant Fractional Marking (CFM) Program maintained a practice of a consistent marking rate, using coded-wire-tags of 25% of released fall-run Chinook salmon (California Hatchery Scientific Review Group 2012). The purpose of this program is to allow estimation of the contribution rates of hatchery fish to Central Valley Chinook populations and their harvest. While this program has allowed for separate abundance estimates of natural and hatchery-origin adult salmon since 2010 (the first year that all adult returns would have been included in the CFM program), the majority of hatchery fish released cannot reliably be distinguished from natural origin fish or identified to their natal tributary. Given this, and for the purpose of the VA hypotheses and metrics for population-level Chinook salmon abundance and life history metrics, initially both natural- and hatchery-origin adults will be included in evaluating metrics until hatchery practices allow a more accurate characterization of the proportion of hatchery-origin fish on the spawning grounds.

Following the March 2022 VA Term Sheet and the narrative objective for the update for the Bay-Delta Water Quality Control Plan, the primary baseline for hypotheses regarding population increases will be the estimated abundances during the 1967-1991 period that is used as a baseline for the Anadromous Fish Restoration Program (AFRP) doubling goal. A secondary baseline for these hypotheses, to reflect recent conditions and contemporary adult salmon counting methods, will be the annual abundance of adults (harvest plus escapement) by tributary since 2010 because consistent marking practices were in place for returning hatchery origin adults starting in that year.

$H_{TribPop1}$: Increased availability of floodplain rearing habitat and invertebrate food sources produced on seasonally flooded agricultural land will result in increased usage of these habitats and food sources, reflected in retrospective analyses in the returning adult populations of natural-origin Chinook salmon.

The **metric** for this hypothesis will be the isotopic signature associated with floodplain rearing (Bell-Tilcock et al., 2021) and floodplain-sourced food resources in the otoliths and/or eye lenses**.** The adults sampled to test this hypothesis should be potential beneficiaries of VA restoration actions to increase availability of bypass rearing habitat and production of invertebrate food sources through managed seasonal flooding of agricultural land. Addressing this hypothesis will require an investigation of whether the isotopic signature of floodplain rearing can be detected from otolith or eye lenses obtained from adults, as this capability of the tool has not yet been published and represents an area of uncertainty.

The **baseline** for this hypothesis will be archived samples of otoliths and/or eye lenses of adults returning to the Sacramento Valley before implementation of VA actions to enhance Bypass floodplains. Testing this hypothesis may require an assessment of whether Sutter Bypass rearing and consumption of invertebrates from seasonally flooded agricultural land results in a unique signature in Chinook eye lenses and/or otoliths, as has been shown for Yolo Bypass (see also $H_{BypassFP3}$).

$H_{TribPop2}$: Implementation of the suite of VA measures within a tributary will result in an increase in the average estimated annual natural origin Chinook salmon adult abundance, and the trend in annual abundance values.

The **metrics** for this hypothesis will be the average of annual natural origin Chinook salmon spawning stock production estimates (harvest plus escapement) calculated over the period of implementation of VA measures, and the trend in annual Chinook salmon spawning stock escapement estimates calculated over the period of implementation of VA measures. The annual reports made available through Pacific States Marine Fisheries Commission (PSMFC) and CDFW on the estimated proportion of the adult population comprised of hatchery fish, based on the Constant Fractional Marking Program (Letvin et al. 2021) will be the basis for estimated natural origin fish. Notably, to accurately evaluate this hypothesis, it will be necessary to estimate the tributary-specific origin of harvested fish, including ocean harvest using otolith microchemistry (Barnett-Johnson et al. 2008).

The **baseline** for this hypothesis will be values of the metrics calculated over the period of 1967-1991 per the Anadromous Fish Restoration Program (AFRP) doubling goal. A secondary baseline, to reflect recent conditions and contemporary adult salmon counting methods, will be the annual abundance of adults (harvest plus escapement) by tributary, since 2010.

$H_{TribPop3}$: Implementation of the suite of VA measures within a tributary will result in a positive trend in adult Chinook salmon Cohort Replacement Rate (CRR) for natural origin fish over the period of implementation of VA measures.

The **metric** for this hypothesis will be the trend in annual Chinook salmon spawning stock CRR for natural origin fish, calculated over the period of implementation of VA measures. Notably, evaluation of this hypothesis will require accurate identification of hatchery and natural origin returning adults and their age to assign returns to cohorts. The annual reports made available through Pacific States Marine Fisheries Commission (PSMFC) and CDFW on the estimated proportion of the adult population comprised of hatchery fish, based on the Constant Fractional Marking Program (Letvin et al. 2021) will be the basis for estimated natural origin fish. Because the 8-year term of the VA Program is limited for assessing a change in the trend, the CRR value will also be tracked on an annual basis.

The **baseline** for this hypothesis will be the trend in annual Chinook salmon spawning stock CRR calculated over the period of record prior to the implementation of VA measures. A secondary baseline, to reflect recent conditions and contemporary adult salmon counting methods, will be the annual abundance of adults (harvest plus escapement) by tributary, since 2010.

2.4.2 System-wide Anadromous Chinook Salmon Population-level Response

H_{SWPop1}: Implementation of the full suite of VA measures will contribute toward increased annual natural origin Chinook salmon abundance across the Sacramento and San Joaquin Basins.

The **metric** for this hypothesis will be estimates of the average annual natural origin adult escapement and harvest of fall-run Chinook salmon for the Sacramento and San Joaquin Basins over the period of VA implementation.

The **baseline** for this hypothesis will be the average of natural-origin escapement values associated with the Anadromous Fish Restoration Program Doubling Goal (years 1967-1991). A secondary baseline, to reflect recent conditions and population numbers, will be estimates of natural-origin escapement for fall run Chinook salmon since 2010.

H_{SWPop2}: Implementation of the full set of VA measures will contribute to a trend of population growth for natural origin Chinook salmon over time.

The **metric** for this hypothesis will be annual natural-origin adult Chinook salmon cohort replacement rates and trends over multiple years (e.g., > 3 years) over the period of VA implementation.

The **baseline** for this hypothesis will be the annual natural-origin adult Chinook salmon cohort replacement rate trends during the period associated with the Anadromous Fish Restoration Program Doubling Goal (years 1967-1991). A secondary baseline, to reflect recent conditions and population numbers, will be annual adult Chinook salmon cohort replacement rates and trends for natural-origin fall run Chinook salmon since 2010.

2.4.3 Population-level responses for Native Species Communities in the Delta

H_{SWPop3}: Population estimates for native species, including California Bay shrimp, Sacramento splittail, longfin smelt, and Delta smelt will increase as a result of increased Delta outflow and increased area of suitable habitat during spring months.

The **metric** for this hypothesis will be increased distribution and population estimates of spawning adults and rearing juveniles for native species in the Delta using a statistically appropriate sample design for detecting differences in distribution and abundance. Notably, population estimates of the listed native species are not all currently available, except for Delta smelt through the enhanced Delta smelt monitoring program (EDSM, operated by the USFWS). For Delta smelt, some change in abundance is expected regardless of VA flow and habitat actions because of supplementation with cultured Delta smelt occurring since 2021. The number of supplemented Delta smelt should be tracked as an important covariate, and as much as possible, quantitatively tracked as a contributing factor to population changes. For other species, abundance is tracked through seasonal abundance indices, which do not have an uncertainty estimate with respect to population size. Seasonal abundance indices can serve as a surrogate where population estimates are lacking; however, sampling designs that are statistically appropriate for developing population estimates with uncertainty estimates are necessary for adequate evaluation of this hypothesis.

The **baseline** for this hypothesis will be the seasonal abundance indices for California Bay shrimp, longfin Smelt, Delta smelt, and other selected native species using the baseline in the 2017 Draft Scientific Basis Report Supplement and the 2023 Draft Scientific Basis Report Supplement. Delta smelt population estimates for the period of record for the survey can serve as an additional baseline for Delta smelt.

H_{SWPop4}: Increased availability of spawning habitat through implementation of VA flow for longfin smelt will result in improved spawning success.

The **metric** for this hypothesis will be the estimate of the number of larval Longfin smelt per estimated number of spawning adults.

The **baseline** for this hypothesis will be the estimated ratio of larval longfin smelt to adult spawning adults in available historical data in years with habitat area availability consistent with that achieved during VA flow and habitat implementation and years with lower outflow. For longfin smelt, this baseline must be derived from historical datasets that sampled the full geographic coverage of the spawning habitat for the species.

3 Monitoring Networks to Support VA Metrics

The VA Science Program has a geographic scope spanning the upper watersheds of VA Bay-Delta tributaries (below rim dams) to Suisun and San Pablo Bay. The VA Science Program is intended to cover multiple scales (local to population-level responses), multiple trophic levels and native species communities, as well as covariate data on stressors that may impede realization of VA measure benefits. Given the goal of examining ecosystem responses at multiple scales and across the full watershed, it is necessary to examine, build, and tune the monitoring networks such that they produce data that can be integrated across tributaries, can track species populations across multiple life stages, and actively inform adaptive management of both flow and non-flow VA measures.

Throughout the watershed, an extensive suite of monitoring programs already exist and has been producing data for decades (Heublein et al. 2017; Johnson et al. 2017; Delta Independent Science Board 2022). Existing monitoring programs have been established in response to a plethora of regulatory mandates and management questions and have continued for varying lengths of time. In some cases, despite having similar information needs, monitoring approaches may use different methodologies, making comparisons and data integration difficult. To achieve the consistency and targeted monitoring needed to support evaluation of VA metrics, it is necessary to evaluate existing monitoring efforts through the lens of what is needed for VA metrics. As appropriate, existing monitoring activities will be leveraged to provide data to populate the metrics for evaluating the hypotheses at the Local, Full Tributary and Delta, and Population-level Tiers. A summary of the relevant existing monitoring activities to collect data on these metrics is described here; however, in some cases the existing monitoring activities will not be sufficient for addressing relevant hypotheses. To this end, this section also summarizes the major gaps in current monitoring networks, particularly for addressing metrics required for evaluating hypotheses at the Full Tributary and Delta and Population-level Tiers.

3.1 Monitoring Needed for Local Tier Hypotheses

3.1.1 Monitoring Needed to Assess Tributary Habitat enhancements

Assessing the localized responses to efforts to enhance habitat for Chinook salmon and other native fishes in tributaries involves 4 general types of data collection: (1) mapping habitat in order to calculate area of suitable habitat; (2) assessing lower trophic responses to habitat changes by measuring benthic macroinvertebrate community composition and biomass; (3) juvenile salmon utilization of enhanced rearing habitat, along with the native fish community assemblage; and (4) adult salmon use of enhanced spawning habitat. The necessary approaches for each of these types of data collection are described in this section and compared with existing monitoring efforts to identify where data collection needs are covered and where there are gaps.

3.1.1.1 Tributary Habitat Mapping (H_{R1}, H_{S1}).

To achieve a consistent estimate of available spawning and rearing habitat and to assess changes in the available area after habitat enhancements have occurred, habitat maps need to be produced through a combination of remotely sensed elevation and topography, and hydraulic modeling to assess the water depth and velocity as critical measures for quantifying habitat area. The topography and elevation should be remotely sensed (e.g., via LiDAR) and augmented by multi-beam echosounder bathymetry as necessary to ensure that the habitat map is based on a consistent, synoptic measurement. Four elements are needed for the VA tributaries to have consistently produced maps and to measure change in habitat area in a consistent way: (1) a Digital Elevation Model (DEM), (2) a 2-dimensional hydraulic model, (3) a cover map that illustrates habitat features such as cover and woody vegetation, and a substrate map characterizing substrate composition, and (4) a hydrology model simulating operations and hydrology scenarios in order to determine the habitat area under different conditions. The general methodology for assessing spawning and rearing habitat area is described in Section 4.1 on Accounting Protocols for Non-Flow Habitat Measures.

Most, but not all, tributary systems have a DEM based on remotely-captured imagery, a 2-D hydraulic model, at least partial cover and substrate maps, and a hydrologic model for simulations. However, there are some systems using ground survey data and bathymetry for the DEM, cover maps are lacking from some systems, and there is not consistency in the hydraulic model used (Table 2).

Table 2. Summary of habitat mapping efforts by tributary. SRH-2D = Sedimentation and River Hydraulics – Two Dimensional Model (USBR 2008); TUFLOW = proprietary hydraulic model (www.tuflow.com); HecRAS = US Army Corps of Engineers Hydrologic Engineering Center River Analysis System (https://www.hec.usace.army.mil/).

Tributary	DEM availability/source	Hydraulic Model Platform	Cover Map Available	Hydrologic Model, Period of Simulation
Upper Sacramento	Yes/ 2017 Lidar, 2018 Sonar	Yes, 2D, SRH-2D	No	CALSIM2, 1922 – 2003
Upper Sacramento – Clear Creek	Yes/2017 LiDAR and Sonar	Yes, 2D, SRH-2D	Yes	CALSIM2, 1922 – 2003
Feather				
Yuba	Yes/ 2017 LiDAR and multibeam echo sounder	Yes, 2D, TUFLOW GPU	Yes	Yuba Daily Operations Model, 1922-2021
American	Yes/ 2017 LiDAR	Yes, 2D, HecRAS	Yes	CALSIM2
Mokelumne	Yes/ 2015 LiDAR and ground survey	Yes, 2D, HecRAS	Partial	HEC-HMS, calibrated to events of Feb 1986, Jan 1997, Feb 2017
Putah	Yes/2005 LiDAR	Yes, 2D, HecRAS	Partial	CalSIM2 (*verifying*)
Tuolumne	Yes/ 2012 and 2013 LiDAR	Yes, 1D, 2D, TUFLOW and HecRAS	Partial	Tuolumne River Operations Model, daily, range of years with variation in hydrology

3.1.1.2 Lower trophic responses in tributaries (H_{R2}, $H_{TribFP2}$).

Assessing the response of secondary producers in tributaries to habitat enhancements in-channel and floodplains involves collection and identification of benthic macroinvertebrates (BMI). There are multiple approaches for BMI sampling and laboratory identification (Carter and Resh 2001). However, standard operating procedures exist for California rivers and streams under the Surface Water Ambient Monitoring Program of the State Water Resources Control Board (SWAMP – Data and Interpretive Tools | California State Water Resources Control Board) and increasingly BMI data is being collected and shared through the California Environmental Data Exchange Network (CEDEN, CEDEN AdvancedQueryTool (ca.gov)). In the last decade, the California Stream Condition Index (CSCI) was developed to create a standardized index that could be compared across systems and used as a metric of ecosystem health (Mazor et al. 2016).

Despite statewide efforts to obtain consistency, an overview of BMI sampling efforts in VA tributaries reveals that data are not consistently collected and when data are collected, methodologies vary (Table 3). The upper Sacramento River and the Tuolumne River are the only systems reporting routine BMI monitoring. Most other systems collect BMI data on an as needed basis for special studies or restoration effectiveness monitoring. Most of the data are not readily available in a publicly accessible data repository. Therefore, more data requests are required to thoroughly determine whether existing efforts can be leveraged for evaluation of VA habitat enhancements. Existing efforts need to be spatially relevant to VA habitat enhancement sites.

For site-specific evaluations of the response of the BMI community to habitat enhancements, it may not be necessary to have entirely consistent methodologies across tributaries if the study design for individual efforts allows a comparison between project sites and comparison (non-enhanced sites) as described in the desired baselines for hypotheses H_{R2} and $H_{TribFP2}$. However, for synthetic report elements (Years 3 and 6 of the VA Program), it will be desirable to have consistent methodologies to communicate the range of responses observed across sites.

Table 3. Overview of Benthic Macroinvertebrate Sampling Efforts by Tributary.

Tributary	BMI Collected?	Equipment Type (Mesh Size if applicable)	Taxa ID Level	Data Availability
Upper Sacramento	Yes – as needed for special studies or restoration effectiveness monitoring and routine monitoring	Net (500 µm)	Lowest practicable level	Upon Request; anticipated posting of some data to SWAMP Data Dashboard and CEDEN database
Upper Sacramento – Clear Creek	Yes – as needed for special studies or restoration effectiveness, following BACI design	Quadrat	Lowest practicable level	Upon Request
Feather	Yes – as needed for restoration effectiveness monitoring	Net	Lowest practicable level, mostly to family	Mainly in technical reports, not necessarily online; some previous data published (Esteban and Marchetti 2004)
Yuba	Yes – as needed for special studies and restoration effectiveness monitoring	Net (500 µm)	Genus	Publicly available technical report posted online (Yuba County Water Agency 2013)
American	Yes – as needed for special studies and restoration effectiveness monitoring	Both Net (368 µm) and Quadrat	Family	Contained in technical reports, not necessarily online
Mokelumne	No	N/A	N/A	N/A
Putah	Yes – as needed for special studies and restoration effectiveness monitoring	N/A	N/A	Reports at https://www.scwa2.com/lower-putah-creek-coordinating-committee/lpccc-reports/
Tuolumne	Yes – as part of routine monitoring	Annual Hess (quadrat) or Kick-net (net-type sampling) at selected, consistent locations	Lowest practicable level (mostly to Family)	Upon Request

3.1.1.3 Juvenile salmon habitat use and densities on tributaries (H_{R3}, H_{R4}, $H_{TribFP3}$, $H_{TribFP5}$)

Juvenile salmon habitat use and density can be assessed through snorkeling surveys, seining, electrofishing, and special studies using individualized tagging approaches such as hydroacoustic tags. For assessment of VA hypotheses juvenile salmon response to in-channel and floodplain habitat enhancement projects, it will be necessary to pair sampling between project sites and comparison sites (non-enhanced sites), such as nearby tributary locations without restored habitat but that exhibit similar covariate (e.g., water temperature) suitability values.

Juvenile salmon habitat use is assessed in all VA tributaries, primarily through snorkeling efforts (Table 4) that cover all in-channel habitats. In most systems, tributary floodplain habitat is not covered in routine monitoring efforts, representing a gap in monitoring needs for understanding how juvenile salmon utilize enhanced floodplain habitat ($H_{TribFP3}$). Existing monitoring efforts, depending on their locations relative to in-channel habitat enhancement sites, may be appropriate for evaluating in-channel habitat enhancement projects. However, a closer investigation of the datasets is needed to conclusively determine whether these existing survey efforts can be leveraged or if new monitoring needs to be established. Ideally, and if appropriate, new efforts will use methodologies that are comparable to existing ones so that data can be assessed across all surveyed sites for additional context. While different methods (snorkeling, seining) may be used across tributaries and locations, the resulting density units (e.g., # fish/unit length of river or stream) should be comparable across efforts such that datasets from different systems can be used in an integrated analysis and responses to habitat enhancement efforts can be compared across systems.

Notably, it may be possible to address other Local Tier hypotheses on the tributaries through snorkel surveys, electrofishing, and/or seining conducted for juvenile salmon habitat use assessments. If non-salmonid species are recorded, the presence/absence and densities of these species can be assessed and related to utilization of enhanced floodplain habitat ($H_{TribFP6}$). In fact, these surveys may be the most likely opportunity for obtaining information on non-salmonid habitat use and distribution. Otherwise, non-salmonids are only tracked at rotary screw traps installed for assessing the timing and abundance of outmigrating juvenile salmonids (described in Section 3.2.1).

The potential for entrapment and/or stranding on tributary floodplain habitat ($H_{TribFP5}$) after hydraulic connectivity with the mainstem has ceased also requires some empirical observation of juvenile salmon in these areas, and this can be done with snorkel or seining surveys.

Table 4. Overview of approaches for assessing juvenile salmon habitat use and densities across tributaries.

Tributary	Survey Type	Metric	Habitat Types Sampled	Data Availability
Upper Sacramento	Snorkel	Juvenile salmon density (#/reach)	All in-channel habitats (pool, riffle, side channels). Floodplains not sampled.	*Information is Pending*
Upper Sacramento – Battle Creek	Snorkel	Juvenile salmon density (#/reach)	All in-channel habitats (pool, riffle, side channels). Floodplains not sampled.	*Information is Pending*
Upper Sacramento – Clear Creek	Snorkel	Juvenile salmon density (#/reach)	All in-channel habitats (pool, riffle, side channels). Floodplains not sampled.	*Information is Pending*
Feather	*Information is Pending*	*Information is Pending*	*Information is Pending*	*Information is Pending*
Yuba	Snorkel	Presence/absence, habitat use, density (#/reach)	All in-channel habitats (pool, riffle, side channels). Floodplains not sampled.	Upon request
American	Snorkel, seine, video	Juvenile salmon density (#/reach), behavior (from video)	All in-channel habitats, (pool, riffle, side channels). Floodplains at selected locations.	Upon request as well as some published data (Sellheim et al. 2016; Merz et al. 2019; Sellheim et al. 2020)
Mokelumne	Seine, backpack electrofishing	Presence/absence, fish condition	All in-channel habitats and floodplains when inundated	Upon request
Putah	Snorkel, seine, hydroacoustic tags	Juvenile salmon density (snorkel), species diversity (seine), mortality by reach and fish passage (hydroacoustic tags)	All in-channel habitats (pool, riffle, side channels). Floodplains not sampled but covered in fish movements from hydroacoustic tracking	Publicly available technical reports posted online (LPCCC Important Documents – scwa2.com)
Tuolumne	Snorkel	Presence/absence, relative abundance	All in-channel habitats, (pool, riffle, side channels). Floodplains at selected locations.	Publicly available technical reports posted online.

3.1.1.4 Adult salmon use of spawning habitat (H_{S2}).

Redd surveys, in which spawning areas are visually observed for the presence of redds, are the preferred way of collecting information on redd densities. Redd surveys are conducted on the American River, Upper Sacramento River systems (both Clear Creek and Battle Creek), Mokelumne and Yuba rivers. However, redd surveys are not currently conducted in the Feather River or in Putah Creek. Where spawning habitat enhancements are planned as part of the VA commitments (Sacramento River, American, Feather, Tuolumne, and Putah), redd surveys should be included as part of the project-specific science and monitoring plan.

If appropriate, redd surveys or other visual observations of adult anadromous fishes should be considered above fish passage improvement projects to assess species utilization and increased access to habitat that is upstream of locations that previously proved problematic for fish passage (H_{Pass2}).

3.1.2 Monitoring Needed for Bypass enhancements for floodplain habitat

3.1.2.1 Modeling bypass floodplain acreage and frequency of inundation ($H_{BypassFP4}$)

Evaluating changes in the acreage of floodplain habitat provided on Bypasses on the Sacramento River system requires hydraulic and hydrologic modeling that estimates the timing, frequency, extent, and duration of inundation over varying hydrological conditions and infrastructure scenarios (e.g., across alternatives for fish passage structures). For example, the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project, underway by DWR and USBR for the 2009 NMFS Biological Opinion for the Central Valley Project and DWR used hydraulic modeling for the Environmental Impact Statement and Report (USBR and DWR 2019), and can be used as a baseline for evaluating changes in floodplain acreage and frequency of inundation. A similar baseline model is currently under development for the Sutter Bypass and Butte Sink as part of the Floodplains Reimagined Program (https://floodplainsreimagined.org).

3.1.2.2 Measuring ecological connectivity between floodplain bypasses and river mainstem ($H_{BypassFP5-7}$)

In addition to evaluating the inundation footprint, frequency, and duration in the bypasses it is also necessary to monitor whether the increased area of inundation translates into ecological connectivity, which includes the ability of fish to volitionally access the floodplain habitat and emigrate from it to re-join the mainstem for outmigration, as well as transport of secondary production from bypass floodplains to the mainstem (Flosi et al. 2009). Important indicators of ecological connectivity are whether floodplain enhancement actions increase utilization of the bypass system by juvenile fishes and allow upstream passage of adult anadromous fishes. Monitoring of juvenile access to the floodplain requires a combination of acoustic tagging to track entrainment of juveniles through weir notches, as well as simulating entrainment through modeling approaches, such as the Critical Streakline Analysis and Eulerian–Lagrangian–agent method (ELAM, Goodwin et al. 2006). To assess juvenile salmon utilization of and egress from the bypasses, monitoring the population exiting the bypass is needed (e.g., using a rotary screw trap) as well as beach seine surveys to estimate numbers of stranded fish. Stranding surveys may be particularly necessary near artificial structures because evidence shows that juvenile salmon generally increase emigration rates from the Yolo Bypass during natural drainage periods (Takata et al. 2017), but are vulnerable to entrapment in stilling basins or artificial pools created by weirs or other structures (Sommer et al. 2005).

Tracking passage of adult anadromous fishes should include sonar imagery (e.g., using acoustic cameras such as the Dual Frequency Identification Sonar (DIDSON) camera, or the Adaptive Resolution Imaging Sonar (ARIS) technology) at fish passage structures. Concurrent with imagery, water depth, velocity, and temperature should be monitored at weir structures to assess conditions and compliance with passage criteria for anadromous fishes (NMFS 2023).

During periods of inundation, utilization of bypass floodplains by native fishes needs to be assessed through regular monitoring in a balanced design across the inundated area. Given that increased productivity and elevated densities of invertebrate taxa in floodplains relative to mainstem reaches are well-established in the scientific literature, the outcome of floodplain enhancement projects for food webs is not included in VA hypotheses. However, both fish species composition and invertebrate densities has been regularly monitored by the DWR Yolo Bypass Fish Monitoring Program since 1998 (https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs/Yolo-Bypass). As floodplain enhancement projects proceed in the Sutter Bypass, the Yolo Bypass Monitoring Program can serve as a model for designing a comparable monitoring program.

3.1.3 Monitoring Needed for Tidal Wetland Restoration (H_{TW1-5})

Evaluating the Local Tier hypotheses for tidal wetland restoration actions requires three general types of assessment, monitoring, or experimental approaches to acquiring information: (1) ability to accurately model habitat area according to according to physical habitat criteria of water velocity and inundation level by tidal stage; (2) community composition and densities of zooplankton, benthic, and epiphytic invertebrate and fishes along with abiotic covariates (i.e. water quality parameters) in tidal wetland restoration areas and reference sites; and (3) biological covariates (cyanoHABs, invasive aquatic vegetation, predator densities and predation risk) in tidal wetland restoration sites and their vicinities.

3.1.3.1 Modeling Tidal Wetland Habitat Area (H_{TW1}).

Estimating the total area of tidal wetland habitat requires a multi-dimensional modeling approach that uses an updated bathymetry layer and can simulate flow conditions with consideration of water project operations, and that has geographic boundaries encompassing the Suisun Marsh, confluence area including Sherman Lake, and the Cache Slough Complex. Modeling of habitat acreage may use the same Resource Management Associates (RMA) Bay-Delta model, which has a 2-D depth-averaged approximation of salinity and was used in the 2023 Draft Scientific Basis Report Supplement (SWRCB 2023) to represent tidal wetlands (Figure 5-4 in SWRCB 2023). An alternate open source 3-dimensional model for estimating acreage is SCHISM (Semi-implicit Hydroscience Integrated System Model, Zhang and Baptista 2008; Zhang et al. 2016), which can be used for estimating the area of tidal wetlands with specific biological and physical characteristics across varying hydrological conditions. SCHISM has been validated for the San Francisco Bay-Delta (Chao et al. 2017). Both models use inputs on water operations from CALSIM or SACWAM.

This modeling approach can be used iteratively to assess change in modeled habitat area. Additional bathymetric data will need to be collected after tidal wetland to update the elevations for the RMA Bay-Delta model.

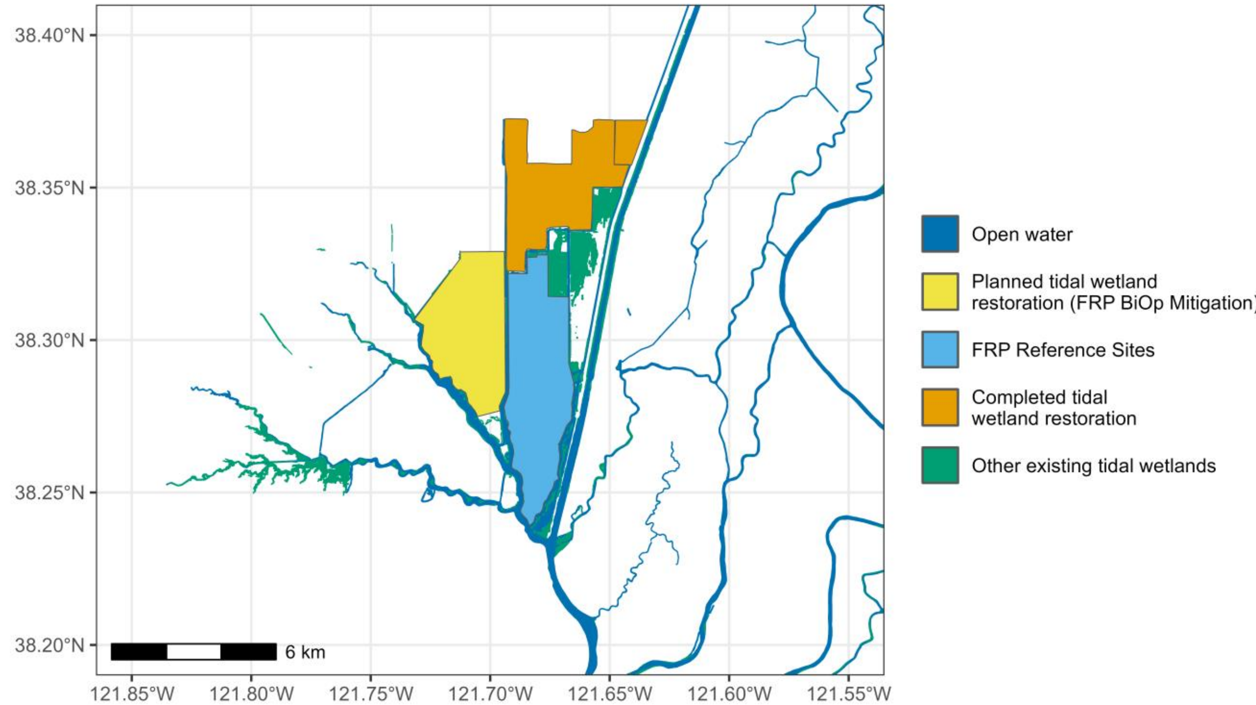
Multi-dimensional modeling approaches also allow for assessing habitat suitability for target species (MacWilliams et al. 2016). The RMA Bay-Delta Model can simulate specific conductivity as a surrogate for salinity, turbidity, and temperature, which are all covariates that inform suitability of habitat for longfin smelt, Delta smelt, and juvenile salmonids.

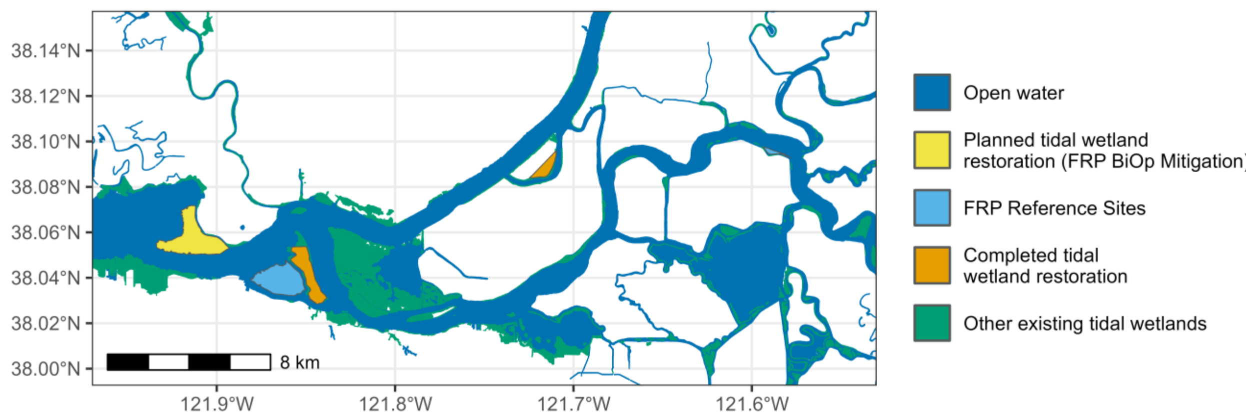
3.1.3.2 Community composition and densities of invertebrates (zooplankton, benthic and epibenthic invertebrates) and fishes along with covariates in tidal wetlands (H_{TW2}, H_{TW3}, H_{TW4}, H_{TW5}).

To evaluate these hypotheses, composition and densities of zooplankton, benthic invertebrates, and epiphytic invertebrates will be sampled in tidal wetland restoration sites and in the surrounding area within the tidal range of the project before and after the restoration occurs, as well as at reference locations. Benthic macroinvertebrate monitoring includes assessment of introduced clams, which can reduce densities of beneficial zooplankton taxa through filter-feeding. The fish community composition must also be sampled at restoration sites, ideally before and after restoration occurs and at reference sites, to determine if restored areas are being utilized by a native fish assemblage. The Fish Restoration Program (FRP) has been sampling the tidal wetlands of the Delta and Suisun Marsh since 2015 and the program is guided by conceptual models (Sherman et al. 2017) and a monitoring framework (IEP TWM PWT 2017).

The FRP monitoring framework uses a Before-After-Control-Impact (BACI) design to assess how newly restored tidal wetland sites function compared to pre-restoration conditions and compared to other, pre-existing wetlands (reference sites). Because of the annual variability in hydrology and climate in the region, multiple years of data are required to detect changes. The FRP monitoring is focused on the Northern and Western (confluence) regions of the Delta and Suisun Marsh (Figure 3). Sampling for zooplankton and invertebrates is conducted in a semi-random fashion at FRP sites and can be compared to sampling conducted as part of other routine monitoring programs in other regions and habitats, such as open-water areas. The fish community is also sampled, following the same design, along with water quality parameters including water temperature, specific conductivity, pH, and turbidity. The FRP also conducts visual assessments for *Microcystis* spp. following a standard protocol for scoring severity (Flynn et al. 2022).

At this time, tidal wetland restoration sites proposed for the VAs are not part of the FRP sampling, though some FRP sites may be useful as reference sites. Adding VA tidal wetland restoration sites to the program would require additional resources to implement FRP standardized sampling and reporting of relevant data, using the existing monitoring framework (IEP TWM PWT 2017).


38.40°N
38.35°N
38.30°N
38.25°N
38.20°N
6 km
121.85°W
121.80°W
121.75°W
121.70°W
121.65°W
121.60°W
121.55°W
Open water
Planned tidal wetland restoration (FRP BiOp Mitigation)
FRP Reference Sites
Completed tidal wetland restoration
Other existing tidal wetlands


38.14°N
38.12°N
38.10°N
38.08°N
38.06°N
38.04°N
38.02°N
38.00°N
8 km
121.9°W
121.8°W
121.7°W
121.6°W
Open water
Planned tidal wetland restoration (FRP BiOp Mitigation)
FRP Reference Sites
Completed tidal wetland restoration
Other existing tidal wetlands

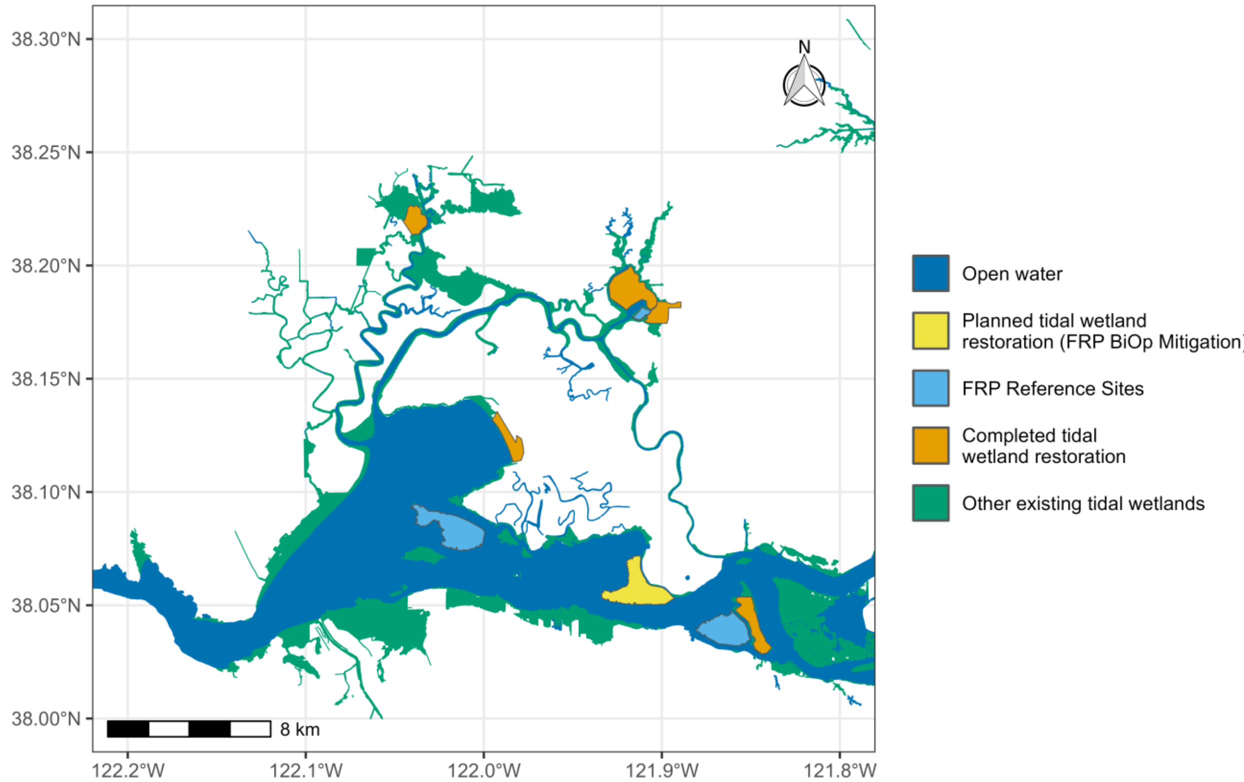


Figure 3. Sampling regions for the CDFW Fish Restoration Program. Reference sites are existing tidal wetland restoration areas in the North Delta (top), Confluence area (middle), and Suisun Marsh (bottom). The program samples for zooplankton, benthic macroinvertebrates, epiphytic invertebrates, and fish at reference sites, completed restoration sites, and in sites planned for tidal wetland restoration as part of the State Water Project's mitigation requirements in the 2019 Biological Opinion.

To compare densities and community compositions of invertebrates and fishes, it is necessary to have concurrent sampling in adjacent pelagic habitats for comparison purposes. VA hypotheses regarding invertebrates and fishes require evaluation of the full tidal footprint of tidal wetland habitat restoration sites, which may include pelagic areas. Long-term monitoring surveys operated by the USFWS, CDFW, and DWR have collected data on zooplankton and benthic invertebrates (Figure 4) and fishes (Figure 5) in these habitats for multiple decades over the entire region, and data from these surveys can be used for comparison of tidal wetland assemblages with adjacent pelagic areas (as approached in Hartman et al. 2022a). A full description of each survey can be obtained at the Interagency Ecological Program website (https://iep.ca.gov/Science-Synthesis-Service/Monitoring-Programs).

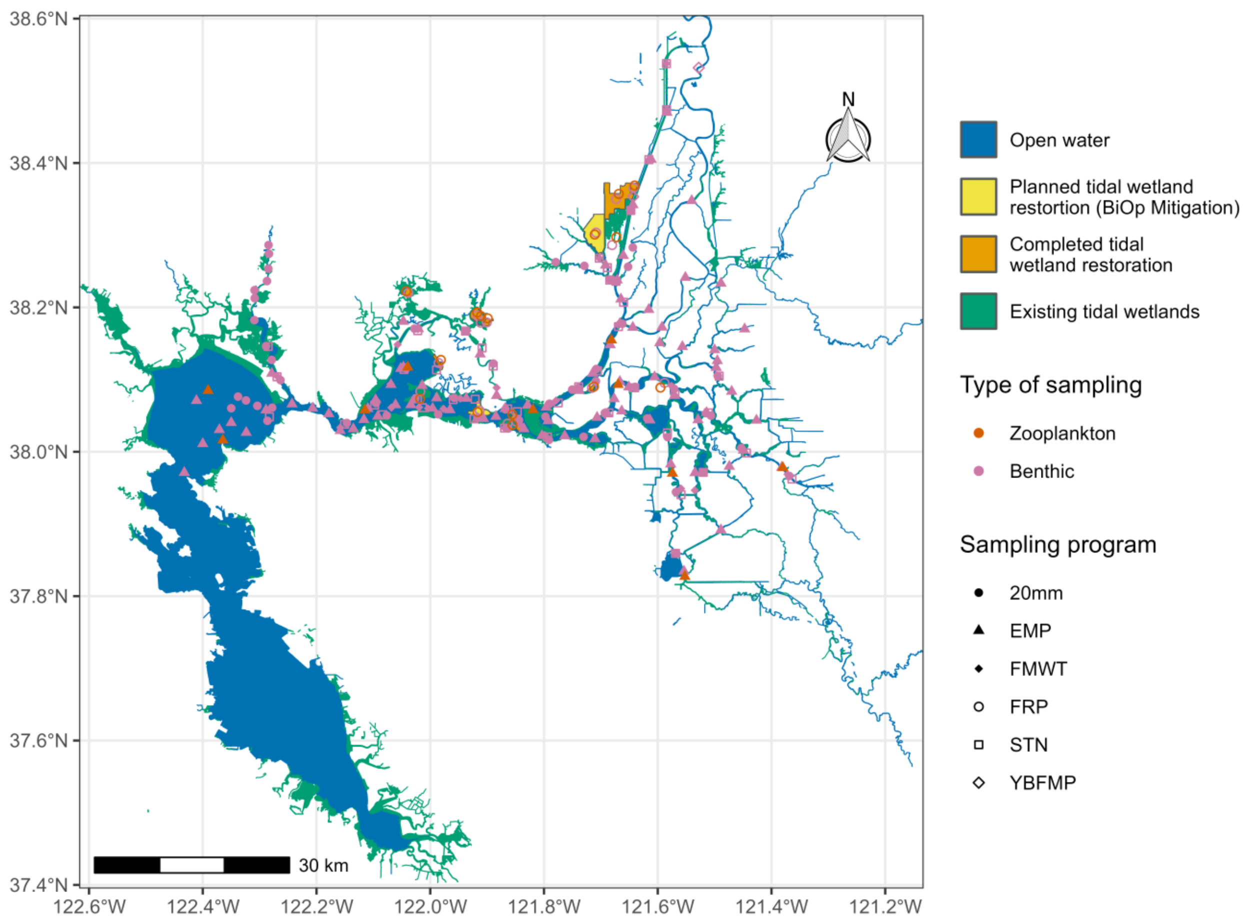


Figure 4. Long-term monitoring surveys collecting benthic invertebrate and zooplankton samples in both tidal wetland and pelagic habitats. 20mm = 20mm Survey, EMP = Environmental Monitoring Program, FMWT = Fall Midwater Trawl, FRP = Fish Restoration Program, STN = Summer Townet Survey, YBFMP = Yolo Bypass Fish Monitoring Program.

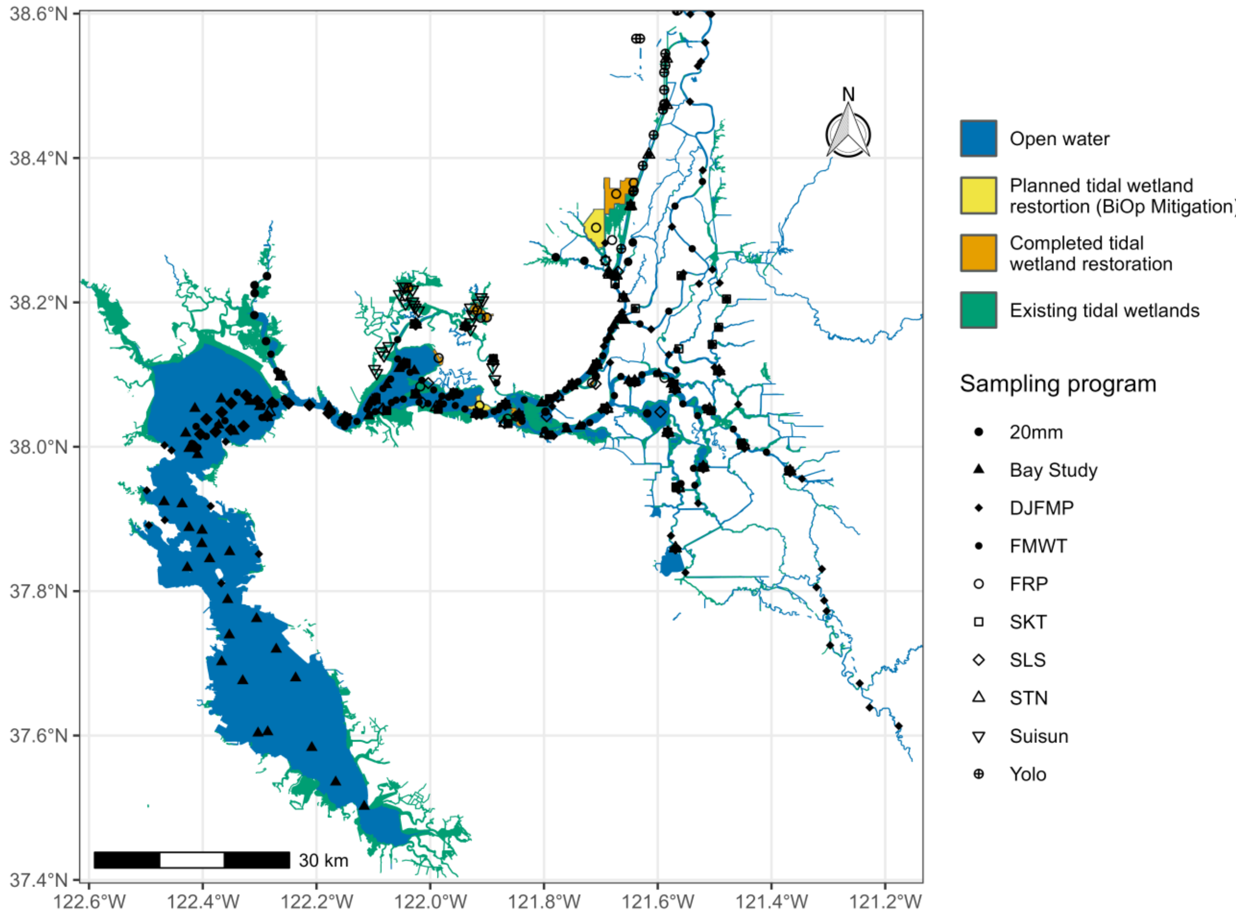


Figure 5. Long-term monitoring surveys collecting fish assemblage and density data through trawling and seining in both tidal wetland and pelagic habitats. 20mm = 20mm Survey, DJFMP = Delta Juvenile Fish Monitoring Program, FMWT = Fall Midwater Trawl, FRP = Fish Restoration Program, SKT = Spring Kodiak Trawl, SLS = Smelt Larval Survey, STN = Summer Townet Survey, Suisun = UC Davis Suisun Marsh Survey, Yolo = Yolo Bypass Fish Monitoring Program.

3.1.3.3 Biological Covariates for Aquatic Vegetation and Predators

Coverage of aquatic vegetation at restoration sites (Covariate for H_{TW5}). Monitoring of aquatic vegetation is conducted via remote sensing techniques (aerial or satellite methods) to capture imagery over a broad region and then classify the imagery to determine the coverage of emergent, floating, and submerged plant communities. Remote sensing techniques require matching field data to train classification algorithms. Field-based surveys using acoustic doppler techniques or manual sampling of the vegetation can cover smaller areas and get more detailed coverage information while also getting species-specific data for submerged species (Khanna et al. 2018). In the Delta and Suisun Marsh, maps based on remote sensing techniques have been produced for the full region or sub-regions in most years since 2003, except for 2009 - 2013 (Figure 6, Table 5).

Capture of regional trends of changes in aquatic vegetation coverage and community composition is important for understanding how the full system is changing and how vegetation responds to variation in hydrology and climate conditions. These broad regional changes influence site-specific changes that are relevant to the outcomes of tidal wetland restoration projects planned for the VAs. However, at a site-specific scale to capture coverage of aquatic vegetation and detect specific plant communities, drones offer a cost-effective approach for capturing high-resolution imagery and can feasibly be done multiple times per year to assess seasonal changes to vegetation (Bolch et al. 2021).

Most of the mapping work for aquatic vegetation in the Delta and Suisun Marsh has been done at the regional scale (Figure 6) and there are relatively few studies that have examined patterns at a more localized scale, such as the project scale of the tidal wetland restoration sites.

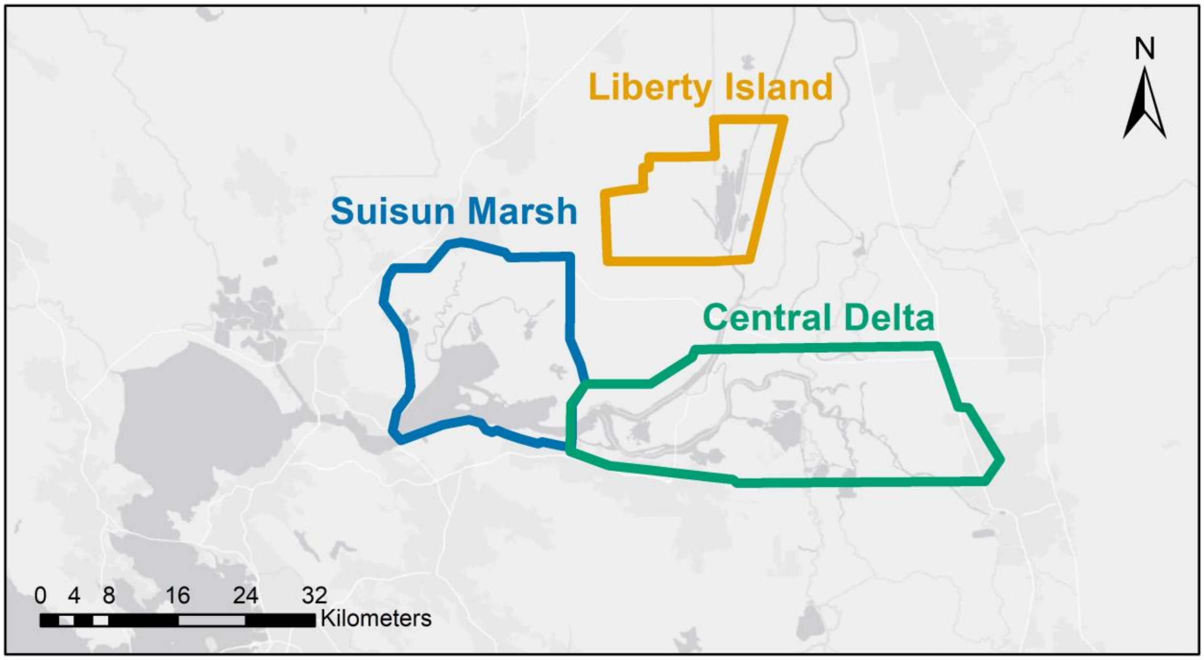


Figure 6. Map of Delta and Suisun Marsh, with delineations of regions that have been consistently mapped in year 2003 – 2008 and 2014 – 2022 (2023 mapping is anticipated, not complete). These regions are referenced in Table 5.

Table 5. History of imagery capture for aquatic vegetation mapping 2003 – 2023. The sensor type has changed over time with the availability of new sensors that can produce finer levels of spatial resolution (pixel size). Image extent corresponds to the above map of Delta regions.

Year	Image acquisition date	Sensor	Pixel Size	Image extent
2003	Jul 1	HyMap	3.0m	Central Delta (narrow) + Suisun (only grizzly island)
2004	Jun 25 – Jul 7	HyMap	3.0m	Full Delta
2005	Jun 22 – Jul 8	HyMap	3.0m	Full Delta
2006	Jun 21 – 26	HyMap	3.0m	Full Delta
2007	Jun 19 – 21	HyMap	3.0m	Full Delta
2008	Jun 29 – Jul 07	HyMap	3.0m	Liberty island to S. Delta
2014	Nov 14-25	AVIRIS-ng	2.5m	Full Delta
2015	Sep 17-21	AVIRIS-ng	2.5m	Full Delta
2016	Oct 8-9	AVIRIS-ng	2.5m	Liberty island, central Delta
2017	Nov 1	AVIRIS-ng	2.5m	Liberty island, central Delta
2018	Oct 6-9	HyMap	1.7m	Liberty island to Lost slough, central Delta, Suisun
2019	Apr 9-12	HyMap	1.7m	Liberty island to Lost slough, central Delta, Suisun
2019	Sep 23-28	HyMap	1.7m	Full Delta
2020	Jul 15-18	Fenix	2.0m	Full Delta
2021	Jul 8-28; Aug 11	Fenix	2.0m	Full Delta + Suisun
2022	Jul 14-18	Fenix	2.0m	Full Delta + Suisun
2023	Aug expected	AVIRIS-3	2.0m	Full Delta + Suisun

Predator densities at tidal wetland restoration sites (Covariate for H_{TW5}). Little spatially-explicit data is available for large-bodied fishes that might provide baseline data for predator densities at tidal wetland restoration sites. The CDFW Striped Bass Study (no longer active, Striped Bass Study (ca.gov)) was an ongoing study since 1969 that used fyke nets to capture, tag, measure, and assess the sex ratio of striped bass in the Sacramento River near Knights Landing, with the most recent field season occurring in 2019 (Danos et al. 2020). This study provides information regarding relative abundance across years but is not useful for assessing predator dynamics at specific locations. Electrofishing is another method for capturing large fish that is spatially explicit and the USFWS, in collaboration with the USGS, has operated a boat electrofishing survey since 2018, using a stratified random sampling design to estimate spatial and temporal trends in species abundance and capture probabilities across littoral habitats in the Delta (McKenzie et al. 2022). This survey may produce data that could be used to model occupancy likelihood for predator species of interest in tidal wetland habitats.

Understanding local densities of predators and their behavior in tidal wetlands is a challenging task because of high spatial and temporal complexity over the tidal cycle, requiring tool development to sample predator movements and relate predation risk to microhabitats. Focused sampling efforts on predators in tidal wetland habitats and adjacent areas have already been producing valuable information on predator densities and predator diets to understand the interaction between predator and prey populations within the complex habitat mosaic of tidal wetlands (Colombano et al. 2021; Young et al. 2022). However, recent studies from other systems have used acoustic cameras such as the Dual Frequency Identification Sonar (DIDSON) camera to assess the species assemblage of predators and their movements at entry/exit points of tidal wetlands (Boswell et al. 2019; Bennett et al. 2021). Because the technology is sonar based, it has been effective even in turbid environments. The DIDSON technology, along with a more recent innovation called Adaptive Resolution Imaging Sonar (ARIS), has been used for similar applications in North Delta tidal wetlands (D. Ayers, USGS and UC Davis, pers. comm.).

In addition to predator diets and sonar imaging, tethered prey stationed across habitat types using Predation Event Recording Systems (PERS, Demetras et al. 2016) has also been used in the Delta to quantify relative predation risk (Michel et al. 2020) and can be applied to tidal wetland habitats as well.

To address the potential for predators to occupy tidal wetlands and use the newly created habitat as a foraging opportunity will require continued special studies at VA tidal wetland restoration sites. These studies will utilize recent technologies of sonar imaging, PERS, and diet analyses that may leverage from genetic approaches for a full characterization of the species assemblage in predator diets.

3.2 Monitoring Needed for Full Tributary and Delta Tier of Hypotheses

3.2.1 Juvenile Salmon Outmigration Survival, Productivity, Condition, and Diversity ($H_{TribFlow2}$, $H_{TribFlow3}$, $H_{TribWide1}$, $H_{TribWide2}$, $H_{TribWide3}$)

Many of the hypotheses at the Full Tributary Tier require an assessment of the juvenile salmon population exiting each tributary. Rotary screw traps (RSTs), which are anchored at a specific location and designed to capture a portion of the fishes traveling downstream with a rotating, screened cone leading to a live collection box, are a common method for capturing a portion of the outmigrant population to assess timing of outmigration, body size, and abundance. If batches of tagged fish are released as part of an assessment of the juvenile salmon response to pulse flows, capture at the RST can provide data on travel time, survival, and outmigration rate. However, it is necessary to have estimates of RST efficiency to estimate the proportion of the population being captured and in turn overall abundance. Trap efficiency estimates are obtained through a mark-recapture approach in which marked fish of a similar size as outmigrating fish (typically hatchery fish) are released above the trap, and the number of marked fish re-captured in the trap provides the efficiency estimate. Efficiency is affected by flow rates, size and life stage of fish, debris load on the trap, turbidity, wings or other infrastructure on the trap to guide water and fish toward the cone, time of day, and trap noise (Volkhardt et al. 2007). Because the factors that affect trap efficiency are dynamic, trap efficiency experiments need to be frequent and use large release groups (> 100 fish). High trap efficiencies are necessary for the precision of the abundance estimate of outmigrating juvenile salmon (Newcomb and Coon 2001), which is an essential annual data point for each VA tributary in assessing population trends.

As RST capture efficiencies increase, juvenile abundance estimates improve in precision. At minimum, capture efficiencies should be 5% in order to carry out a mark-recapture approach to trap efficiency estimation (Newcomb and Coon 2001; Willete and Templin 2013). Efficiency estimates should be carried out multiple times per trapping season to adequately inform models for juvenile abundance, and covariate information (e.g., river discharge, turbidity), should also be recorded to inform statistical models of abundance. Supportive trap infrastructure for safe operation under higher flow conditions (debris booms, anchors, etc.) is also essential and can improve efficiency.

Each VA tributary system operates at least one RST in its lower reaches. The locations and summary of the information gathered at each RST monitoring station is provided in Figure 7. The Upper Sacramento system has an RST at Red Bluff Diversion Dam, and two tributaries to the Upper Sacramento (Upper and Lower Clear Creek, and Battle Creek) also operate their own RSTs such that it may be possible to distinguish population contributions from each of these secondary systems. Some systems operate 2 or 3 RSTs in tandem to cover a greater proportion of the channel width (Red Bluff Diversion Dam, Feather, Yuba, Mokelumne, American, Tuolumne). Additional RSTs (not shown in Figure 7) are located in the lower Sacramento River at Knights Landing and Tisdale Weir, as well as in the perennial Tule Canal of the lower Yolo Bypass.

An overview of the RST methodologies across tributaries reveals variation in efficiency and juvenile abundance estimations. While trap efficiency for fry is obtained for nearly all RST monitoring stations (with the exception of Putah Creek, future evaluation is planned), estimates for the American, Tuolumne River, and all RSTs on the Upper Sacramento River conducted fewer than 10 efficiency trials per year, while other systems are conduct up to 30 trials per year. Only the Mokelumne and American River report fry trap efficiencies of >5%, with the majority of others estimating their efficiency to be in the range of 2-5%. Older juveniles (>65mm), for which trap efficiency is likely to be lower because of their increased ability to avoid the trap, is estimated at a smaller subset of RST monitoring stations, and missing at Putah Creek, Yuba River, and Feather River. Finally, statistical models that utilize the efficiency trial data to produce abundance estimates are not available for all systems (missing for the Feather, Yuba, Mokelumne, Putah, and Clear and Battle Creeks). Where an efficiency model is available (for the American, Tuolumne, Red Bluff Diversion Dam), different covariates are used, revealing that statistical approaches for using RST information vary in addition to field methodologies.

In addition to population abundance information, RSTs also present an opportunity to characterize the juvenile salmon because the fish need to be handled and processed before being released. Body length and weight can be measured, thus providing fish condition information ($H_{TribWide2}$). Tissue samples may also be collected and used for genetic run assignment or other genetic diversity information. All RST stations collect body length data from all or a subsample of juvenile salmonids, but body weight is logistically challenging in the field and only collected routinely at RSTs on the American, Mokelumne, and Tuolumne Rivers as well as Putah Creek (Figure 7). The Yuba, American, and Tuolumne River RSTs collect tissue samples routinely from a subsample of the captured salmonids, and the other RSTs can collect tissues samples if requested. Finally, as RSTs capture other species besides salmonids, they also present an opportunity to characterize general community composition of fishes in each system, though trap efficiencies are variable across species and not measured. All RSTs on VA systems record information on non-salmonids.

In summary, RST monitoring stations on VA tributaries are positioned to provide the necessary information for evaluating hypotheses regarding flow pulse events and trends in juvenile salmon abundance and life history diversity. However, significant attention and changes to current protocols are required to achieve consistency and improved information from all stations. Specifically, RSTs need consistent methodologies and increased effort for fry RST efficiency estimation, increased effort for estimating RST efficiencies for larger juveniles, and consistent methodologies for statistical approaches to processing efficiency and trap data to estimate abundance. Furthermore, as shown in Figure 7, RST monitoring stations are not consistently posting data to public data repositories. This step is essential to data management for the VA Science Program and facilitates efficient synthesis of information for VA reporting.

Figure 7. Locations and information summaries for Rotary Screw Traps (RSTs) on Voluntary Agreement tributaries to the Bay-Delta. The "upon request" symbol is used where juvenile salmon body mass data is collected only when requested, and when RST data are not available online and must be requested from survey leads.

3.2.2 Monitoring Needed for Increased Spring Delta Outflow

3.2.2.1 Modeling Habitat area ($H_{Deltaflow1}$)

The hypothesis for acreage of appropriate spawning and larval rearing habitat for Delta Smelt and longfin Smelt will use the network of existing monitoring stations to parameterize models of appropriate salinity, temperature, and turbidity to map total acreage of suitable habitat using the methods described in the 2023 Draft Scientific Basis Report (SWRCB 2023). Data for parameterizing these models may come from discrete water quality data collection taken as part of routine surveys for water quality, fish, and invertebrates (Figure 4, Figure 5), as well as the extensive network of in-situ water quality sondes maintained by USGS and DWR (Figure 8). Models of habitat acreage may use the same RMA model used by the 2023 Draft Scientific Basis Report (SWRCB 2023), or other 3-dimensional hydrodynamic models, if appropriate. For example, SCHISM (Semi-implicit Hydroscience Integrated System Model) is an open-source, 3-dimensional modeling system (Zhang and Baptista 2008; Zhang et al. 2016) that can be used for estimating the area of habitat with specific suitability criteria across varying hydrological conditions, and has been validated for the San Francisco Bay-Delta (Chao et al. 2017).

Notably, water quality and flow monitoring stations (Figure 8) will provide important covariate data for many of the hypotheses regarding restored tidal wetlands in the Delta and Suisun Marsh, and increased Delta outflow. Flow sensors can be used to parameterize hydrodynamic models such as DAYFLOW (https://data.cnra.ca.gov/dataset/dayflow), or to directly assess flows through particular regions of the Delta.

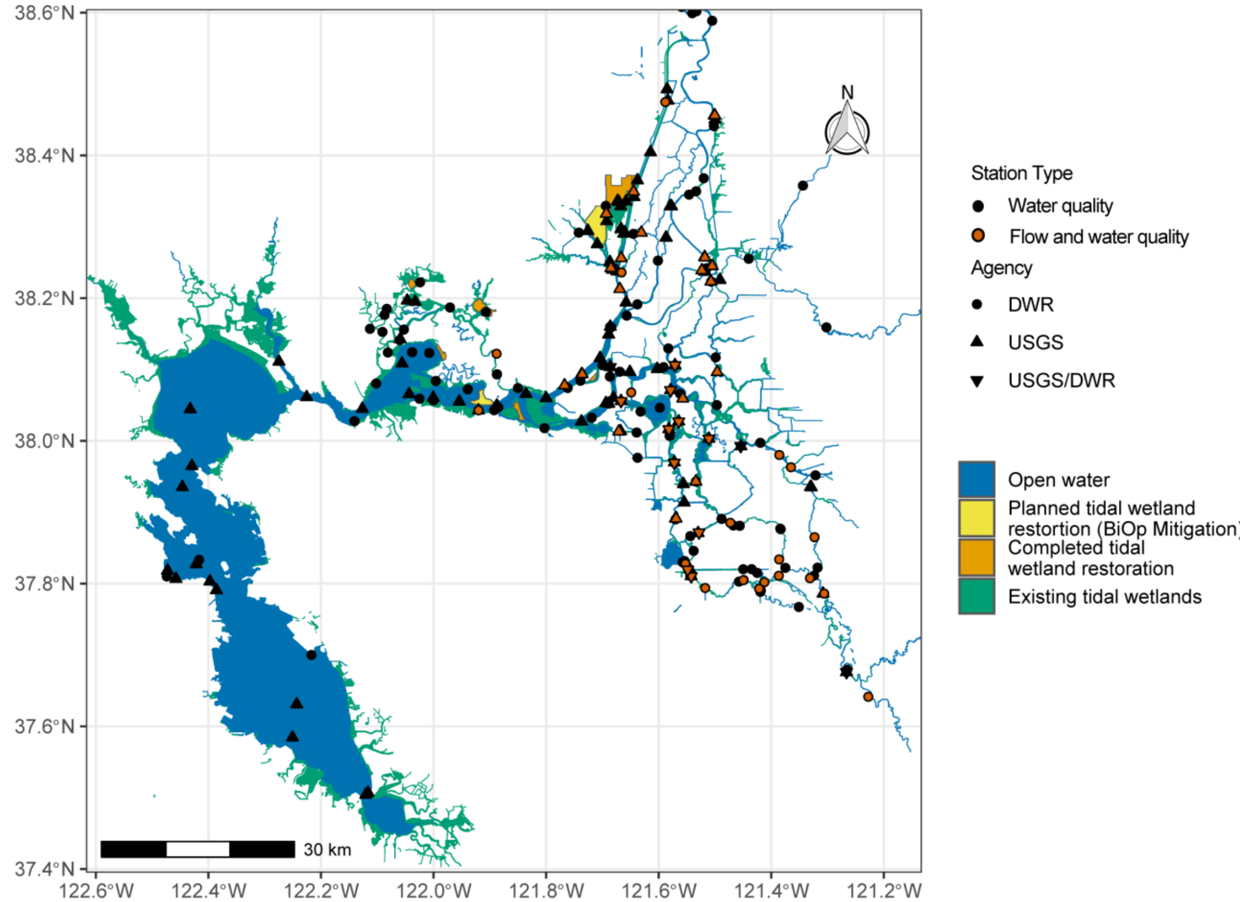


Figure 8. Map of in-situ flow and water quality stations in the Delta. The stations indicated above are installed on site and collect data at regular intervals (e.g., 15 min, 1 hour) throughout the day and night. Many stations are telemetered such that the data can be accessed in real-time, typically on the California Data Exchange Center (CDEC, California Data Exchange Center). Point color denotes flow (red) and water quality (black).

Other water quality and biological parameters that may effect ecosystem processes, such as phytoplankton biomass, temperature, turbidity, and dissolved oxygen are monitored through the discrete values recorded by long-term monitoring surveys (Figure 4, Figure 5), and the network of continuous water quality sondes.

3.2.2.2 Monitoring and Modeling Transport and entrainment of fish ($H_{DeltaFlow2, 3}$)

The hypothesis for transport and entrainment of larval and juvenile longfin smelt, Delta Smelt, and Chinook salmon will rely on the expanded Enhanced Delta Smelt Monitoring Survey, Smelt Larval Survey and 20mm Survey (Figure 5). Rates of entrainment of juvenile salmon will use data collected by the fish salvage facilities, which are expanded for estimated entrainment. In addition, the expanded Smelt Larval Survey for the Longfin Smelt Science Program conducted for the 2020 Incidental Take Permit for the State Water Project, issued by CDFW to DWR, will provide data to parameterize and validate models of larval entrainment. Other long-term surveys for juvenile and adult smelt and salmon (Figure 5) will assist in parameterizing the Delta Smelt life cycle model and the Longfin Smelt life-cycle model (currently in development as part of the Longfin Smelt Science Program) that will further validate models of larval entrainment.

3.2.2.3 Special studies for assessing effects of increased spring outflow on salmonid survival and habitat use ($H_{DeltaFlow4,5}$)

The hypothesis for survival and travel time for juvenile salmonids through the tidal region of the Delta will require study designs of comparing the survival and travel time of acoustically tagged juvenile salmonids using a study design that allows for targeted examination of these metrics at different levels of Delta outflow. There is an existing network of acoustic telemetry receivers throughout the Delta, available through the Central Valley Enhanced Acoustic Tagging Project (CalFishTrack website: https://oceanview.pfeg.noaa.gov/CalFishTrack/). This network includes receivers at the fish collection facilities in the South Delta near the pumping operations, in the Old and Middle River corridor, the Central Delta, and at the confluence of the Sacramento and San Joaquin Rivers (Chipps Island). This array allows detection of acoustically tagged fish in the tidal regions, including their responses to pulse flows. On the CalFishTrack website, tagged fish can be tracked in real time as they move through the system, along with survival and routing probability.

Similarly, the hypothesis regarding evidence of floodplain rearing will require special studies, but will rely on existing fish surveys to collect biological samples from outmigrating fish (eye lenses, otoliths, Bell-Tilcock et al. 2021) that can be used to assess the prevalence of floodplain rearing. It is anticipated that samples for this analysis will be sourced through the USFWS Delta Juvenile Fish Monitoring Program (DJFMP, Figure 5), which trawls for juvenile salmon and other species at the confluence of the Sacramento and San Joaquin Rivers (Chipps Island Trawl, Speegle et al. 2022). As needed, other special studies can be used to increase sample size when floodplain conditions allow.

3.2.2.4 Monitoring status and trends of sturgeon, zooplankton, and prevalence of cyanoHABs ($H_{DeltaFlow6-8}$)

The hypothesis for increased year class indices of white sturgeon will be assessed through data collected by the San Francisco Bay Study (Figure 5, https://wildlife.ca.gov/Conservation/Delta/Bay-Study). This survey collects monthly otter trawls and midwater trawls throughout the estuary and calculates an annual index of white sturgeon population size (Fish 2010).

The effect of increased flow on zooplankton will also leverage the long-term monitoring (Figure 4): the Environmental Monitoring Program's Zooplankton Survey, the Fall Midwater Trawl, Summer Townet, and 20mm Survey's zooplankton samples and FRP zooplankton sampling. These programs collect zooplankton across the estuary once or twice per month. These data can be used to statistically assess changes in zooplankton abundance with increased spring flows or used to parameterize models of zooplankton transport as per Kimmerer et al. (2018).

The hypothesis for frequency and distribution of cyanoHABs will be evaluated primarily through visual assessments carried out as part of routine fish and water quality surveys (as described by Hartman et al. 2022b). Together, these surveys provide over 800 point samples per summer across the estuary that give a qualitative assessment of relative abundance of *Microcystis* and *Aphanizomenon*, which are two of the most common cyanoHAB taxa in the Delta. These visual assessments are only semi-quantitative, rating the density of *Microcystis* on a scale of 1-5 (Flynn et al. 2022), but can be used to track broad-scale trends in *Microcystis* over time and conditions, including varying temperatures and flow regimes (Hartman et al. 2022b). Some routine monitoring of cyanotoxins is conducted at important locations, such as Big Break Regional Shoreline and State Water Project Facilities which can be used to supplement visual observations, however no regular monitoring for cyanotoxins across the estuary is currently in place.

3.3 Monitoring Needed for Population-level Tier Hypotheses

3.3.1 Adult Chinook Salmon Populations ($H_{TribPop1}$, $H_{TribPop2}$, $H_{TripPop3}$, H_{SWPop1}, H_{SWPop2})

The hypotheses for population level effects for Chinook salmon require tracking the abundance and return rates of natural-origin Chinook adults by tributary and at the system-wide scale (Sacramento and San Joaquin Valleys). As noted above, the Constant Fractional Marking Program provides an estimate of natural-origin fish and hatchery-origin fall run Chinook salmon based on a 25% marking rate. Central Valley recoveries of coded-wire tagged salmon, with estimates for the proportion of the population made up of hatchery-origin fish are summarized annually (most recent report, Letvin et al. 2021).The coded-wire tagging approach allows for all tagged fish to be identified to the source hatchery (and hence tributary), but untagged fish cannot be identified to tributary source without geochemical analysis of otolith samples (Barnett-Johnson et al. 2008), which is labor intensive and expensive. Therefore, increasing the marking rate to 100% would improve accuracy of estimates for natural origin fish and better address the hypotheses regarding tributary and Valley-wide populations of Chinook salmon.

Evaluation of tributary populations of Chinook salmon requires monitoring the escapement, which are the adults that have escaped harvest and successfully migrated to their natal tributary system or straying into a non-natal system. Escapement is monitored using a variety of methods that include direct counts at passage structures, surveys of redds accompanied by fish counts, and by counting carcasses and conducting carcass mark-recapture studies to develop efficiency estimates of the surveys such that a range of potential adult abundances can be calculated. A number of reasons may contribute to the decision to take on a specific approach or combination of approaches for estimating adults, including funding, conditions and feasibility of any given approach, including a suitable location for conducting direct counts.

With carcass surveys, and in some direct counting efforts of live adults, the fish are handled and there may be an opportunity to collect biological samples that can further help characterize the population. Tissue and scale samples can be collected non-lethally and provide information on genetics and age structure for each individual sampled, while otolith and eye lens samples are lethal samples and are usually collected from carcasses. Carcasses can also be examined for fin clips to identify them as hatchery-origin, and heads can be collected for locating coded-wire tags. These measures provide a way to estimate the proportion of the population that is natural-origin.

The VA tributary systems all have monitoring programs in place for adult Chinook salmon and have at least one method for estimating abundance (Table 6). For the purpose of the VA hypotheses on adult salmon, there is not a need to have wholly consistent methods across each tributary system as long as abundance estimates are developed. However, the utility of abundance estimates depends on whether their accuracy is estimated such that the abundance estimate can be framed with an approximation of the level of uncertainty around the abundance number. Additionally, it is important that the abundance estimate include an estimate of the natural-origin adults, because natural-origin Chinook salmon are the target beneficiaries of the VA Program. On the Upper Sacramento, only Battle Creek obtains accuracy estimates (none on mainstem or Clear Creek), reporting a rate of ±50%. The Feather, Yuba, and American Rivers all obtain accuracy estimates (albeit through different methods) and report a general accuracy level of ±10%. Importantly, however, abundance of natural origin adult salmon is not consistently estimated: Putah and the upper Sacramento mainstem examine a relatively small number of carcasses for hatchery marks or tags (<50), while the American, Feather, and Mokelumne Rivers inspect over 500 carcasses. Given that there are existing sampling efforts on all systems, the greatest improvement and utility towards robust evaluation of hypotheses regarding adult Chinook salmon would be investment in estimating and improving accuracy of abundance estimates, with a concerted effort towards estimating abundance specifically of natural-origin salmon.

Tissues, scales, and otolith samples are collected in all systems. Eye lenses, a relatively new type of biological sample used for geochemical analyses, are only collected in Putah Creek (Table 6). A close examination of archived samples for each system may be helpful in determining whether they can be used for retrospective analyses of the proportion of the population that was natural origin or examination of life history characteristics. Such studies may be helpful for establishing a baseline of population attributes for each tributary system.

Table 6. Overview of adult Chinook salmon sampling methods for escapement, with corresponding abundance estimate accuracies, and biological sample collections, by VA tributary system. Biological sampling efforts are represented by "T/O/S/E", indicating presence or absence of **T**issue, **O**tolith, **S**cale, and **E**ye lens collections.

Tributary	Redd Survey (Y/N, Abundance Estimate Accuracy)	Carcass Mark-Recapture (Y/N, Abundance Estimate Accuracy, T/O/S/E samples)	Direct Count via Video (Y/N, Total Abundance Estimate Accuracy, Natural Origin Abundance Accuracy, T/O/S/E samples)
Upper Sacramento: Mainstem	No redd surveys	90% Confidence Interval generated by PSMFC, no accuracy estimate for Carcass Mark Recapture T/O/S/E: Upon Request/Yes/Yes/Upon Request	Direct Counts at individual, smaller tributaries, no accuracy estimate for total or natural origin abundance T/O/S/E: No/No/No/No
Upper Sacramento: Battle Creek	Redd surveys, no abundance estimates	No Accuracy Estimate T/O/S/E: Yes/Yes/Yes/No	(1) Video observations: No accuracy estimate for Chinook salmon total or natural origin abundance. T/O/S/E: No/No/No/No (2) Direct Count (fish are handled): +/- 50% accuracy for both total and natural origin abundance. T/O/S/E: Tissue samples collected for all runs, Otoliths collected for late-fall run, no scale or eye samples collected
Upper Sacramento: Clear Creek	Redd surveys, no abundance estimates	No Accuracy Estimate T/O/S/E: Yes/Yes/Yes/No	Direct counts, no accuracy estimates T/O/S/E: No/No/No/No
Feather River	No redd surveys	+/-10% Accuracy T/O/S/E: Yes/Yes/Yes/No	No Direct Counts
Yuba River	Redd surveys, no abundance estimates	Accuracy estimated, is variable T/O/S/E: Yes/Yes/Yes/No	+/- 10% Accuracy of total abundance, Natural-origin abundance not estimated

Tributary	Redd Survey (Y/N, Abundance Estimate Accuracy)	Carcass Mark-Recapture (Y/N, Abundance Estimate Accuracy, T/O/S/E samples)	Direct Count via Video (Y/N, Total Abundance Estimate Accuracy, Natural Origin Abundance Accuracy, T/O/S/E samples)
			T/O/S/E: No/No/No/No
American River	Redd surveys, +/- 10% accuracy of abundance estimate.	+/-10% Accuracy T/O/S/E: Yes/Yes/Yes/No	No Direct Counts
Mokelumne River	Redd surveys	No Carcass Mark-Recapture	+/- 10% Accuracy of overall abundance and +/- 50% accuracy of natural origin abundance T/O/S/E: Upon Request/Upon Request/Yes/Upon Request
Putah Creek	Redd surveys in subset areas	No Carcass Mark-Recapture	+/- 50% Accuracy for overall abundance, Natural-origin abundance not estimated, but a study is in progress at UC Davis T/O/S/E: Yes/Yes/No/Yes
Tuolumne River	Redd surveys, Abundance estimates from escapement survey or weir counts, no abundance estimates from redd counts	Carcass Mark-Recapture. Abundance estimates with uncertainty using CJS model O/S collected annually, T only for special studies.	T/O/S/E: No/No/No/No

3.3.2 Monitoring Needed for Native Species Communities in the Delta

The metric for this hypothesis is population estimates of starry flounder, Bay shrimp, Sacramento splittail, and longfin smelt, and Delta smelt. Notably, population estimates of these native species are not all currently available, except for Delta smelt through the enhanced Delta smelt monitoring program (EDSM, operated by the USFWS). All species have historically been tracked by the long-term fisheries surveys described in Figure 5, and the annual abundance indices derived from the Fall Midwater Trawl and San Francisco Bay Study conducted by CDFW have been reported for purposes of tracking population trajectories of these species. These indices are correlated with design-based estimators of population abundance (Melwani et al. 2022). In future, developing population abundance estimates for these species may be important in identifying the effectiveness of increased spring outflow, parameterizing life cycle models, and identifying limiting factors for populations (see information gaps, below) which can inform prioritization of habitat and flow investments (see information gaps, below). However, developing population estimates for these species will require rigorous review of existing monitoring programs and how they align with the needs for spatial balance in sampling across the geographic distribution for each species and life stage, as well as review of the gear efficiencies for sampling the target species. This level of effort and analysis to achieve surveys designed for population estimates needs to be evaluated and prioritized along with other monitoring and information gaps for the VA Science Program.

3.4 Priority Monitoring and Information Gaps

The monitoring needs discussed above provide a coarse look at how increased investment in science and monitoring will be needed to develop the VA Science Program to provide all the needed information. Given the comprehensive list of hypotheses and associated monitoring, the VA Science Committee will need to conduct a more detailed examination of information gaps and prioritize which gaps should be given attention first. However, given the monitoring needs discussed above, several high-level gaps have emerged that will be important for the VA Science Program to work toward filling, leading up to and early in the implementation of the VA Program. Each of these gaps has implications for the ability of the VA Science Program to draw broad inferences about the effects of the VA Flow and Non-Flow Measures in support of the Narrative Objectives, and therefore on the ability to adequately inform the State Water Board's assessment process near the end of the term of the VA Program. These gaps include:

- **Ability to differentiate natural-origin and hatchery-origin adults for each tributary**. A primary intention of the suite of VA Flow and Non-Flow Measures is to increase juvenile salmonid production from the tributaries and to increase condition and survival during outmigration. However, the Narrative Salmon Doubling Objective describes desired populations of returning adult salmon populations. Understanding how actions taken with the VA program relate to adult returns, for each tributary system and for the entire Sacramento and San Joaquin Valleys requires an ability to track which returning adults are the product of increased juvenile production and which are the product of hatchery operations. Currently, relative contributions of natural-origin and hatchery-origin Chinook salmon are estimated through the constant fractional marking program because only 25% of hatchery-origin fall-run Chinook salmon are marked (e.g., with fin clips or coded-wire-tags) or are physically identifiable. One of the primary objectives of the constant fractional marking program is to determine the proportions of hatchery- and natural-origin salmon in spawner returns to CV hatcheries and natural areas. To determine the contribution of hatchery- and natural-origin salmon, all *CWT* are summed to estimate the total number of hatchery salmon in each survey. The contribution of natural-origin salmon for each survey can then be determined by subtracting the total number of hatchery salmon from the total escapement estimate (Letvin et al. 2021). Refinement of these estimates could be made through a 100% marking program, but until that program is implemented, the current CFM program provides the best estimates, and is supported by the use of baseline data from 2010, the first year of complete CFM tagged returns, in H_{SWPop1} and H_{SWPop2}. Release of the data summary from this program in a timelier manner would aid in analysis of the VA program.

  Retrospective analyses of otoliths for growth patterns characteristic of natural-origin fish (Barnett-Johnson et al. 2007), and for tributary-specific microchemistry (Barnett-Johnson et al. 2008) provides an approach for identifying natural vs. hatchery origin by tributary, and could provide supporting analyses to address population-level hypotheses for Chinook salmon. However, this approach is labor intensive for sample sizes needed for population-level analyses and without the ability to rapidly identify all hatchery origin salmon as such and to their natal tributary system, hypotheses that relate VA actions at the individual Tributary scale and Systemwide Scale ($H_{TribPop1}$ – $H_{TribPop3}$, H_{SWPop1}, and $H_{SWPop2,}$ respectively) will be difficult to address.

- **Consistency of monitoring approaches across tributaries to support system-level analysis.** As described in Section 1, a primary benefit of the VA Program is the coordination of science across tributaries to better understand the effects of VA measures. Consistency in monitoring approaches to estimate core metrics relevant to the hypotheses will be an important contributor to this broad and synthetic understanding. Consistency in several specific dimensions will need to be improved:

- *Juvenile production estimates*: Rotary Screw Traps (RSTs) are currently used in the tributaries to assess juvenile abundance during outmigration. However, improved consistency across specific points of monitoring protocols is needed in order to provide robust juvenile production estimates, which are critical metrics for each tributary system. Areas of monitoring that need enhancement and increased consistency include whether and how estimates of capture efficiency are made for larger juveniles, rigor of fry efficiency estimates, and the regularity of fish condition assessments.
- *Adult population estimates*: Adult estimates within tributaries are currently conducted using a variety of methods and have varying accuracy across the tributaries (Table 6). In many cases, the accuracy of abundance estimates is not assessed, and fish origin (hatchery or natural origin) is not consistently identified or is not possible to identify given that hatchery-origin fall-run Chinook salmon are only marked at a 25% rate. Identifying ways to standardize approaches and improve accuracy will be an early priority of the VA Science Committee.
- *Invertebrate communities*: Production of benthic invertebrates and zooplankton is not currently assessed in all tributaries (Table 3) and is generally only done for special studies. Standardizing approaches to assess food web processes at the site scale and instituting monitoring to support assessment of broader measures of river and stream health (e.g., invertebrate community indices) will be a priority for the VA Science Committee.

As stated above and in Table 2 - Table 6, VA tributary systems vary in the degree and approach for all categories of data collection for evaluating Local tier, non-flow habitat measures and for developing estimates for both juvenile and adult Chinook salmon life stages, and the adjustments needed to achieve consistent and sufficient information for priority information gaps also varies across tributary systems.

Table 7 provides a summary of the opportunities for investments in the monitoring network within each of the tributaries to provide consistent evaluation of key metrics articulated in metrics table in Section 2.

Table 7. Summary of where changes are needed to obtain consistent information to address VA hypotheses for tributary systems. The symbology in the table is as follows: Teal indicates few or only minimal adjustments required, **yellow** indicates modest changes required, and **orange** indicates significant changes required. (White cells pending input).

	Juvenile Production Estimates	**Adult Population Estimates**	**Tributary Juvenile Habitat Use**	**Tributary Invertebrate Sampling**	**Habitat Mapping**
	Teal *= Both size classes have efficiency estimates and data are online;* ***Yellow*** *= Larger juvenile efficiency estimate missing and/or data are not online;* ***Orange*** *= Efficiency estimates missing for both size classes.*	***Teal*** *= Accuracy estimates exist, including for natural-origin fish;* ***Yellow*** *= Accuracy estimate missing for natural-origin fish;* ***Orange*** *= Accuracy estimates are missing*	***Teal*** *= Habitat use is assessed through regular surveys and density data are produced;* ***Yellow*** *= Juvenile habitat use is assessed only a project-specific basis and/or only presence/absence data are produced;* ***Orange*** *= Very limited or no habitat use surveys occur*	***Teal*** *= Sampling is routine and data are online;* ***Yellow*** *= Sampling is episodic over time and data are not available online;* ***Orange*** *= Limited or no sampling occurs*	***Teal*** *= DEM based on LiDAR with 2D model platform, full cover map is available;* ***Yellow*** *= Cover map or other mapping elements are partial;* ***Orange*** *= Full component of habitat mapping (Table 4) is missing*
Upper Sacramento	[teal]	[yellow]	[teal]	[teal]	[yellow]
Feather	[yellow]	[yellow]	*input pending*	[yellow]	*input pending*
Yuba	[yellow]	[yellow]	[yellow]	[yellow]	[teal]
American	[teal]	[yellow]	[teal]	[yellow]	[teal]
Mokelumne	[teal]	[teal]	[yellow]	[orange]	[teal]
Tuolumne	[yellow]	[yellow]	[teal]	[teal]	[yellow]
Putah	[orange]	[yellow]	[teal]	[yellow]	[teal]

- **Design of population estimates for non-salmonid target species in the Delta.** Population-level hypotheses for responses to the VA Flow and Non-Flow measures in the Delta require population estimates with associated uncertainty estimates for the California Bay shrimp, Sacramento splittail, longfin smelt, and Delta smelt. However, for all species except the Delta smelt, current surveys only provide abundance estimates, and it is not clear whether these estimates are correlated with true population abundance, and they lack uncertainty estimates. To adequately address these information gaps, it will be necessary assess the monitoring network for each species, and determine what measures are needed to develop population estimates (efficiency estimates for current monitoring approaches for each life stage, spatial coverage of monitoring over the species' ranges in the Delta system, and sampling design). Based on detailed examinations of the monitoring networks, the VA Science Committee can recommend necessary steps to evaluating the feasibility of achieving population estimates for these target species.

  Notably, the monitoring network for Delta smelt has already been undergoing this process through a major review, and in 2016 added the Enhanced Delta Smelt survey (eDSM), which samples the subadult and adult Delta smelt population using a stratified randomized design and produced population estimates (McKenzie et al. 2022).

  As part of the SWP 2020 Incidental Take Permit issued to DWR by CDFW in 2020, a Longfin Smelt Science Program is also underway, endeavoring to develop datasets to inform a Life Cycle Model, similar to the models that exist for Delta smelt and Winter-run Chinook salmon and that allow predictive capacity for evaluating climate and management scenarios. The Longfin Smelt Science Program is implementing an expanded Smelt Larval Survey to enhance coverage of the survey in the

Suisun, San Pablo, and San Francisco Bays to better cover the full geographic distribution for the species. This effort along with others of the Longfin Smelt Science Program are advancing the ability to track vital rates (e.g., survival) across life stage transitions for the species and may inform population-level trends for longfin smelt, including spawning success (H_{SWPop4}).

- **Data availability and centralization to support coordinated analysis and reporting.** An important gap in the VA Science Committee's ability to complete triennial synthesis is the availability and storage of data in a centralized location and in consistent formats. In order to position the VA Science Committee to produce synthetic information and to promote the operating guideline of Open and Transparent Data, increasing data centralization through a public data repository will be an early priority of the VA Science Committee.

4 VA Science Committee Reporting and Analysis

4.1 Assessment of Non-Flow Measures

The VAs will result in new Non-flow Measures, including habitat restoration and enhancements, that are intended to contribute to the achievement of the Narrative Objectives, and which will be implemented in specific geographic locations overseen by Tributary/Delta Governance Entities (Tributary/Delta GEs). Coordinated by the VA Science Committee, the Tributary/Delta GEs will conduct accounting and assessments of Non-flow Measures as follows:

- **Accounting for Non-flow Measures** will be conducted to inform the Systemwide Governance Committee and State Water Board on progress relative to the VA Parties' Non-flow Measure commitments as described in the March 2022 VA Term Sheet and applicable amendments, summarized in Table 19 of the Strategic Plan. The Non-flow Measure accounting process is described further in Section 3.1.4 of the Strategic Plan. The specific methodology quantifying the added acreage of new or enhanced habitat and accounting for other non-flow measures such as fish passage will be described in the next draft of the VA Science Plan.
  - **Habitat suitability assessments**, described in Section 4.1.1 of the VA Science Plan, consider habitat suitability design criteria, as well as additional factors (covariates) that may affect species utilization and their ability to feed, grow, avoid predators, and reproduce in the new or enhanced habitat. These covariate suitability metrics are additional to the metrics informing the habitat accounting procedures and often regard water quality (e.g., water temperature). For example, covariate suitability metrics for spawning habitat, in-channel rearing habitat, tributary floodplain habitat, bypass floodplain habitat, and tidal wetland habitat are described in VA Science Plan Hypotheses H_{S1}, H_{R1}, $H_{TribFP1}$, $H_{BypassFP4}$, and H_{TW1}, respectively. The habitat suitability assessment is separate from the habitat accounting method described in Section 3.1.4 of the Strategic Plan because it considers suitability metrics that may not be possible to control through project design but may affect utilization and biological effectiveness. The results of the habitat suitability assessments will be provided in VA Program reports as described in Section 9.4 of the VA Term Sheet as well as the ecological outcomes analysis to be provided prior to Year 7 of the VA Program, as described in Appendix 4 of the VA Term Sheet.
  - **Habitat utilization and biological effectiveness assessments** described in Section 4.1.2 of the VA Science Plan, will be conducted to determine whether target species are using the new or enhanced habitat areas, are exhibiting expected near-term benefits (e.g., improved fish passage, increased growth rate) that can be attributed to the completed habitat action, and whether these measures are achieving or are likely to achieve the anticipated ecological outcomes by creating, restoring, or enhancing the habitat of one or more target species and lifestages. For example, Hypothesis H_{R4} in the VA Science Plan tests whether the new or enhanced rearing habitat for Chinook salmon has higher juvenile salmon densities compared to areas outside of the new or enhanced habitat project locations. The results of the habitat utilization and biological

effectiveness assessments will be provided in VA Program reports as described in Section 9.4 of the VA Term Sheet as well as the ecological outcomes analysis to be provided prior to Year 7 of the VA Program, as described in Appendix 4 of the VA Term Sheet.

This section describes the general methodological framework by which suitability, utilization, and biological effectiveness metrics will be applied to assess the effective suitability and biological effectiveness of habitat enhancement measures, respectively. It is recognized that each Governance Area Entity will build upon this methodological framework to develop detailed assessment protocols tailored to the specific habitat enhancement measures being implemented within their respective governance area. The methodological framework presented below is intended to be applied at the site-specific scale, as well as at the reach and/or tributary scales to enable assessments of total suitable habitat acreage increases over time at the system-specific level (tributary, Bypass, Delta). Results of the site-specific implementation analyses will be summarized for each system.

4.1.1 Methods for Assessing Habitat Suitability

Suitability of a habitat enhancement measure is determined by evaluating conformance with design criteria (e.g., water depth, velocity, substrate, cover), as well as other abiotic factors that may affect species utilization and their ability to feed, grow, avoid predators, and reproduce in the enhanced habitat. Therefore, evaluation of the factors affecting habitat suitability also involves assessment of covariates described for each habitat enhancement action, such as water temperature, dissolved oxygen, or other conditions listed in Table 1.

The VA Science Committee will summarize non-flow measure implementation by system and then over time, examine whether habitat enhancement projects continue to meet suitability criteria (including design criteria and covariate factors affecting suitability). Compiling a summary of the total number of acres of enhanced habitat on a system-specific basis requires quantification of site-specific habitat enhancement measures using the approaches described in the VA Strategic Plan (Section 3.1.4).

The persistence of habitat enhancement sites meeting suitability criteria will be assessed over time. Where site-specific suitability diminishes over time relative to initial implementation, consideration will be given to assessing suitability persistence for the reach in which the habitat enhancement project was implemented. This could be done to explore the phenomenon of spatial “dynamic equilibrium”. For example, gravel placed at a spawning enhancement site could be transported downstream rendering the site less suitable over time, but the downstream area receiving the transported gravel could exhibit new or increased suitability. Site- and/or reach-specific assessments will be conducted by the VA Science Committee periodically during the duration of the VA Program following project construction. The continued assessment of habitat enhancement projects’ ability to meet suitability criteria over time allows evaluation of trends in the persistence of enhancement projects and informs adaptive management considerations for the VA Program.

Covariate data will be collected and reported for expected periods of utilization, assessed for consistency with species- and lifestage-specific suitability indices using published literature, and reported along with implementation summaries, as well as utilization and biological effectiveness assessments for each habitat enhancement project. Covariate data to describe habitat suitability will also be assessed over time to examine changes in suitability across seasons and across years with different hydrological conditions.

4.1.2 Methods for Assessing Habitat Utilization and Biological Effectiveness

Constructed VA habitat enhancement measures will be assessed over time to evaluate whether each project is effective in achieving anticipated biological outcomes. In general, it is assumed that utilization and biological effectiveness assessments will be based primarily on empirical data and observations obtained through monitoring, but may also include simulation modeling.

Triennial reports generated in Year 3 and Year 6 of VA implementation will include updated assessments of utilization and effectiveness as much as possible given their implementation status at the time of reporting. Triennial reports will document status and trends in the utilization of habitat measures and will inform adaptive management of these measures. For the Year 3 and Year 6 triennial reports, the ecological outcomes (i.e., effectiveness) of the VA habitat measures at the local scale will be analyzed using the metrics described in Section 2.2 on Hypotheses, Metrics, and Baselines for Local Tier Hypotheses for Non-flow measures. The synthesis reports will also describe whether continuation of the VAs beyond Year 8 would help improve species abundance, ecosystem conditions, and contribute to meeting the narrative objectives, and use existing and improved life cycle models as appropriate to provide quantitative evaluations of continuing the VA program across a range of hydrological conditions. This synthesis report will inform the SWRCB's evaluation of the VAs and proposed pathway after Year 8, as described in Section 7.4.B of the MOU Term Sheet (Green, Yellow, and Red options).

Utilization metrics focus on whether, and the extent to which, constructed habitats are being used by the target populations and lifestages across the range of design flows. For application to the assessment of VA habitat measures, biological effectiveness refers to how well the constructed habitat is performing in achieving the intended biological outcomes. Utilization and biological effectiveness metrics address biological responses at the site-specific scale and are generally expressed as a rate (e.g., number of individuals per unit area). Inherent variability in initial abundance of annual cohorts (e.g., number of spawning adults, number of juveniles) directly influence the values of the biological response variables (i.e., expected outcomes). For example, redd density in restored spawning sites is dependent on the number of returning adult spawners that, in turn, is dependent on out-of-basin conditions upon which site-specific habitat measures have no bearing. Similarly, the number of juveniles per unit area is directly influenced by the number of spawners and survival from spawning through post-emergent fry. Consequently, pre-project values of biological metrics may have limited utility to serve as a baseline for assessments of site-specific utilization and biological effectiveness. The basis of comparison for the evaluation of utilization metrics will therefore be adjacent, non-enhanced habitat areas, with metrics being measured concurrently at both project sites and comparison locations.

The assessment of biological effectiveness includes consideration of utilization and observed outcomes while accounting for covariates that may affect the biological outcome. As such, utilization and biological effectiveness assessment methods also involve evaluation of the abiotic habitat conditions (e.g., water temperature, dissolved oxygen, described for individual hypotheses above and listed in Table 1) that potentially influence the utilization and/or effectiveness of habitat enhancement measures. Covariate monitoring will determine the frequency and magnitude under which covariate conditions constrain the suitability or effectiveness of constructed habitat enhancement sites across the range of design flows.

4.2 Schedule for Reporting

Consistent with the March 29, 2022 MOU Term Sheet for the VAs, the VA Science Committee will contribute to Annual Reports and Triennial Reports for Years 3 and 6 of VA implementation. Science Committee contributions to these reports will help fulfill requirements of these reports to do the following from Section 9.4.A of the MOU and Term Sheet:

- Inform adaptive management;
- Be technical in nature, identify actions taken, monitoring results, and milestones achieved
- Document status and trends of native fish

VA Science Committee reports and their contents will also inform public workshop proceedings of the SWRCB as well as professional reviews of the scientific rationale for the VAs, such as the Delta Independent Science Board.

4.3 Data Management Plan

The VA Science Committee will produce a detailed data management plan within the first year of adoption of the VA Program. In keeping with the VA Science Committee's participation principle of Transparency and Communication, the data management plan will adopt guiding principles of Findability, Accessibility, Interoperability, and Reusability (FAIR, Wilkinson et al. 2016). Data management plans will also be required to protect the sovereignty of Tribes and not disclose sensitive or confidential information. For projects based on traditional and tribal knowledges, the project team will prepare a data sharing agreement that defines how project results and deliverables will be used, in alignment with the CARE data principles (Collective benefit, Authority to control, Responsibility, and Ethics, (Carroll et al. 2020). As noted above, a priority information gap for the VA Science Committee is data availability and centralization to support coordinated data analysis and reporting. A first step to filling this gap is for individual monitoring efforts (such as rotary screw trapping efforts for juvenile abundance estimation on VA tributaries, Figure 7) to provide their data in an open data repository.

For individual project science and monitoring plans provided to the VA Science Committee, the expectation is that each project will include a data management plan that has components of data and metadata description, plan for backing up and archiving data, explanation of the data format, data quality assurance protocols, and plan for sharing data. This review step will allow the Science Committee to assess how well the project's methodologies will provide data that is interoperable with other data collection efforts for VA flow or non-flow measures. The project's plan for sharing data should explain how the data can be accessed via public platforms such as the Environmental Data Initiative, CEDEN (CEDEN, CEDEN AdvancedQueryTool (ca.gov), California Data Exchange Center (California Data Exchange Center), and the CalFish Track (CalFishTrack (noaa.gov)), or the California Natural Resources Agency Open Data Portal (Welcome - California Natural Resources Agency Open Data).

The VA Science Committee will explore the potential for a data platform that would collectively gather and/or link to data that will be needed to evaluate the hypotheses and metrics for the VA Science Plan (Table 1**Error! Reference source not found.**). This platform would be open to the public and allow for searching and visualization of quality-assured data relevant to flow and non-flow measures of the VA Program.

4.4 Evaluation of Hypotheses for Decision-Making to Inform Adaptive Management

4.4.1 Annual and Triennial Synthesis Reports

The VA Science Committee will contribute to Annual Reports and Triennial Reports for Years 3 and 6 of VA implementation. These reports will provide a synthesis of the evaluated hypotheses at Local (project scale), Full Tributary and Delta tiers. These reports will also contain a summary of observed trends at the population level scale native species, as compared with appropriate baselines (Table 1). Based on Triennial Reports from Years 3 and 6, the VA Science Committee will submit a synthesis report on the scientific data and information generated by the VA Science Program that analyzes the ecological outcomes of the VA actions and examines whether continuation of the VAs beyond Year 8 would help improve species abundance, ecosystem conditions, and contribute to meeting the narrative objectives. This report will inform the SWRCB's evaluation of the VAs and proposed pathway after Year 8, as described in Section 7.4.B of the MOU Term Sheet (Green, Yellow, and Red options).

Syntheses will inform recommendations to the Systemwide Governance Committee on outstanding information gaps and how they should be addressed, specifying the areas of uncertainty that the Science Committee would prioritize in order to better inform decision-making processes. Furthermore, syntheses and scientific information gained through the VA Science Program will be used to parameterize and structure quantitative aspects of decision-making processes of the Science Committee.

4.4.2 Structured Decision-Making Processes within the VA Science Committee

Recommendations from the Science Committee will be the outcome of structured decision-making processes, as appropriate. The Science Committee will test hypotheses related to VA Flow and Non-flow Measures so that experiments and monitoring can inform decision support models (See section 4.4.3). By statistically designing study plans, measuring consistently collected metrics, and providing accessible data, information generated by VA Science Plan activities can be leveraged into these models. Decision support models can then predict information regarding metrics at Local, Full Tributary and Delta, and Population-Level tiers, which can inform the importance of specific hypothesized mechanisms and relationships linking management actions to biological and ecosystem outcomes. By incorporating VA Science Plan generated information, decision support models can also assess the value of additional information gathering to continue explore the most influential hypotheses for outcomes. By documenting the importance of management action mechanisms and the value of science action information to supporting the achievement of biological objectives, the Science Committee can contribute information to VA structured decision-making processes. In turn, these structured decision-making processes will feed recommendations for adjustments in management and science actions using the new science generated by the Science Program.

4.4.3 Use of Decision Support Models for Habitat Enhancement Actions for Salmonids

Salmonid decision support models use the best available information to predict how actions might improve populations. These models can be used to estimate population level responses of VA assets, at both juvenile and adult lifestages, to help estimate the relative degree that different VA actions are likely to contribute to overall population level changes. They can also be used to prioritize restoration actions (Peterson and Duarte 2020), for example by understanding how populations respond to changes in floodplain habitat vs tributary rearing habitat, and/ or to evaluate how VA habitat actions will interface with other large scale management actions such as commercial and recreational harvest and hatchery production. Several decision support models are available for use in the VA Science Program and are briefly described in this section. The VA Science Committee will evaluate the appropriate model for individual decision-making processes to develop evidence-based recommendations to the VA Systemwide Governance Committee. These model descriptions are provided to serve as examples of the available modeling tools and illustrate that model outputs are relevant to VA Science Plan hypotheses at the Full Tributary and Delta and Population-level Tiers.

4.4.3.1 Central Valley Project Improvement Act Science Integration Team Decision Support Models (CVPIA SIT DSM)

The CVPIA Salmonid Decision Support Models[1] are stochastic, stage-based models that operate on a monthly time step and simulate populations on a 20-year horizon. The model includes the mainstem Sacramento River and San Joaquin River and their major tributaries, the Sutter and Yolo Bypasses, and the North and South Delta. Model inputs include flow data, CalSim modeled flows (1980 to 2000 hydrology which includes both wet and dry multi-year cycles and operational rules per the 2019 Biological Opinion), temperature data, Hec5q and additional temperature modeling where needed, habitat data, and habitat acres from various sources.

[1] More information on the CVPIA SIT Decision Support Models can be found here: https://cvpia.scienceintegrationteam.com/cvpia-sit/ , under “Resources” with links to: Documents, Interactive Web Apps, DSM R Packages, FAQs, and Data Assets. The SIT decision support models are intended to be transparent and open source. They are available to download, use, and modify for user-specific purposes. Changes to the model can be documented through language developed by SIT, found in the FAQ section.

Model outputs include: number of spawners, juvenile biomass at Chipps Island, and proportion of natural origin spawners. There are four decision support models, one representing each run of Chinook salmon (fall-run, late-fall-run, winter-run, and spring-run) and models for Central Valley steelhead and green sturgeon. The late-fall-run, Central Valley steelhead, and green sturgeon DSMs are still considered in "beta" mode and has not yet been used to evaluate candidate restoration strategies. The DSMs differ with respect to timing of life history events, inputs, yearling dynamics, and juvenile movement rulesets.

The Science Integration Team (SIT) developed 13 candidate restoration strategies to evaluate in the Chinook salmon decision support models. These strategies define potential sets of primarily habitat-based restoration actions to improve Chinook salmon habitat or survival with the goal of maximizing the model outputs of number of spawners and juvenile biomass at Chipps Island. Each candidate strategy was simulated in the fall-run, winter-run, and spring-run models and the SIT evaluated the model output to inform the development of priorities in the CVPIA SIT Near-term Restoration Strategy. The SIT is an open participatory group working to propose model revisions, evaluate scenarios with the models, and assess information needs for the models.

In each yearly timestep, the following modeling actions occur in the Chinook Decision Support Models: As adults return from the ocean to the watershed, the en route survival submodel represents prespawn mortality as it is applied to adults returning to their natal tributaries and the pre-spawn survival submodel represents mortality while adults are at the spawning grounds. The modeling approach to en route survival and pre-spawn mortality is as follows, with links provided for accessing more detailed information:

- En route survival is a function of migratory temperatures, whether the bypasses are overtopped (this represents fish loss due to stranding), and the adult harvest rate.
- Pre-spawn mortality is a function of temperature, specifically the number of degree days that a fish experiences before spawning.

The number of juveniles produced is calculated based on the number of spawners, fecundity, and an egg-to-fry survival sub model. Egg-to-fry survival is a function of the temperature, the probability of the nest being scoured, and the proportion of natural fish spawning.

In each monthly timestep, the following modeling actions occur: Juveniles rear in-channel or on the floodplain or migrate downstream depending on habitat availability and size of the juvenile. Tributary habitat capacity to support juvenile rearing is determined based on the total habitat in a tributary and a size-dependent territory requirement. Habitat availability varies by month and year and is based on flow levels. More info on habitat can be found in the Decision Support Model habitat package[2]. Growth is applied to juveniles each month and differs with habitat type: seasonally inundated (floodplain, including tributary floodplain habitat and habitat in the Yolo and Sutter bypasses) and perennially inundated (in-channel), prey density, and temperature. Juveniles rearing on floodplains grow at a faster rate than juveniles who rear in-channel. Rearing survival is a tributary-specific function based on water temperature, water diversions, weeks of floodplain inundation (when applicable), and predator prevalence. When habitat capacity is non-limiting, fish outmigrate when they reach the "very large" size class or at the end of the rearing season. The exception is for the spring-run Decision Support Model where fish that are still small or medium size in their natal tributaries at the end of the outmigration window will remain in the natal tributaries as yearlings until the next year's outmigration window. The remaining juveniles not assigned to rear in natal tributaries will leave the watershed and migrate downstream and a migratory survival is applied.

[2] https://cvpia-osc.github.io/DSMhabitat/

After a juvenile makes it out to the ocean, ocean survival is applied, and they are assigned to return to their natal tributary one to three years later.

4.4.3.2 Reorienting to Recovery Decision Support Models (R2R DSM)

The California Central Valley Salmonid Recovery Project, nicknamed the Reorienting to Recovery (R2R project), is currently modifying the CVPIA SIT fall-run model for their project purposes[3]. These code modifications and model outputs were not reviewed or interpreted by the CVPIA Science Integration Team but have been reviewed by R2Rs Science Advisory Team. Model modifications include the addition of functionality that enables evaluation of the isolated and combined effects of a broader range of recovery actions than the CVPIA SIT base-model, including increase and refinement of habitat, habitat expansion beyond existing levee confinements within the state system of flood control, reintroduction of historical independent populations above rim-dams, changes to in-river and ocean harvest, changes in hatchery production (production numbers, release timing, and release location) , and modifications to flows (magnitude and timing in different water years types). The R2R project seeks to develop an effective and implementable strategy for recovering listed and non-listed salmonids in California's Central Valley that draws on and integrates the full range of potential recovery actions while considering the diverse range of other social, ecological, and economic values within the region. The R2R model has performance metric outputs related to salmonid biological objectives, habitat and ecological process objectives, recreational and commercial harvest, access of land and water, economic objectives related to water supply, agricultural production, and power generation, and regulatory, public health, and infrastructure objectives. In addition to the model outputs available in the CVPIA DSM, the model has been modified to enable the following outputs: adult return ratio and juvenile to adult return ratio.

4.4.3.3 Winter-run Life Cycle Model (WRLCM)

The winter-run life cycle model (WRLCM)[4] is a stochastic stage-structured model that operates on a monthly time step and simulates over an 80 year time period, dependent on the hydrology inputs (i.e., 82 years if using CalSim II or 94 years if using CalSim 3). The spatial structure of the model includes five different geographic areas within the Sacramento River watershed (Upper mainstem Sacramento River, Lower mainstem Sacramento River, Yolo Bypass, Delta, and Bay), as well as the Ocean. Model inputs include monthly modeled flows (CalSim II or CalSim 3), Delta modeled hydrology (DSM2), and temperature data (Hec5q or USBR's Sacramento River Water Quality Model (SRWQM)). The WRLCM also relies on inputs from several submodels, including habitat capacity models to estimate monthly habitat capacity in each of the five geographic areas, and a submodel to estimate monthly outmigration survival through the Delta. The model tracks abundance for each lifestage, geographic area, and timestep. Model outputs are relative to a baseline and include number of spawners (abundance), cohort replacement rate (CRR), and freshwater productivity (smolts/spawner). The WRLCM was specifically designed to assess the effects of water operations and habitat restoration as defined by the Operations Criteria and Plan (OCAP), Biological Opinion (BiOp), and Reasonable and Prudent Alternatives (RPA) on long-term population dynamics of winter-run Chinook salmon.

[3] Documentation on the R2R models being used can be found here: https://reorienting-to-recovery.gitbook.io/documentation-site/zCZ2Z2yqFYMUQrtZdTlg/

[4] More information on the model can be found here https://oceanview.pfeg.noaa.gov/wrlcm/intro, with tabs explore, simulate, learn, and resources, to learn more and explore the model.

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Appendix D

Draft Early Implementation Project List

Draft Early Implementation Project List

The following table provides a non-exhaustive list of Non-flow Measures that may potentially be credited under Early Implementation, pending testing and refinement of the Non-flow Measure Accounting description provided above.

Tributary	Project	Description	Instream Rearing (acres)	Spawning Maintain (acres)	New Spawning (acres)	Floodplain (acres)	Tidal (acres)	Fish Food Production	Fish Passage	Predation Hotspot Removed (acres)	Stranding Area Removed (acres)	Large Wood Clusters (# Added)	Boulder Clusters (# Added)	Est. Completion Date
American River	American River salmonid habitat improvement at upper river bend	Excavating material from the floodplain to create side channel habitat for juvenile rearing. The excavated material would be sorted and placed into the river to improve substrate conditions for spawning at and downstream of the site.	0.5	2	2	2.5	0	0	0	0	0	25	0	Done
American River	American River salmonid habitat restoration - Ancil Hoffman	Restore juvenile Chinook salmon and steelhead rearing habitat and enhance natural channel processes. Add spawning and rearing habitat.	1.0	2.0	2.0	2.5	0	^	^	0	0.25	20	0	Done
American River	American River salmonid habitat restoration - Lower Sailor Bar	Restore juvenile Chinook salmon and steelhead rearing habitat and enhance natural channel processes. Add spawning and rearing habitat.	1.6	3.0	5.0	1.0	0	^	^	0	0	70	0	Done
American River	American River salmonid habitat restoration - Sailor Bar	Restore juvenile Chinook salmon and steelhead rearing habitat and enhance natural channel processes. Add spawning and rearing habitat.	2.0	1.5	2.0	1.0	0	^	^	0	0	0	0	Done
American River	American River Spawning and Rearing Habitat - Sacramento Bar	Restoration and enhancement of spawning and rearing habitat for anadromous fish in the Lower American River at Sacramento Bar, primarily through gravel addition and/or floodplain or side channel excavation.	0.027	0	15.5	5	0	^	^	0	0	0	0	Done

American River	American River spawning and rearing habitat	Restore juvenile Chinook salmon and steelhead rearing habitat and enhance natural channel processes. Add spawning and rearing habitat.	1	1.5	2	3	0	^	^	0	0	50	12	Done
American River	American River Spawning and Rearing Habitat - Nimbus Basin	Spawning/rearing habitat combination project. Maintenance of previously enhanced site that experiences heavy spawning activity - due to location in upper river. Included in completed programmatic permitting effort.	3.44	1.46	^	1.46	0	^	^	^	^	^	^	Done
Antelope Creek	Antelope Creek Fish Screen Project	Eliminate fish mortality due to diversions of water from CVP rivers in the Central Valley. 100 CFS diversion/pump replacement/screen installation.	5	0	0	0	0	0	0	0.75	^	0	0	Done
Battle Creek	Battle Creek winter run chinook reintroduction and Battle Creek Colemn Weir passage project	Design and construction of the infrastructure (monitoring, trapping, holding, and sampling) for the Battle Creek (BC) winter-run "jump-start".	5.28	0	0	0	0	^	^	^	^	^	^	Done
Battle Creek	North Fork Battle Creek Natural Barrier Removal	North Fork Battle Creek Natural Barrier Removal.	9.7	0	0	0	0	0	^	0	0	0	0	Done
Butte Creek	Butte Creek Diversion 55 Fish Screen Project	Eliminate fish mortality due to diversions of water from CVP rivers in the Central Valley. 7 CFS diversion/pump replacement/screen installation.	0.35	0	0	0	0	0	^	0.25	^	0	0	Done
Clear Creek	Clear Creek Gravel Augmentations	Annual gravel augmentations into Clear Creek to provide spawning habitat for anadromous salmonids, and to promote geomorphic processes that create habitat for all in-river fish life history stages. The project can also utilize boulder clusters and large wood placements. This project should continue in purpetuity, as Whiskeytown Dam cuts off sediment supply and alters geomorph process.	0.25	13.2	0	0.25	0	^	^	0	0	14	8	Done

Clear Creek	Clear Creek phase 3B	Complete Phase 3B floodplain restoration actions that were left undone at time of Phase 3a construction due to state bond crisis. 3b is the final component of Phase 3a. The main focus of 3b is to revegetate barren floodplains and remove legacy irrigation materials. Project will be complete in Spring 2024.	0	0	0	7.5	0	^	^	0	0	0	0	2023
Clear Creek	Clear Creek Phase 3C	Improve stream channel, floodplain, and associated habitats to provide increased spawning and rearing habitat for salmonids. The main focus of the project was to return the creek to its historic allignment and plug a 1950s era man-made ditch. The construction portion of the project was completed in 2021. Revegetation efforts will be complete in 2023.	17.5	0.0	0	1.0	0	^	^	0	0	100	0	Done
Delta	Prospect Island	Tidal restoration project. Benefits to Delta and longfin smelt spawning & rearing habitat; and salmonid rearing habitat (acreage reduction possible due to BiOps).	^	^	^	^	^	1540	^	^	^	^	^	2026
Delta	Tides End	Floodplain, tidal restoration, and farmland food production project. Benefits to Delta and longfin smelt spawning & rearing habitat; and salmonid rearing habitat.	^	^	^	140	670	2100	^	^	^	^	^	2027
Feather River	Garden Highway Mutal Water Co. Fish Screen Project	Eliminate fish mortality due to diversions of water from CVP rivers in the Central Valley. 112 CFS diversion/pump replacement/screen installation.	5.6	^	^	^	0	^	^	1	^	^	^	Done
Feather River	Feather River Salmonid Spawning Habitat Improvement	The placement, sorting, and harvesting of gravel and cobble (1/4”-5”) to restore spawning habitat in the Feather River.	^	^	4.5	^	0	0	^	^	^	^	^	Done

Feather River	Sunset Pumps	Remove a fish passage barrier to improve upstream passage for salmonids and green sturgeon. Install fish protective screens at existing diversions to reduce mortality of migrating juvenile salmonids.	^	^	^	0	0	0	Yes	^	^	0	0	2026
Feather River	Star Bend Setback Levee	Provide optimal habitat for floodplain rearing and reduce stranding during high flow events.	^	^	^	50	0	^	^	^	^	^	^	^
Feather River	Nelson Slough Floodplain Restoration	The project could increase floodplain habitat available to Feather, Yuba, and Bear River salmonids by 3,000 to 5,000 acres. Additional floodplain inundation resulting from this project could provide rearing benefits to Sacramento River origin juvenile winter and spring-run Chinook salmon, juvenile Butte Creek spring-run Chinook salmon in the Sutter Bypass as well as to Feather River basin spring-run Chinook salmon.	^	^	^	3000	0	^	^	^	^	^	^	^
Mokelumne River	Gravel Enhancement Maintenance	Provide maintenance gravel annually to existing restored 1 mile reach on the Lower Mokelumne River. Maintains habitat suitability in enhanced spawning areas.	^	0.87	^	^	^	0	0	0	0	^	^	Done
Mokelumne River	Screen High Priority Diversions	Prioritize riparian pumps for screening based on timing of operation and size of fish passing. Screen highest priority pumps. Improve survival of juveniles.	1.71	^	^	^	^	0	5	^	^	^	^	^
Mokelumne River	Creation of Floodplain Habitats	Design and build floodplain habitat to maximize rearing capacity in a 2 or 3 year recurrence cycle. Improves instream growth and improve outmigrant survival.	^	^	^	28.67	^	^	^	^	^	^	^	Done

Mokelumne River	Lower Mokelumne River Salmonid Spawning and Rearing Habitat Improvement	The excavation and recontouring of the lower Mokelumne River stream bank to provide seasonal floodplain habitats for juvenile salmonid rearing and to sort and harvest gravel and cobble (1/4"- 5") from the excavated materials, which will be used to improve or expand nearby spawning habitats.	1.21	0.3	0.3	0.8	^	^	^	0	0	0	0	Done
Putah	Expansion of Available Spawning Habitat	Creation of 62,000 sqft of spawning habitat in Lower Putah Creek through gravel scarification (loosening of existing gravels) and new spawning side channels in conjunction with other floodplain habitat improvements at two project sites. This project is intended to double available salmonid spawning habitat in Lower Putah Creek.	^	^	1.4	^	^	^	^	^	^	^	^	2024
Sacramento River	Meridian Farms Pump Replacement	Eliminate fish mortality due to diversions of water from CVP rivers in the Central Valley. 135 CFS Pump Replacement & Fish Screen Project.	6.8	0	0	0	0	^	^	3.0	0	0	0	2024
Sacramento River	Natural and artificial rearing structures in the Upper Sacramento River	Projects add natural and/or artificial rearing structures, including large woody structures, in the Upper Sacramento River within the first 10 river miles downstream of Redding.	0.4	0	0	0	0	^	^	0	0	40	0	Done
Sacramento River	Restore rearing and spawning side channels in the upper sacramento river	Restoring side-channels to provide juvenile rearing habitat for salmon and steelhead in the Upper Sacramento River (Keswick Dam to Red Bluff).	1.3	0	0	0	0	^	^	1	0	10	0	Done
Sacramento River	Sacramento River - East Sand Slough restoration	Improves juvenile rearing habitat at East Sand Slough side channel on the Sacramento River in Red Bluff.	5	0	0	5	0	^	^	0	5	300	0	Done

Sacramento River	Sacramento River improve spawning habitat above temperature control points	Includes Gravel Injection at Keswick Dam and instream gravel placement at downstream locations to the temperature control point.	0	5	0	0	0	^	^	0	0	0	0	Done
Sacramento River	Sacramento River Salmonid Habitat Improvement - Keswick to Red Bluff	Implements the top priority habitat improvements along the Sacramento River between Keswick and Red Bluff.	^	^	^	^	0	^	^	^	^	^	^	2025
Sacramento River	South Cypress (Nur Pon)	Reconnected and expanded off channel rearing habitat by excavating a channel between existing ponds, sorted excavated material, and placed the excavated material in the river. Included two channel crossings for City of Redding's public recreation area at the site.	5.2	0	1.0	0	0	^	^	2.9	0	40	0	Done
Sacramento River	Anderson River Park Phase I	Created first of three perennial channels in Anderson River Park for juvenile rearing.	1.5	0	0.5	1.0	0	^	^	6.0	0	60	0	Done
Sacramento River	Anderson River Park Phase II & III	Created second and third of three new channels for juvenile rearing at Anderson River Park. Stockpiled gravel in mainstem Sacramento River for high flows to distribute.	2.9	0	0.5	1.0	0	^	^	0	0	140	0	Done
Sacramento River	East Sand Slough	Created two mile long side channel at East Sand Slough in Red Bluff within the footprint of the old Lake Red Bluff left dry with permanent opening of Red Bluff Diversion Dam gates.	7.1	0	0	0	0	^	^	1.0	0	400	0	Done
Sacramento River	Rio Vista	Excavated a historic side channel to create perennial rearing habitat and added sorted gravel to the mainstem to provide spawning habitat.	2.0	0	0.25	0	^	^	^	0	0	15	0	Done
Sacramento River	Sacramento River Salmonid Habitat Restoration at Reading/Rancheria Island	Sacramento River Habitat Restoration at Reading and Rancheria Islands.	8	0	0.2	8	^	^	^	12	0	150	0	Done
Sacramento River	Sacramento River Salmonid Spawning and Rearing Habitat Restoration	Charter included multiple spawning and rearing habitat projects between Keswick and	3	3	0	0	0	^	^	1	1	50	0	Done

		Red Bluff. Projects listed individually.												
Sacramento River	Sacramento River Tributaries Non-Natal Rearing Evaluation and Restoration	Confirm current non-natal use and existing/potential habitat in tributaries along upper Sac River. Identify access issues. Plan and implement restoration on tributaries.	^	^	^	^	0	^	^	^	^	^	^	2025
Sacramento River	NOFO Middle Creek Gravel (JH)	The objective of this project is to restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	^	15	^	^	0	^	^	^	^	^	^	2023
Sacramento River	NOFO Redding Riffle Gravel (JH)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	^	^	3	^	0	^	^	^	^	^	^	2023
Sacramento River	NOFO Tobiason Island (JH) (Michieils Island)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	4	^	1	0	^	^	^	0	^	80	^	2023
Sacramento River	NOFO Rockwad Phase I (JH)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	1	^	0	0	^	^	^	0	^	0	25	2023
Sacramento River	NOFO Rockwad Phase II (JH)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	0.5	^	0	0	^	^	^	0	^	0	20	2023
Sacramento River	NOFO Kapusta Island Side Channel (JH)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	2.8	^	1	0	0	^	^	0	^	40	^	2023
Sacramento River	NOFO Kapusta 1B Side Channel and Gravel (JH)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	1.5	0	0.25	1	0	^	^	^	^	130	^	Done

Sacramento River	NOFO Keswick Gravel (JH)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	0	18.7	0	0	0	^	^	0	0	0	0	Done
Sacramento River	NOFO Market Street Gravel - 2019 (JH)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	0	3	0	0	0	^	^	0	0	0	0	Done
Sacramento River	NOFO Market Street Gravel - 2023 (JH)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	5	6	0	0	0	^	^	0	0	0	0	2023
Sacramento River	NOFO Shea Side Channel (JH)	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	2.5	0	1.7	0	^	^	^	0	0	40	0	Done
Sacramento River	American Basin fish Screen Project Phase 2 Riverside Diversion	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	2.3	^	^	^	^	^	^	1	^	^	^	2023
Sacramento River	American Basin Fish Screen Project - Phase 4, Elkhorn Diversion	Restore, maintain, and improve Chinook Salmon and steelhead habitats and thereby improve the status of the species in California.	3	^	^	^	^	^	^	1	^	^	^	2025
Sacramento River	Willow Bend	Modify a side channel to provide access to 3,400 ft. of seasonally inundated habitat and remove a stranding hazard. (~4.7 acres)	^	^	^	4.7	0	^	^	^	^	^	^	^
Sacramento River	Fish Food Pilot Program	Program to determine optimal process to grow fish food on the dry side of the levees and transport it to migrating juvenile salmon in the river. Improves food accessibility for migrating juvenile salmon. This is an ongoing program that will continue to enroll new acreage.	^	^	^	^	0	15,000	^	^	^	^	^	^

Sacramento River	Sutter Bypass Weir 1	Improve adult passage for upstream migration, and out-migrating juveniles to access Sutter Bypass. Includes a new Lower Butte/Sutter Bypass Water Management Plan.	0	0	0	^	0	^	1	^	^	^	^	2024
Stanislaus River	Goodwin Dam Gravel (22,700 tons)	Added spawning gravel in Goodwin Canyon at the Float Tube Pool and Cable Crossing.	0.25	1.26	0	0	0	^	^	0	0	0	0	Done
Stanislaus River	Knights Ferry -- Lancaster Road	Restore at least 1.7 acres of floodplain and 500 ft of side channel habitat on private property adjacent to the Stanislaus River.	0.4	0	0	0	0	^	^	0	0	0	0	Done
Stanislaus River	Stanislaus Knights Ferry Floodplain Restoration Project- Rodden Road	Restore functional seasonally inundated floodplain and side channel habitat at the USACE Knights Ferry Recreation Area to increase juvenile rearing habitat.	0	0	0	190	0	^	^	0	0	0	0	Done
Stanislaus River	Stanislaus River at Kerr Park	The project will restore seasonal inundation to approximately 10 acres of floodplain habitat located at Kerr Park (rm 43), with additional in-channel enhancement.	^	7	^	21	0	^	^	^	^	^	^	2024
Stanislaus River	Stanislaus River Juvenile Rearing - Rodden Road	Ongoing project to implement both in- and off-channel restoration designed to provide additional rearing habitat for juvenile salmon and steelhead in the Stanislaus River in collaboration with private landowners across the river from the City of Oakdale.	4.9	^	4.9	^	0	^	^	^	^	^	^	Done
Stanislaus River	Stanislaus Gravel Project	Spawning gravel placement below Goodwin Dam for the maintenance of spawning habitat.	25	0	25	0	0	^	^	0	0	0	0	2024
Yuba River	Yuba Daguerre/Hallwood/Yuba R Juvenile Salmonid Rearing Habitat Restoration	Side Channel and Floodplain Restoration.	17.6	0	0	71.4	0	^	^	0	0	0	0	Done
Yuba River	Yuba River Narrows Restoration	Yuba River Narrows Restoration Project.	7	0	2	0	0	^	^	0	0	0	0	Done

Yuba River	Hallwood Project (Phase 2 to 4)	Creation and enhancement of 68 acres of juvenile floodplain rearing habitat and 3.3 miles of seasonal channels, alcoves, and swales. Improves natural river morphology and increases floodplain habitat, riparian habitat, instream cover, and habitat complexity, diversity and availability over a broad range of flows.	^	^	^	68	0	^	^	^	^	^	^	2024
Yuba River	Hallwood Project (Phase 4 of 4)	Remove Middle Training Wall (400,000 cubic yards of sediment) and enhancing 21 acres of floodplain and seasonally inundated side channel habitat.	^	^	^	21	0	^	^	^	^	^	^	2024
Yuba River	Long Bar Salmonid Habitat Restoration	42.8 total acres: creation of seasonally or perennially inundated side channels (5.9 acres), backwaters (2.4 acres), flood runner channels (1.9 acres), and backwater channel (5.4 acres), and lowering of floodplain elevations (27.2 acres) to support juvenile salmonid rearing habitat.	^	^	^	40.9	0	^	^	^	^	^	^	Done
Yuba River	Upper Rose Bar Habitat Restoration Project	The project footprint is approximately 40 acres, and will provide approximately 5 acres of salmon spawning habitat. The project also includes placement of large wood, and other measures that provide refugia and suitable rearing habitat for juvenile salmonids, resulting in approximately 1.2 acres of juvenile Chinook salmon instream rearing habitat.	^	^	5	1.2	0	^	^	^	^	^	^	2024

^Information is forthcoming.