Adaptive Management Program for the California Water Fix and Current Biological Opinions on the Coordinated Operations of the Central Valley and State Water Projects

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1 Executive Summary

Adaptive management is a science-based, flexible approach to resource management decision-making. When correctly designed and executed, adaptive management programs provide the ability to make and implement decisions while simultaneously conducting research to reduce the ecological uncertainty of a decision's outcome. These characteristics facilitate a management regime that is transparent, collaborative, and responsive to changes in scientific understanding.

The Federal and State water operations agencies (Bureau of Reclamation (Reclamation) and Department of Water Resources (DWR)) and the State and Federal fisheries agencies (U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS) and the California Department of Fish and Wildlife (CDFW)) (collectively the 'Five Agencies') commit to adaptively manage the Endangered Species Act Section 7 compliance for the continued Long-Term Operation (LTO) of the Central Valley Project (CVP), for its authorized purposes, and the State Water Project (SWP), for its authorized purposes.. The purpose and need for modifications to the LTO is to operate the CVP and SWP in a manner than enables Reclamation and California Department of Water Resources to maximize water deliveries and optimize marketable power generation consistent with applicable laws, contractual obligation, and agreements; and to augment operational flexibility by addressing the status of listed species (82 FR 61790, Dec. 29. 2017). This document sets forth the Adaptive Management Program (AMP) to accomplish the purpose and need.. This document highlights areas under the Proposed Action for the LTO that will require investments in research, monitoring, and modeling. This document describes how efforts to avoid jeopardy in the Section 7 consultation for the LTO may interface with other programs and efforts in the Central Valley and Delta, including collaborative science enterprises seeking to recover listed species and restore ecosystem functions outside of the Section 7 requirements on the LTO. However, many of the collaborative science enterprises include entities other than the 5 agencies and have decision making processes beyond the direct control of the 5 agencies. This document will be used by the five agencies for the purposes of coordinating with stakeholders and making decisions within each agencies respective regulatory and statutory requirements.

Structured Decision Making (SDM) provides a proven collection of practices, rooted in decision science, for informing management decisions under circumstances with scientific uncertainty. This Adaptive Management Program includes SDM within four overarching phases: (1) Plan; (2) Assess; (3) Integrate; and (4) Adapt.

- During **Phase 1: Plan**, research priorities are set through the identification of the scientific uncertainties most likely to influence a course of action, as informed by SDM. Science plans address how uncertainties associated with the operational and other stressors affecting covered species will be addressed and incorporated into updated Decision Support Models (DSMs) under SDM. Science Plans will be developed collaboratively using multi-agency and stakeholder forums such as the CSAMP/CAMT process and/or local watershed groups. The Science to be conducted to address uncertainties will undergo peer review consistent with the standards established by the appropriate decision making entity..

- Through **Phase 2: Assess**, the products developed through the Science plans, and the subsequent synthesis into updated DSMs, will undergo independent review, and the outcomes of this research will provide the basis for future proposals for management adjustments developed during Phase 3.

- In **Phase 3: Integrate**, interagency and agency-stakeholder discussions (based on the results of Phase 2's scientific assessments) will inform development of management adjustment proposals and additional research alternatives through SDM. This 'scoping' process will also lead to the

development of additional adaptive management alternatives to continue to address covered species and operational needs, assess benefits and identify uncertainty.

- During **Phase 4: Adapt**, the agency or agencies with final decision-making authority decide whether to adopt or reject a management adjustment proposal. Decisions will be evaluated to determine whether additional consultation and/or take statement/permit amendments are required based on reinitiation triggers (50 CFR 402.16).

A Biological Opinion Coordination Team (BOCT) will be co-led by Reclamation and DWR. Members of the BOCT will include a designated representative[1] each from Reclamation, USFWS, NMFS, DWR, and CDFW. CVP and SWP Public Water Agencies (PWAs) may provide a designate representatives to participate in the BOCT. Reclamation and DWR shall be responsible for managing the representation of their respective PWAs and shall endeavor to manage number of representatives and their conduct to achieve effective coordination. The BOCT's role in implementing this AMP is described in Section 4.1.1. One or more project-specific teams will be required to implement the actions in the Science Plans. These project teams shall allow for the participation of a representative from each of the 5 agencies and will include stakeholders.

Success of the adaptive management process outlined within this AMP hinges upon continued investments in research, monitoring and modeling. These investments address key uncertainties related to water operations and threatened and endangered species that have been raised in a number of different venues (e.g., the IEP Management, Analysis, and Synthesis Team and Salmon and Sturgeon Assessment of Indicators by Lifestage and the Collaborative Science and Adaptive Management Program (CSAMP) Salmon Scoping Team, CVPIA Science Integration Team, the Delta Science Program Structured Decision Making efforts, the Winter-Run Chinook Salmon Life Cycle Model, and the Delta Smelt Life Cycle Model) as well as during the development of a Proposed Action for the LTO. The Implementing Entities are committed to leveraging the expertise found in these different venues; filling critical data and information gaps in the areas of integrated monitoring and research, mechanistic studies and models, information synthesis, and data access from their respective resources. The agencies are committed to using Structured Decision Making to provide a proven transparent collaborative framework for the incorporation of science into decisions.

Working through the collaborative process outlined herein, the Five Agencies commit to reach a common understanding of the Proposed Action for the LTO and the regulatory requirements imposed upon the LTO to avoid jeopardy to the maximum extent possible, while still retaining individual agency discretion to make decisions. To that end, the Implementing Entities seek to use the flexibility provided by an adaptive management approach in a way that balances gaining knowledge to improve future management decisions with taking actions in the face of uncertainty and achieving the best near-term outcomes possible for all the authorized purposes of the CVP and SWP.

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[1] "Designated Representative" means in the case of DWR and CDFW the official representative designated by the Governor to act on his behalf, and in the case of the SWP/CVP contractors the official representative designated by an elected board of directors to act on their behalf.

2 Introduction

At its most basic level, adaptive management is a learning cycle and feedback loop whereby resource managers may simultaneously make management decisions while gathering further knowledge and information about a single resource or set of natural resources. Adaptive management is inherently collaborative, requiring "communication and transparency among all interest groups as well as a willingness to overcome the institutional barriers to collaborative decision-making," (Luoma *et al.* 2015). Starting with Holling (1978) and Walters and Hilborn (1978), a general framework for adaptive management has emerged as a process that incorporates uncertainty by recognizing there are different possible outcomes to management actions. Adaptive management then relies on flexible decision-making that is adjusted as outcomes from management actions and other events become better understood.

Defined objectives and clearly identified expectations of management outcomes are critical to the adaptive management process (Williams, 2011). Based on objectives (and allowing for uncertainty), resource managers can then develop hypotheses about potential resource responses to various management actions and implement the selected action(s), while collecting information to compare the outcomes expected to those observed (Williams *et al.* 2009). The goal of any adaptive management program is to incrementally reduce uncertainty and management risks by learning more about how the target resource responds to the management regime being evaluated. The challenge becomes how to use the flexibility provided by an adaptive management approach in a way that balances gaining knowledge to improve future management decisions with achieving the best near-term outcome possible (Allan and Stankey, 2009). In practice, the bigger challenge has been reaching general agreement among parties about management tactics and their efficacy. Conroy and Peterson (2013) developed formal practices for Structured Decision Making that has been successfully applied for the Central Valley Project Improvement Act with representatives from the 5 Agencies, PWAs, and NGOs.

Commented [A1]: Conroy, M.J. and J.T. Peterson. 2013. Decision Making in Natural Resource Management: a structured adaptive approach. Wiley-Blackwell.

3 Intent and Objectives

Through the Adaptive Management Program described in this document, the Implementing Entities are committing to the ongoing adaptive management of Section 7 compliance for the LTO. The intent of this AMP is to guide the Implementing Entities as they:

1. Report upon the compliance with Incidental Take Statements and Permits under the Biological Opinions.

2. Revise the regulatory requirements necessary to avoid jeopardy and meet other regulatory standards applicable to state and federally-listed fishes.

3. Develop and implement conservation measures under the Proposed Action.

4. Develop and implement Science Plans consistent with potential revisions to the Proposed Action under this adaptive management plan.

5. Describe how the proposed adaptive management program integrates with existing efforts, including those of the Central Valley Project Improvement Act (CVPIA), Interagency Ecological Program (IEP), Collaborative Science and Adaptive Management Program (CSAMP), Delta Stewardship Council/Delta Science Program (DSP), and individual agency science initiatives.

A preliminary set of objectives associated with the application of this Adaptive Management Program are included in *the Notice of Intent to Prepare a Draft Environment Impact Statement, Revisions to the Coordinated Long-Term Operation of the Central Valley Project and State Water Project, and Related Facilities* (82 FR 61790, Dec. 29. 2017). Final objectives for this adaptive management program will be developed using collaborative processes under Structured Decision Making and be limited to those measures within the Proposed Action identified as subject to Adaptive Management.

Key Uncertainties

With regard to CVP and SWP water operations, there remain a number of key uncertainties associated with identifying biological response to potential management actions. These uncertainties have been raised in a number of different venues (e.g. by the Long-term operations biological opinions independent review panel (LOBO IRP), Interagency Ecological Program (IEP) Management, Analysis, and Synthesis Team (MAST) & Salmon and Sturgeon Assessment of Indicators by Lifestage (SAIL), and CSAMP Salmon Scoping Team (SST)) as well as during the development of a Biological Assessment for the LTO.

Through IEP, the MAST and SAIL reports provide recommendations to fill critical data and information gaps, enhance the existing monitoring network and improve quantitative modeling capability to support transparent decision-making. Key recommendations from the MAST report related to the Proposed Action on the LTO include:

- Refine entrainment and transport estimates of all life stages of Delta Smelt to quantify their effect on overall population viability,

- Develop tools to better evaluate and monitor Delta Smelt food availability and composition, and

The SAIL report reviews multiple qualitative, statistical, and numerical approaches and summarizes how they may be applied to improve the scientific understanding of how water operations decisions affect

salmonids and sturgeon (IEP SAIL 2016). The SAIL report further illustrates how the existing Delta monitoring network can be leveraged with the inclusion of updated technologies to improve data collection and analysis. The following list from the SAIL report identifies five system-wide recommendations to enhance the existing monitoring network and enable information to be incorporated into salmonid and/or sturgeon lifestage models:

- Incorporate genetic information to identify individual runs of Chinook Salmon,
- Develop juvenile abundance estimates for salmonids and sturgeon,
- Collect data associated with different life history metrics at multiple life stages for salmonids and sturgeon,
- Expand, enhance, and integrate fish survival and water quality monitoring, and
- Collect fish condition data on salmonids and sturgeon.

The CSAMP SST also prepared a report on the key findings of historical research and monitoring efforts and provided a gap analysis of existing and missing data that are critical to our understanding of salmon and steelhead survival in the Delta in the context of hydrodynamic conditions and water exports. Like the SAIL report, the SST report, *Effects of Water Project Operations on Juvenile Salmonid Migration and Survival in the South Delta* (CSAMP SST 2016), recommends building on the current and substantial body of scientific understanding. This CSAMP SST report also highlights key information gaps, which, if filled would likely improve our ability to more effectively manage operations and hydrodynamics to increase survival of salmonids emigrating through the Delta. These information gaps include our understanding of the role of factors influencing salmonid survival through the Delta, the role of Delta conditions in salmonid fitness at the individual and population level, and opportunities to improve salmonid population abundance and viability through changes to Delta conditions and water project operations. The SST's report recommendations are broken into four categories of action:

- Continue existing survival studies, monitoring, and analysis of data
- Implement short-term actions to improve salvage facility operations
- Develop a long-term monitoring, research and adaptive management plan
- Implement the long-term monitoring, research and adaptive management plan

Collectively, these efforts and others have sought to assess the current state of Delta science and highlight opportunities to assess the value of taking or modifying certain actions, reduce environmental uncertainty, and inform future management actions and decisions. The LTO Proposed Action describes the following Annual Scheduling efforts to improve the understanding of fish and water operations:

- Shasta Spring Pulse Flows
- Shasta Spring Management of Spawning Location and Timing
- Delta Smelt Subadult Habitat (Suisun Marsh Salinity Control Gates and modification to the 2008 RPA Fall X2 Action)

The Proposed Action further includes the following conservation measures:

- Salmonid Spawning and Rearing Habitat
- Small Screen Program
- Food web Subsidies
- Winter-Run Conservation Hatchery
- Fish Conservation and Culture Laboratory
- Shasta Cold Water Management Tools
- WRCS Adult Rescue and Juvenile Trap and Haul
- Folsom Cold Water Management Tools
- Stanislaus Temperature Study
- San Joaquin Basin Steelhead Telemetry Study
- Predator Hot Spot Removal
- Salvage Facility Improvements

4 Conceptual Framework: Decision Making, Process, Governance

The proposed approach outlined in this Adaptive Management Program incorporates aspects of adaptive management that are both "active" (where managers and operations are pushed in a process of experimentation to explore the benefits, limits and response to management actions) and "passive" (which lacks explicit experimentation and is instead more an assessment of existing and future conditions and circumstances). Ultimately the approach used in this Adaptive Management Program will proceed with an iterative development of management alternatives whereby managers will use a few contrasting scenarios to explore the uncertainty surrounding the future consequences of a management decision.

4.1 Decision-Making

This Adaptive Management Program outlines a collaborative process that may improve the ongoing operation of the CVP and SWP for their authorized purposes. Under the adaptive management program, new information gained during implementation will inform operational decisions within the ranges of criteria and effects analyzed in applicable BiOps and CESA authorizations. Each agency retains discretion to make decisions as appropriate within its authority and within its role in a Section 7 consultation. The reinitiation triggers provided by 50 CFR 402.16 will govern changes to the Proposed Action. These triggers include:

a. If the amount or extent of taking specified in the incidental take statement is exceeded;

b. If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

c. If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or

d. If a new species is listed or critical habitat designated that may be affected by the identified action.

Consistent with 50 CFR 402.16, the FWS and/or NMFS may also reinitiate formal consultation. Reclamation will coordinate with DWR as the "Applicant"..

Reclamation, at its sole discretion, will be responsible for changes to the Proposed Action and the requirements to fulfill its NEPA and [insert ESA prelim.]. Reclamation will coordinate with the 5 Agencies and within the BOCT to the extent practicable and allowable by law.

USFWS and NMFS, at their sole discretion, will be responsible for considering updates to their effects analyses, jeopardy determination, and may make changes to their Incidental Take Statements and the necessary measures to fulfill their ESA requirements. USFWS and NMFS will coordinate with the 5 Agencies and within the BOCT to the extent practicable and allowable by law.

Additional efforts or groups will be needed to fulfill all aspects of this Adaptive Management Program and support the decision-making process by the 5 Agencies Descriptions of certain groups and how they will be involved in the various phases of this Program may be found in *Appendix 7—Groups Involved In Each Phase of the Adaptive Management Program*.

4.1.1 Biological Opinion Coordination Team (BOCT)

The BOCT, co-led by Reclamation and DWR, will include a representative of Reclamation, USFWS, NMFS DWR, CDFW, and one or more PWAs from the SWP and CVP. These representatives will likely be senior managers. Additional staff from any of the BOCT members and/or consultants may also participate to provide technical assistance or other support.

The BOCT shall have primary responsibility for support, coordination and implementation of the AMP and shall:

1. Be responsible for funding and permitting the priority science needs identified by Collaborative Science Workgroups necessary to carry out the Adaptive Management Program.

2. Review scientific information and recommend changes to monitoring schema and management actions to the appropriate agency.

3. Refer management related actions or proposals, as appropriate, for review by an independent science panel for example, the Long-term operations biological opinions independent review panel (LOBO IRP).

4. Identify and secure needed infrastructure and resources to support scientific activities/monitoring.

5. Review and approve the Annual Monitoring and Research Plan and progress reports.

4.2 Relationship of Adaptive Management to Real-Time Operations

The Proposed Action includes specific actions for scheduling flows and identifies certain conditions that cannot be addressed through the Proposed Action, e.g. Shasta Cold Water Pool Tier 4. The adaptive management and decision-making processes described here do not apply to real-time operations; where individual real-time operations decisions must be made on a daily, weekly or monthly time scale; because new research efforts cannot be developed and deployed in that same window of time. However, changes to operational criteria in the BiOps and associated CESA authorizations may be changed over time through the adaptive management process. The need for additional Section 7 Consultation would be determined based on reintiation triggers.

4.3 Adaptive Management Program

Under this Program, adaptive management changes to operations and other implementation actions would occur on an annual or longer (multi-year) basis, and are not intended to apply to seasonal nor real-time operations.

Four process diagrams, referred to here as "phases," illustrate the major components of the proposed adaptive management process: (1) Plan; (2) Assess; (3) Integrate; and (4) Adapt. The four diagrams (Figures 5-2 – 5-5) describe each phase of the process as well as how each phase relates to one another.

Certain analytical tools are useful during implementation of the phases of adaptive management, and are described below. Section 5.4.5 describes structured decision making and its utility in formulating research, monitoring and adaptive management actions at multiple scales, from the individual study up to overall program management. Section 5.4.6 describes the use of conceptual models in adaptive management and provides examples of how such models are already in use to address ecological

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In implementing this AMP, the Five Agencies will also bring forward adaptive management proposals outside the Delta, that may impact Delta operations, to the IICG for its recommendation and input.¶

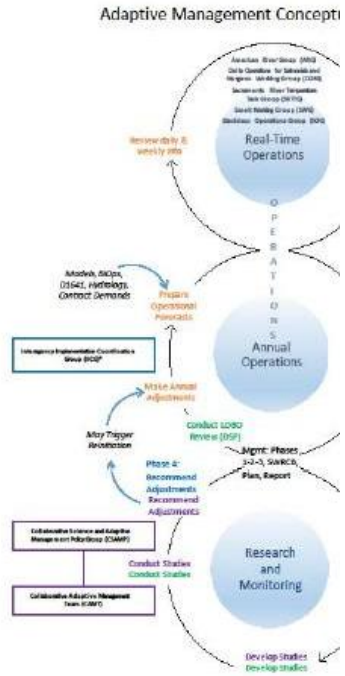

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Figure 5-1. Describing the multiple time-scales of adaptive management for the California
Water Fix and current USFWS and NMFS Biological Opinions on the coordinated operations of .
the Central Valley and State Water Projects¶

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Adaptive Management Response to Climate Change¶
Gradual long-term changes in sea level, watershed hydrology, precipitation, wind patterns, and air and water temperature are projected to occur due to climate change. These changes contribute to uncertainty related to the factors affecting native species, water project operations and ecological responses. Because of this, climate change projections will be incorporated into management and science plans. Implementation of this Program requires monitoring of climate change effects and projections, taking management actions, and adjusting water operations, research and monitoring in response as needed. Such adaptive management responses may ...

questions in the Delta. Further evolution of these models will be an integral part of the adaptive management process.

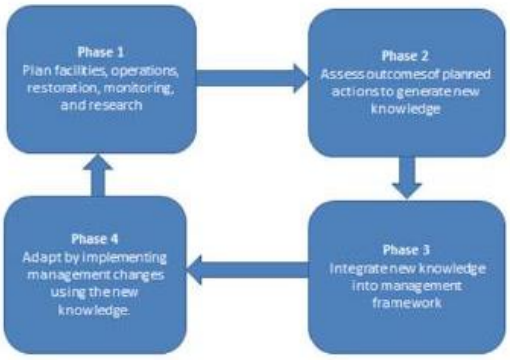

Figure 5-X. The four phases of the adaptive management process.

4.3.1 Structured Decision Making

Structured decision making (SDM) is a general term used for a suite of analysis tools that can help inform useful, robust decisions. Every decision consists of several primary elements: management objectives, decision options, and predictions of decision outcomes. By analyzing each component separately and thoughtfully within a comprehensive decision framework, it is possible to improve the quality of decision making. The actions identified as requiring adjustments due to uncertainty, will be addressed in this Adaptive Management Program through the steps outlined in Table 1 below.

Table 1. Structured Decision Making

Step	Information to be Developed	Responsible Party(ies)
1. Define the problem	What specific decision has to be made? What is the spatial and temporal scope of the decision?	Implementing Entities , other stakeholders
2. Define issues and objectives	What are the management objectives? Ideally, these are stated in quantitative terms that relate to metrics that can be measured. Setting objectives falls in the realm of policy, and should be informed by legal and regulatory mandates, as well as stakeholder viewpoints.	IICG
3. Develop alternatives	What are the different management actions from which we can choose? This element requires explicit articulation of the alternatives available to the decision makers.	Implementing Entities , other stakeholders

	The range of permissible options is often constrained by legal or political considerations, but structured assessment may lead to creative new alternatives.	
a. Understand the uncertainty associated with each alternative	Because we rarely know precisely how management actions will affect natural systems, decisions are frequently made in the face of uncertainty. Uncertainty makes choosing among alternatives far more difficult. A good decision-making process will confront uncertainty explicitly, and evaluate the likelihood of different outcomes and their possible consequences.	Implementing Entities
b. Identify risk tolerance	Identifying the uncertainty that impedes decision-making, then analyzing the risk that uncertainty presents to management is an important step in making a sound decision. Understanding the level of risk a decision-maker is willing to accept, or the risk response determined by law or policy, will make the decision-making process more objectives-driven, transparent, and defensible.	Implementing Entities
c. Identify linked decisions	Many important decisions are linked over time. The key to effectively addressing issues associated with linked decisions is to isolate and resolve the near-term issues while sequencing the collection of information needed for future decisions.	Implementing Entities
4. Quantify the consequences of alternative management actions	What are the consequences of different management actions? To what degree would each alternative lead to successfully reaching a given objective? Depending on the information available or the quantification desired for a structured decision process, consequences may be modeled with highly scientific computer applications, or with personal judgment elicited carefully and transparently. Ideally, models are quantitative, but they need not be;	Implementing Entities

	what is most important is that they link actions to consequences.	
5. Understand the tradeoffs	If there are multiple objectives, how do they trade off with each other? Numerous tools are available to help determine the relative importance or weights among conflicting objectives; this information is used to compare alternatives across multiple attributes to find the 'best' solutions.	Implementing Entities, other stakeholders
6. Decide, take action, and monitor	For those decisions that are iterated over time, actions taken early on may provide a learning opportunity that improves management later. Decisions should be well-documented outcomes of steps 1-5 above.	Agency or agencies with final decision-making authority

4.3.2 Conceptual Models

In the history of Delta ecosystem research, the term "conceptual model" has generally been used to refer to a process-based diagrammatic conceptual model that identifies sensitive resources and physical or biological processes that determine their state. An early example was the suite of models developed for the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP), ca. 2008. An example dealing with factors affecting fish habitat is shown in Figure 56.

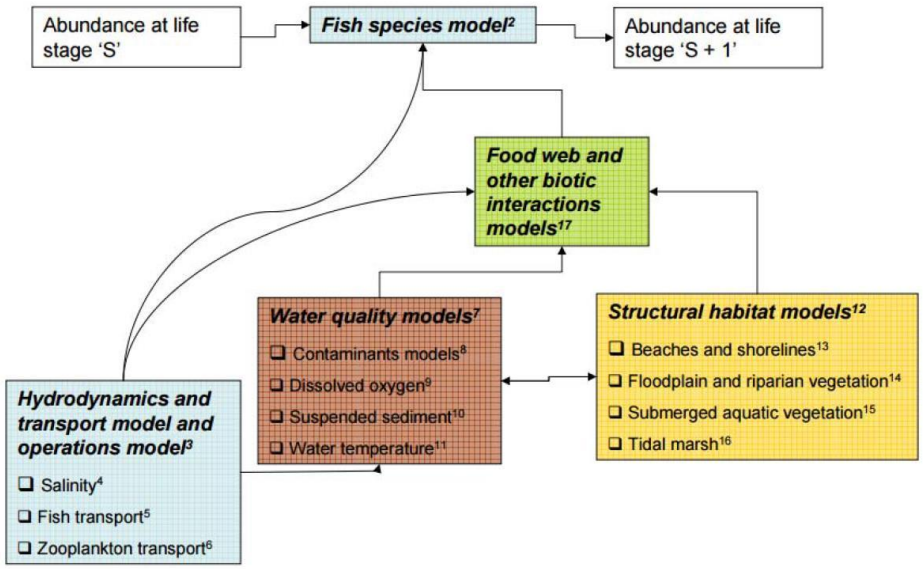

Figure 5-6. The Delta Aquatic Habitat Linkage Model of Nobriga (2008), an example DRERIP model.

Since this early example, there has been considerable development in the number and complexity of conceptual models being used to study Delta ecosystems. The 2015 annual report of the Collaborative Adaptive Management Team (CAMT 2015), for instance, refers to the use of conceptual models for the following:

- A life cycle model for winter-run salmonids in the south Delta
- A process model for Delta Smelt entrainment risk with reference to Old and Middle River flows
- An approach to aggregating study a suite of hydrodynamic, water quality, and particle tracking models, referred to collectively as an individual-based model (IBM), to identify adult Delta Smelt behaviors that best explain movement towards SWP and CVP, and entrainment.
- A re-evaluation of the re-examine life cycle model results of Maunder and Deriso (2011) using updated data sets and revised assumptions.
- Critically review the conceptual models that underlie adult Delta Smelt salvage and determine through multi-regression models the best suite of variables that explain historical salvage patterns.
- Use an existing life cycle model to understand the effects of entrainment on the Delta Smelt population.
- Perform a gap analysis evaluating the analytical tools currently in place to evaluate water project effects on salmonid survival.

Efforts under the Central Valley Project Improvement Act, CSAMP, and with the Delta Stewardship Council's Delta Science Program have developed DSMs to support SDM. These and similar efforts illustrate the utility of conceptual modeling tools to formalize understanding of how water operations affect fish, to assess the accuracy of these concepts in the context of information acquired through monitoring, research, and numerical modeling tools, and to formulate proposals to further test and improve the conceptual models.

Phase 1: Plan

During **Phase 1**, research priorities are set through the identification of the scientific uncertainties most likely to influence a course of action, as informed by SDM. Science plans address how uncertainties associated with the operational and other stressors affecting covered species will be addressed and incorporated into updated Decision Support Models (DSMs) under SDM. Science Plans will be developed collaboratively using multi-agency and stakeholder forums. Changes to the Science Plans beyond year-1 could incorporate management adjustments made in **Phase 4: Adapt**, A diagram of the decision-making process for effecting an adaptive management change under the Program is described in Appendix 7.

4.3.3 Phase 1: Plan

Define the bounds of the management problem and set management and research objectives.

Successfully bounding ecological uncertainty with regard to management outcomes must include clearly defined problem statements (objectives that will be used to inform decision points) and the means to address those questions (the suite of actions under consideration).

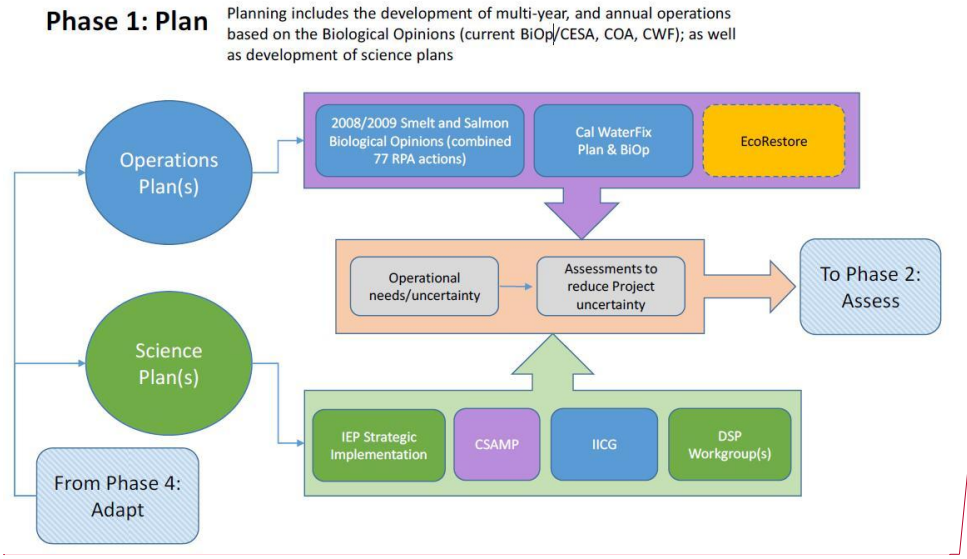

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Figure 5-2 Phase 1, Plan: Facilities and operations, restoration/ecosystem management, and monitoring and research.

4.3.3.1 Design and Operations Planning in the Context of Endangered Species Act and CESA

Given that adaptive management is intended to accommodate change both in the management of a resource and the corresponding response, objective triggers are an essential component of this Adaptive Management Program to signal when an alternative management action may be warranted. Triggers are defined, pre-set and measurable conditions that prompt evaluation of information collected to that point in the context of current conditions and considering whether potential alternative approaches are warranted. For the purposes of this Adaptive Management Program, triggers will be focused on longer term outcomes. The BiOps are expected to specify , the amount or extent of incidental take that will trigger reinitiation of consultation as described within their respective incidental take statements. Reinitiation of ESA consultation is also required under 50 CFR 402.16 if the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that had not been considered; if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; or if a new species is listed or critical habitat designated that may be affected by the identified action.

Phase 2: Assess

Through **Phase 2: Assess**, identified uncertainties are translated into research studies designed to reduce these uncertainties. Agency and stakeholder groups conducting research and modeling to answer adaptive management questions will vary depending on the logistics involved (e.g., major field studies will probably require the IEP). The Proposed Action includes specific opportunities to vary operations within the year in order to better understand the relationship between water operations and fish requirements.. Products pertinent to annual operations and assessments to reduce operational uncertainty will be peer-reviewed in a collegial manner to improve the quality of research proposals. The results of these products will provide the basis for future management proposals developed during the scoping process of **Phase 3: Integrate**.

4.3.4 Phase 2: Assess

Represent existing scientific understanding through current operational decisions while continuing to identify uncertainty and alternate hypotheses as a result of ongoing monitoring and research.

The 2015 ISB report, *Fishes and Flows in the Sacramento-San Joaquin Delta* (ISB 2015) recommended implementation of integrative scientific approaches grounded on management questions and focused on processes, drivers and predictions. The approach outlined in Figure 53 reflects the complexities of the ecological responses being examined by individual research projects and tracked by system-wide monitoring.

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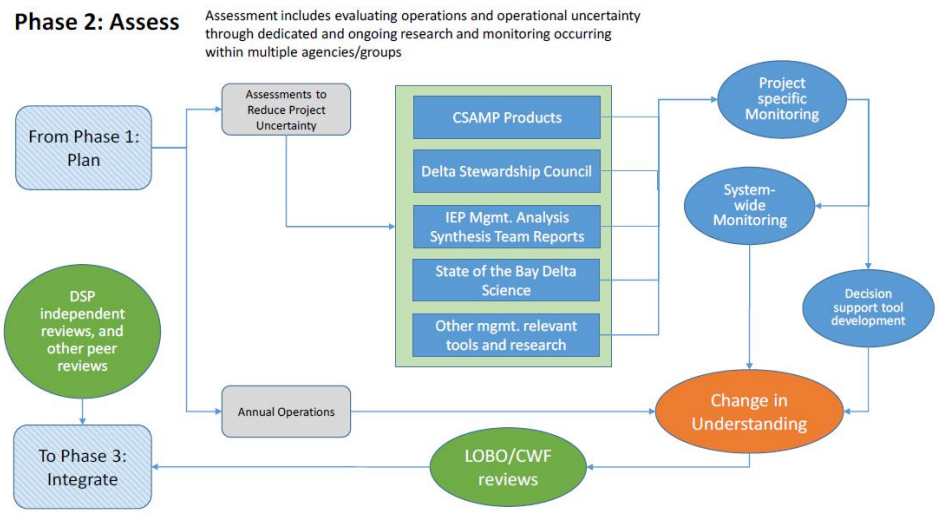

Figure 5-3. Phase 2, Assess: Collaborative Science, synthesis and performance assessment to inform management direction and change as uncertainty is addressed

An essential element of this Adaptive Management Program is the development and execution of a scientifically rigorous research, monitoring and assessment program to provide a robust information base, as well as the synthesis of the resulting information to analyze and understand responses of the ecosystem to a particular management regime. This requires the implementation of an integrated core monitoring network for water operations that also incorporates many project specific monitoring actions (See Section 6: *Tools and Scientific Support*). The scientific and technical information generated from this comprehensive program will be organized to provide a process to assess progress against the triggers and objectives.

4.3.4.1 Annual Review

In order to ensure the realization of objectives of the LTO and ITS authorizations, the BOCT will annual review the status of implementation. These reviews will include an evaluation of operations and the latest scientific, technical, and planning information (*i.e.*, Phase 3: Integration). This integrative adaptive management approach supports iterative improvement in the Proposed Action and Incidental Take Statements. When appropriate, results of these evaluations will be used to inform the potential modification of the Proposed Action by Reclamation or the potential modification of and ITS by FWS and NMFS within Phase 3 (Integrate) and the consideration of those alternatives in Phase 4 (Adapt).

Major findings and updates to DSMs may require a targeted independent review separate from the annual evaluation. Additionally, a comprehensive Independent Review would be anticipated at least every 5 years to to provide technical assessments regarding ongoing and future research priorities, science plans, study designs, water operations, other management actions, or habitat restoration actions. Together these independent reviews, along with the research products from the many Delta science-related groups, will provide greater understanding to inform new management and research options as detailed in Phase 3 (Integrate).

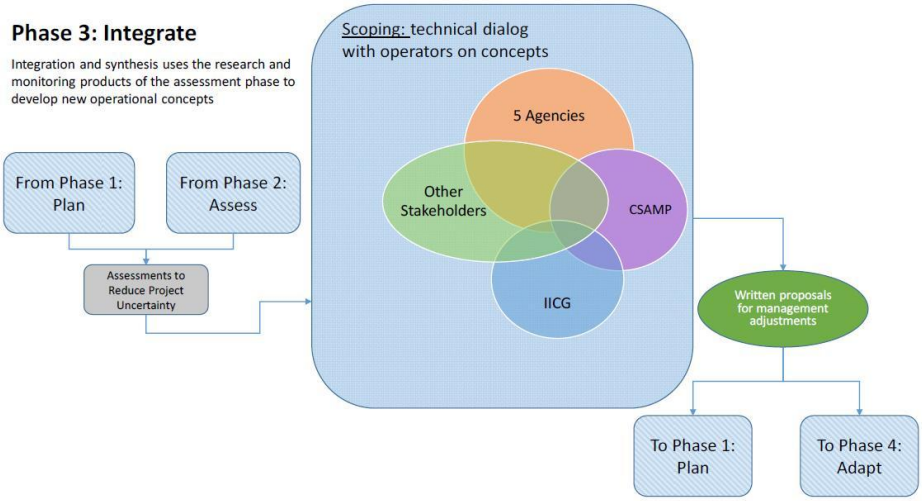

Figure 5-4. Phase 3, Integrate: Management and Science Integration

Phase 3: Integrate

The development of new executive level adaptive management alternatives to address operational needs and uncertainty occurs via several pathways and at multiple levels; these are generally described as scoping in **Phase 3: Integrate**. Through the structured decision making process, designed to test management strategies and data collection, interagency and agency-stakeholder discussions inform management and research alternatives based on the results of scientific assessments from **Phase 2: Assess**.

The results of both science products and their independent reviews are considered at multiple levels and at multiple venues including: between the Five Agencies, within CSAMP, and with the IICG. Determinations regarding whether the results of studies (e.g. monitoring post-construction performance of refugia areas) constitute a significant enough change in understanding to trigger changes to the management of the refugia or their monitoring and research will be made as part of a formal response to independent review and through the structured dialog of the scoping process. In this example, if the monitoring and research indicate that a management adjustment could improve the performance of the predator refugia, proposals to make said adjustment will be developed through the same scoping process.

4.3.5 Phase 3: Integrate

Reflect on outcomes and consider new approaches to management and research based on new understanding.

During the integration phase, which occurs on a continuing basis, the Implementing Entities will develop alternatives for adaptive changes to management actions within their scope of authority and, in some cases, may also recommend changes to monitoring and research approaches (Figure 5-4). In the development of these recommendations, the Implementing Entities will engage stakeholders, academic scientists and other relevant groups through a scoping process to collaborate on the development of management actions and research projects stemming from Phase 2. The scoping process will use structured decision making to analyze key uncertainties and maximize the transparency of decisions. Key structured decision making concepts include making decisions based on clearly articulated objectives, addressing uncertainties, and responding transparently to legal mandates and the public in decision making. The CSAMP, in coordination with the BOCT provides an example of a venue in which to collaboratively define management relevant problems, establish objectives, define potential available alternatives, and evaluate uncertainty and identify research needs. New knowledge revealing a potential opportunity to improve conditions or operations in the Delta and/or its tributaries could then lead to Reclamation proposing a change to the Proposed Action for CVP/SWP operations, adjustments by the Project Teams implementing the collaborative annual planning measures in the Proposed Action, or changes by FWS and NMFS in their ITS in Phase 4 (Adapt).

Within Phase 3, the objective of scoping is to first determine whether information developed in Phase 2's assessment is significant enough to trigger consideration of changes to a management action or a Science Plan, and, if so, to determine the resources needed to implement the change. Scoping via structured decision-making will involve operators and scientists from the Implementing Entities with input from participating science and stakeholder groups. Through scoping dialogue, experts, stakeholders and agency managers seek to develop a common interpretation and understanding of the monitoring and research products. If, through structured decision-making, it is determined that a change in a management action is appropriate, the appropriate Agency will then develop options or approaches to modify the management action to more effectively achieve its desired objectives. It is expected that the appropriate agency develop options in an transparent and collaborative manner and provide for soliciting and incorporating input.

The primary products envisioned for Phase 3 are legal and regulatory documents consistent with Section 7 and NEPA. NEPA includes input from stakeholders gained during the scoping process. Further, because the issues that trigger written proposals for management adjustments may have far-reaching effects, participation by Agency managers is a necessity during Phase 3, Peer review of proposed management actions and their scientific basis will be essential prior to making any decisions related to recommendations for a major management adjustment.

An element of Phase 3 will be to communicate the results of implemented actions, research, and monitoring to policy makers, managers, stakeholders, the scientific community, and the public, so that they can understand and evaluate progress toward addressing uncertainties and respond as necessary. The BOCT will prepare communications from time to time, as needed, and develop materials regarding adaptive management and monitoring matters for communication with a broader range of interests as part of the scoping process. The BOCT will ensure that study products are unbiased and explicitly and evenhandedly deal with uncertainty and disagreement in the analysis and interpretation, and that opposing points of view are clearly and evenhandedly presented in materials presented to stakeholders, external review bodies, and the public. The BOCT may work with CSAMPIEP, DPIIC, and CVPIA to develop reports that serve the following purposes.

- Provide the necessary data and information to demonstrate compliance with the Incidental Take Statements CESA permits.

- Identify the performance of measures with the Proposed Action on covered species and the effectiveness of the conservation measures.

- Disclose planned annual and long-term science priorities and programs and the synthesis of the information developed through the science program and their relevance to Section 7 compliance.

- Document actions taken under the adaptive management program (e.g., process, decisions, changes, results, or corrective actions).

- Disclose issues and challenges concerning implementation of the LTO and identify potential modifications or amendments that would increase the likelihood of meeting the purpose and need for the LTO.

To demonstrate compliance with ITS, an Annual Report will be prepared by Reclamation with input from the BOCT. The Annual Report will be made available to the public.

Phase 4: Adapt

The decision and final authority regarding whether to adopt or reject a management adjustment lies with the agency or agencies with decision-making authority (most often, the Bureau of Reclamation or Department of Water Resources in their respective capacities as operators of the CVP and SWP), and occurs during **Phase 4: Adapt**. Management decisions consider the proposals developed during **Phase 3: Integrate** and are based on the assessment and review of **Phase 2: Assess**. Depending on whether or not the proposed modification is considered within the adaptive limits of operations, changes to the operations criteria established through the BiOps, CESA authorizations and Bay Delta Water Quality Control Plan the proposed modification may require reinitiation of consultation or permit amendment.

4.3.6 Phase 4: Adapt

Revise models and/or management actions based on information gained.

The fourth phase of this Adaptive Management Program encompasses the decision to implement a management change through adjustments in water operations, restoration tactics, or monitoring (Figure 5-5). The responsible agency from Phase 3 will use the Section 7 and NEPA processes to pursue changes to management actions based on their authorities. The final decision will be consistent with the requirements of all relevant laws and regulations, including ESA, CESA, NEPA, the California Environmental Quality Act, Clean Water Act, Delta Plan, and the Bay Delta Water Quality Control Plan.

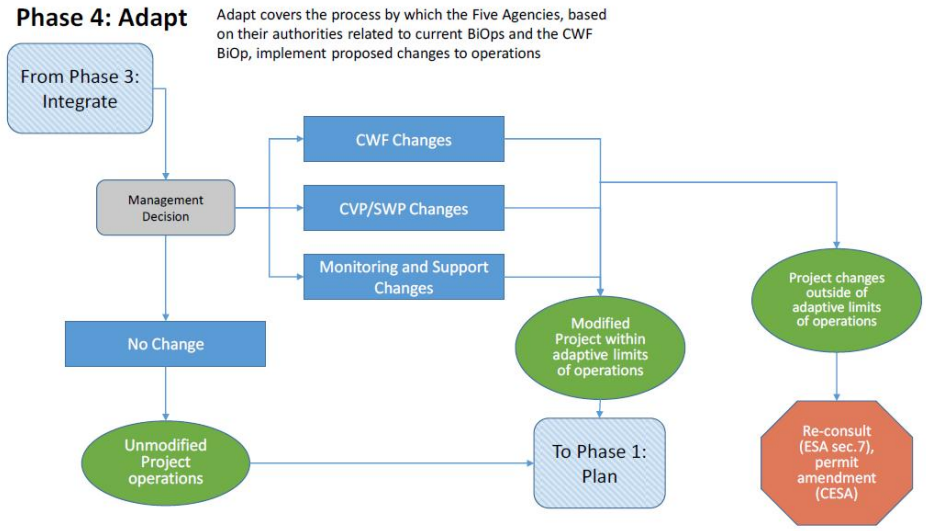

Figure 5-5. Phase 4, Adapt, Process for making an adaptive management change

5 Research and Scientific Support

The current understanding of research needs that support adaptive management is listed within the Proposed Action. In assembling information regarding future research needs, agencies will rely as much as possible on peer-reviewed published literature. When such literature is not available, the Implementing Entities will utilize agency reports that are available to the public (e.g., the MAST and SAIL reports). In some cases, the Implementing Entities will also rely on information from reports or articles that have been submitted to scientific journals but that have not yet been accepted for publication. The below sections outline monitoring and research efforts for Delta Smelt related to avoiding jeopardy under Section 7 Compliance for the ROC on LTO. Efforts to avoid jeopardy are part of larger efforts for the conservation and recovery of species and benefit from coordination outside of the Section 7 consultation.

5.1 Delta Smelt Research and Understanding

Much of our current understanding of Delta Smelt is summarized in a synthesis report developed by the IEP MAST (IEP 2015). The MAST summary is structured around a conceptual model that includes a suite of hypotheses that outline the majority of the knowledge base for current Delta Smelt management efforts. The overall conceptual model is organized in a tiered structure and describes how Landscape, Drivers, and Habitat Attributes successively affect Delta Smelt survival, growth, health and reproduction. Moreover, more detailed models nested within the conceptual model describe how these factors are thought to affect individual Delta Smelt lifestages. Specific to avoiding jeopardy under Section 7 compliance to the ROC on LTO; these include:

Entrainment and Transport: Improved entrainment estimates will more accurately depict how entrainment affect key population attributes (e.g., population dynamics and viability). In order to avoid under- or over-estimating these effects, more precise estimates of entrainment losses of all life stages are needed.

Food: Poor feeding conditions can affect Delta smelt health and even increase the rate of predation on fishes; as such, food availability must be a critical aspect of Delta Smelt habitat that could be affected by several management actionstools that can be used to evaluate the impact of different invertebrate restoration strategies (e.g., tidal marsh, wastewater treatment, overbite clam control, suppressing competition from other fishes, etc.). The development of such tools would benefit from improved sampling of prey in under sampled regions (e.g., Cache Slough complex);

5.2 Salmonid and Sturgeon Research and Understanding

Water project facilities and their operations, coupled with other management actions (e.g., flood management, navigation, local water users, habitat restoration, fish passage, invasive species, waterwater treatment, and harvest/hatchery management both salmonid and predator species) have profound and complex effects on migratory fish and their habitats. There is high uncertainty in how native and migratory fishes will respond to these large changes in physical and biological conditions.

Using the recommendations of the SAIL report and the CAMT SST report, we focus here on identifying long-term integrated core monitoring, research efforts, and synthesis tools that will be necessary to reduce uncertainties about how current and future water project operations impact migratory fish populations. The prioritized items below are not a comprehensive list of the science necessary for successful adaptive management. Rather, they are intended to highlight strategic system-wide science efforts that would benefit from integration into a broader management and regulatory context to facilitate funding security and consistency in implementation at the appropriate scales. Much of our most valuable monitoring and analytical tool development suffers from a lack of long-term funding security and fragmented

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Deleted: <#>expansion of the four major surveys monitoring Delta Smelt (Spring Kodiak Trawl, 20 mm, Tow Net Survey, Fall Mid-Water Trawl) to more consistently sample prey;¶
studies of Delta Smelt growth (using otoliths) and feeding habits (using stomach contents) concurrent with zooplankton sampling; and¶
evaluation of the role of alternative prey, such as amphipods, in Delta Smelt diets.¶
Harmful Algal Blooms: High concentrations of harmful algal blooms (HABs) in the Delta may be having both direct (e.g. direct toxicity) and indirect effects (e.g. impacts to the Delta food web) to the Delta smelt population. Quantitative monitoring programs that collect data on HAB distribution and research on how to minimize adverse effects of these blooms, including through control and suppression, is needed.¶
Longfin Smelt Research and Understanding¶
Our current understanding of Longfin Smelt is summarized in the status review which supported the listing of the species as threatened under the California Endangered Species Act in 2009 (CDFW 2009). The survival of young Longfin Smelt may be influenced by mechanisms that stem from variation in Delta outflow, with peak survival for larvae that reared in the low-salinity zone (~2–4 psu; Hobbs et al. 2010). As a result, Longfin Smelt abundance is strongly affected by outflow; the effect of outflow on recruitment is believed to take place during the egg and larval stages, which occur during winter and spring (*Appendix 6—Delta Outflow*). However, the exact mechanisms driving the relationship between Longfin Smelt abundance and winter-spring outflow are unclear and is an active area of research.¶
Adult Longfin Smelt use a variety of Bay-Delta tributaries for spawning, including the Sacramento River, San Joaquin River, upper Suisun Marsh, the Napa River, and possibly a number of other smaller tributaries to San Pablo, Central and South Bays. The early juvenile life stages rear over a wide geographic area from the west Delta to San Pablo Bay and even into South Bay during wet years. There is uncertainty about the distribution of larval Longfin Smelt, because traditional surveys cover only a portion of the potential range. The only Bay Area tributary that is sampled is the Napa River. The fraction of the subadult Longfin Smelt population leaving and returning to the estuary is another key aspect of their biology that could use better quantification.¶
Longfin Smelt distribution in the north, east, and south Delta is influenced by water year type, with higher distributions occurring in these areas during dryer hydrologies. The life stages of Longfin Smelt affected by project operations are spawning adults, eggs, and larvae/small juveniles. Between June and October, the typical distribution of juvenile and adult Longfin Smelt is primarily in brackish water and coastal marine waters of San Pablo and San Francisco Bays downstream of the Delta and Suisun Bay. Longfin Smelt abundance within the Bay-Delta estuary has been highly variable, but generally declining since regular DFW surveys began. Recent Fall Mid-Water Trawl (FMWT) indices are very low compared to prior years.¶
Individual stressors affect Longfin Smelt at different times based on environmental conditions. Important threats and stressors to Longfin Smelt include reduced quality of rearing habitat; particularly, decreases in the availability of food, competition with and predation by nonnative species (e.g., competition with nonnative clams for food and predation on larvae), entrainment at water diversion facilities, and degrading water quality conditions (e.g., increasing temperatures and decreasing turbidity). Key scientific questions relative to Longfin Smelt are:¶
the population effects of entrainment of adults and larvae in the south Delta,¶
the mechanisms that support the well-documented January-June outflow abundance relationship, and¶
...

implementation, which together lead to inefficiencies in applied science to better inform management decisions.

5.2.1 Integrated Scientific and Management Information System

Enhanced integrated core water quality and biological monitoring designed with adequate precision to support information needs on salmon, steelhead, and sturgeon abundance, movement, and/or survival at critical life stages linked to factors that have immediate effects on fishes' behavior and vital rates. Information needs more specifically include:

Quantify stock-specific juvenile salmon abundances

The current salmon monitoring network provides information on the presence and timing of salmon at various monitoring locations. However, more informative monitoring metrics, such as the abundance of individual salmon runs or populations, are required. Non-lethal genetic sampling coupled with new approaches to estimating trawl and seine efficiencies (e.g., paired coded wire tag and acoustic releases, multi-pass beach seining) can provide accurate information on stock-specific abundances of salmon at strategic locations of scientific and management value (e.g., Sacramento Trawl, Chipps Island, salvage, others). Specific guidance on how to implement this recommendation for juvenile salmonids is provided in the SAIL (IEP 2016).

Expand and integrate electronic tagging with water quality monitoring

A collaboratively designed and implemented expanded tagging program in the Sacramento River system would provide a better understanding of how water project operations influence Chinook salmon survival. This expanded tagging will require increased capacity for data management and capture-recapture modeling. The data generated from this program will build our understanding of how hydrologic variation, water project operations, habitat restoration and other management actions influence salmon survival. Real time monitoring of acoustic tags (in concert with representative tagging) will improve our understanding of where fish are in the system, potentially increasing operational flexibility and an increased ability to meet the Delta's co-equal goals.

Monitor and manage for life history diversity at multiple life stages

Maintenance and regeneration of life history diversity is central to salmon recovery plans and restoration actions, yet it is one of the most challenging metrics to monitor. Genetic, otolith, and passive integrated transponder (PIT) tagging tools will assist in the development of diversity indicators and insights into how to manage water project operations and restoration efforts to support life history diversity and long-term resilience. In order to inform management decisions for the protection of life history diversity, it would be valuable to enhance the current monitoring network with both parentage-based tagging (PBT) and otolith collection from adult spawners with funding and protocols for long-term archiving (i.e., the DFW Tissue Archive). Though relatively new, both of these technologies are well-tested, and would provide substantial management-relevant information. A complementary approach to assess the lifetime survival of the diversity of salmon outmigrants, many too small to acoustically tag, is to tag representative sizes of juveniles with PIT tags throughout the monitoring program to be sampled in downstream monitoring surveys or upon return in adult carcass surveys.

5.2.2 Mechanistic Studies

Field, laboratory and modeling research that focuses on understanding mechanisms (e.g., habitat carrying capacities, disease, predation, food availability, contaminants) linking flow and temperature to different life stages of salmon is required. Specific studies include those that:

5.2.2.1 Assess impacts of predation

Salmon mortality varies across locations in a way that strongly suggests that predation by other fish is the proximate cause. Salmon survival also appears to have declined over time, concurrent with an increase in predatory fish such as large-mouth bass. Recent CAMT and SAIL technical teams working on south Delta salmonid survival and life cycle mechanisms, respectively, highlight that little is known about what ecological mechanisms are directly impacting salmon and sturgeon migration behavior and survival. These analyses and early modeling results indicate predation is non-random in the environment, happening mostly in a small percentage of a river system at "hotspots". From these data, predictive models can be developed to determine hotspot locations. These models require regional calibration, so surveys throughout the Delta as well as the Sacramento River basin will be needed.

5.2.2.2 Implement restoration science and effectiveness monitoring

Focused research on how freshwater habitats influence salmonid size and timing of ocean entry and how this freshwater experience influences their overall ocean performance is needed. Floodplain and shallow water habitats, such as tidal marshes, and bays are not well-sampled by existing monitoring programs. Targeted studies are needed to examine the predicted benefits and risks of these habitats and the influence of associated restoration actions on Chinook salmon and sturgeon populations. Additionally, the benefits of restoration will likely be in fish quality (e.g., condition and growth), diversity in outmigration timing, and delayed survival benefits (e.g., ocean survival) rather than a potential direct increase in juvenile abundance in the freshwater.

Deleted: *Develop Green Sturgeon dynamic rate functions and abundance*¶
A number of key parameters regarding green sturgeon spawning distribution and indices of juvenile abundance are in need of further development. With significant improvement, these parameters could be compared to environmental conditions to identify those conditions associated with green sturgeon production. Further developing an index of age-0 juvenile green sturgeon abundance; juvenile green sturgeon telemetry studies; run size and spawning distribution estimates; and quantitative modeling methods to generate estimates of life stage abundance and survival; will greatly improve our understanding of biology, habitat preference, and potential effects of large-scale projects and restoration actions on life stage. Specific guidance on how to implement this recommendation has been investigated and can be led by IEP affiliated scientists investigating sturgeon, and as identified in the SAIL (IEP 2016).¶
Develop marking/tagging program to identify all hatchery salmonids¶
To ensure our ability to estimate the proportion of natural origin fall-run and the impacts of hatchery practices on the viability of Central Valley fall-run Chinook salmon and ESA-listed stocks, we will need a long-term marking/tagging program of all hatchery salmonids and tag recoveries in the ocean and escapement surveys, as was recommended by the California Hatchery Scientific Review Group (2012). The ability to identify a hatchery fish allows greater flexibility to take actions similar to what is implemented through hatchery reform in the Pacific Northwest to minimize domesticati ...

Deleted: **<#>Investigate salmon route selection and fish guidance technology**¶
Landscape-scale survival studies suggest that the route a fish uses during outmigration strongly influences their survival to the ocean. Factors including distance to ocean, habitat quality, and predatory density, differ among routes and these differences affect overall salmon survival. Two-dimensional fish tracking suggests that routing of fish at channel junctions is determined by their position relative to a demarcation of flow divergence (i.e., the critical streak line). It is important to continue these studies of fish behavior at junctions and the extent to which engineering solutions can enhance fish survival/growth benefits. Current efforts evaluating the use of guidance structures to influence the proportion of fish diverted towards a higher survival route are underway. The CSAMP SST report suggested a broad suite of studies that may be needed to assess fish behavioral responses to various drivers (e.g., velocity, salinity gradients, tidal fluctuations, etc.) which will be important to adapt key operational parameters such as Old and Middle River flow (OMR) and the Inflow to Export ratio (I:E). Engineering solutions may also prove valuable depending on the extent to ...

Deleted: **<#>Modeling and Synthesis**¶
This category includes life-cycle models that integrate core monitoring and mechanistic study data to evaluate the influence of management actions (e.g., water operation, restoration, reintroductions, harvest, hatcheries, invasive species, climate change) into changes in the future viability of fish populations. Specific studies needed include those that:¶
Support system-wide physical models¶
Water project facilities and operations, by design, alter the timing and amounts of water flows, and thus water depth and velocities. The development and refinement of process-based model frameworks that track the movement of water and relevant constituents (e.g., heat, particles, contaminants, dissolved oxygen, etc.) throughout the entire Central Valley system would be very useful. The CSAMP SST report highlighted the need to update the Delta Simulation Model II (DSM2) as a critical step to better assessing the effect of Delta water operations.¶
Support system-wide ecosystem models¶
Biological models, coupled to physical models, are the basis for making the quantitative predictions required for effective adaptive management of anadromous fish and water resources. The development of process-based model frameworks to captu ...

6 Summary of Relationships to Other Programs

The Adaptive Management Program will integrate with the existing and planned efforts summarized below, and others, that are developing and implementing science to apply adaptive management principles to the Delta ecosystem. As the Adaptive Management Program is developed, specific linkage to each of these efforts will be defined. The proposed action will make use of the existing CVPIA and IEP programs and augment those programs with stakeholder involvement, see figure XX.

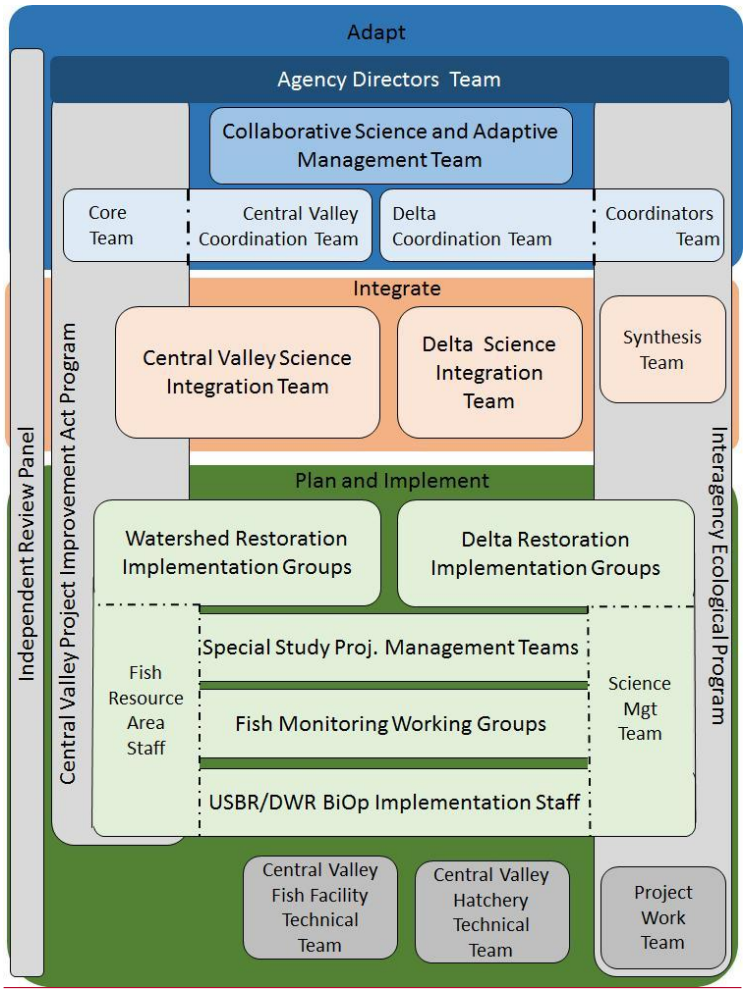

Figure XX. **Primary components of the CVP/SWP Adaptive Management governance structure (not intended to represent a hierarchy).**

6.1.1 Central Valley Project Improvement Act, Anadromous Fish Restoration Area

The CVPIA includes a requirement for reasonable efforts to double anadromous fish populations in the Central Valley by 2002 (fish doubling goal). Recommendations were made to update and improve the science-based framework for priorities, reorganize the program structure and management, improve implementation by making full use of CVPIA water operations authorities, and improve collaboration with all related programs in the Central Valley. As a result, in 2015, Reclamation and the USFWS established an organization structure consisting of:

- Core Team: Senior agency program managers providing input on CVPIA's program;
- Science Integration Team: Data scientists and modelers to develop decision support models open to stakeholder participation; and
- Project Management Teams: agency and stakeholder scientists that design and implement specific restoration projects and science studies.

The CVPIA Core Team coordinates annual priorities, projects, and funding. The CVPIA Science Integration Team consists of a collaborative group of Central Valley river and Delta experts from agencies, water users, NGOs, and consultants, with a science facilitator from the U.S. Geological Survey. The current CVPIA Science Integration Team developed DSMs for Chinook salmon, steelhead, and sturgeon which will be used in the ROC on LTO SDM process. Project Management teams and interagency and stakeholder teams that participate in designing and implementing project charters, which are developed annually as part of the Fisheries Resource Area's annual work planning efforts. Because of the history, size, and scope of this program's restoration, monitoring and research efforts in the Sacramento and San JOaquin rivers and their tributaries, it will continue to be a primary component in the implementation of LTO's adaptive management and monitoring program.

6.1.2 CSAMP

The CSAMP was launched following decisions by the United States District Court for the Eastern District of California to remand the current BiOps to the USFWS and NMFS for further consideration in accordance with the decisions (*San Luis & Delta-Mendota Water Authority v. Salazar*, 760 F.Supp.2d 855 (E.D. Cal. 2010); *Consolidated Salmonid Cases*, 791 F.Supp.2d 802 (E.D. Cal. 2011)), and more specifically following a decision by that court on April 9, 2013 (*In re Consolidated Delta Smelt Cases*, 2013 WL 1455592 (E.D. Cal. 2013) (2013 Court Order)). The 2013 Court Order was issued in response to a motion to extend the court-ordered remand schedule for completing revisions to the current BiOps and completing review under the National Environmental Policy Act (NEPA).

The 2013 Court Order allowed the parties making the motion (i.e., Reclamation, USFWS, NMFS, and DWR) additional time for the development of a proposed robust science and adaptive management program, with collaboration of the scientists and experts from the Public Water Agencies ('PWAs') and the non-governmental organization (NGO) community with the intent to inform the management actions incorporated into the current BiOps (and Reasonable and Prudent Alternatives) and consideration of alternative management actions.

The 2013 Court Order granted a one-year extension of time to deadlines associated with the cases' remand. The parties filed an annual progress report in February 2014, and the court granted a second one-year extension in March 2014. The parties prepared a second annual progress report in February 2015, requesting a third one-year extension. However, the Ninth Circuit Court of Appeals reversed the court's

Deleted: <#>Current Efforts¶
The original IEP studies of the influence of Delta flows on the recruitment of striped bass and the function of their supporting food web were an ambitious interagency attempt at an "adaptive management" program that pre-date the current definition of the phrase adaptive management (used in this Program). In this context, the IEP program has expanded and morphed as agency priorities have evolved. As a result of this cooperative history, there are several very important efforts already underway to implement science-based decision support tools that seek to thereby improve the scientific basis of operational decisions at an annual or multi-year time scale (*Appendix 7–Groups Involved In Each Phase of the Adaptive Management Program*).¶
To be most successful, this Adaptive Management Program will build on and augment the existing efforts that have been developing and implementing science to apply adaptive management principles to the Delta ecosystem since the 1960s. In particular, this Program will incorporate many elements of the process and structure of the IEP and the Collaborative Science and Adaptive Management Program/Collaborative Adaptive Management Team (CSAMP/CAMT), and the State and Federal Contractors Water Agency Science Program, and will continue to rely on the Delta Science Program for peer review and research support. Because these existing efforts will form core elements of this Program, each effort is described below.¶

decisions that remanded the current BiOps to USFWS and NMFS (*San Luis & Delta-Mendota Water Authority v. Jewell*, 747 F.3d 581 (9th Cir. 2014), *cert. denied* 135 S.Ct. 950 (2015); *San Luis & Delta-Mendota Water Authority v. Locke*, 776 F.3d 971 (9th Cir. 2014)).

After reversal of the court's decisions requiring remand of the current BiOps, in 2015, all parties agreed to continue the CSAMP to promote the collaborative development of scientific information to inform sound decision-making in the future.

6.1.2.1 Organization

The CSAMP is structured as a four-tiered organization comprised of:

1. Policy Group consisting of agency directors and top-level executives from the entities that created CSAMP;
2. CAMT made up of managers and staff scientists that serve at the direction of the Policy Group;
3. Scoping Teams created on an as-needed basis to scope specific science studies; and
4. Investigators contracted to conduct studies.

6.1.2.2 Mission Statement

The CAMT mutually agreed on the following mission statement at its July 23, 2013 meeting:

> *The Collaborative Adaptive Management Team (CAMT) will work, with a sense of urgency, to develop a robust science and adaptive management program that will inform both the implementation of the current Biological Opinions, including interim operations; and the development of revised Biological Opinions.*

CAMT expects to revisit its mission statement (by increasing its scope) as it develops its Five Year Plan for CAMT. In the meantime, CAMT intends to remain focused on completing the studies initiated in 2014 and identify new initiatives based on the results of these studies.

Current products that are being developed by the CAMT scoping teams and principle investigators include analysis and synthesis tools and reports concerning Delta Smelt Entrainment, Gear Efficiency, Fall Habitat, and Salmonid survival. These reports from the two scoping teams will identify key findings, issues and recommendations for next steps. The next steps recommended in the two scoping teams' reports will be evaluated and prioritized by CAMT members. The highest prioritized efforts will be presented to the CAMT Policy Group and will be incorporated into the CAMT five year plan that CAMT is currently developing.

Items in the CAMT Five Year Plan may also support and contribute to advancing the objectives of other efforts including CWF and IEP.

6.1.3 Interagency Ecological Program

The IEP has brought state and federal natural resource and regulatory agencies together to monitor and study ecological changes and processes in the Delta since 1972. The IEP currently consists of nine member entities: three state agencies (DWR, DFW, and the State Water Resources Control Board), six federal agencies (USFWS, Reclamation, USGS, USACE, NMFS, and U.S. Environmental Protection

Agency), and two (current) partners: the San Francisco Estuary Institute and the Delta Science Program. These agencies and partners work together to develop a better understanding of the estuary′s ecology and the effects of the SWP/CVP operations on the physical, chemical, and biological conditions of the estuary. The 2014 IEP Strategic Plan describes IEP's goals and strategies to achieve them (http://www.water.ca.gov/iep/docs/IEP_Strategic_Plan102214.pdf).

6.1.3.1 Organization

The IEP is structured as a four-tiered organization comprised of:

1. Member agency directors;

2. IEP Coordinators made up of senior level managers who oversee the program

3. Science Management Team made up of managers and staff scientists that serve at the direction of the Coordinators to scope specific science studies. The IEP Lead Scientist provides strategic direction for, and oversight of, IEP science efforts, acts as the chief science advisor to the IEP Coordinators and Directors, chairs the Science Management Team, and serves as the primary scientific voice to all the groups;

4. Ad hoc project work teams that also develop scientific study concepts that can be recommended to the Science Management Team. The project work teams have included not only agency staff but have had extensive participation from academics and stakeholders; and

5. Investigators who are either agency staff or are academics or consultants contracted to conduct studies.

The IEP has coordinated Bay-Delta monitoring and research activities conducted by state and federal agencies and other science partners for over 40 years (*Appendix 7—Groups Involved In Each Phase of the Adaptive Management Program*). IEP monitoring activities are generally carried out to document CVP and SWP compliance with water rights decisions and California Endangered Species Act (CESA) authorizations and/or current BiOp conditions. Most of the monitoring under the IEP focuses on open-water areas and the major Delta waterways conveying water to the SWP/CVP facilities in the south Delta and downstream, including the entire Bay-Delta and portions of its watershed. The IEP produces publicly accessible data that include fish and invertebrate status and trends, water quality, estuarine hydrodynamics, and foodweb monitoring. Because of the history, size, and scope of this program's monitoring and research efforts in the Delta, it will continue to be a primary component in the implementation of CWF's adaptive management and monitoring program.

Although IEP member agencies have varying priorities, IEP provides a common ground for shared science priorities to come together and focus on supporting management needs for the Bay-Delta ecosystem and the water that flows through it. Some priorities are very explicit, such as monitoring specified in a permit or agreement. Others are focused on informing pending decisions or seeking new understandings that allow better decision making in water project operations or prevent new challenges such as invasive species.

Science Agenda

To meet anticipated science needs of the member agencies and provide the scientific tools and advice that resource managers can rely upon, the IEP has developed an IEP Science Agenda to focus on overarching management challenges anticipated in the next 3-5 years

(http://www.water.ca.gov/iep/docs/2016_IEP_Science_Agenda_FINAL.pdf). The agenda serves as an outline for achieving important objectives by identifying and organizing science needs in the context of conceptual models, related information gaps and uncertainties, and strategies and priorities. The IEP Lead Scientist and IEP Coordinators have guided the development of the agenda, while drawing insights from the program scientists, project work teams, managers, and stakeholders particularly via the CSAMP.

6.1.4 Delta Stewardship Council, Delta Independent Science Board (DISB) and Delta Science Program (DSP)

Established by 2009 Delta Reform Act, the Delta Stewardship Council is charged with achieving the co-equal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The DISB provides a standing board of nationally or internationally prominent scientists with appropriate expertise to evaluate the broad range of scientific programs that support adaptive management of the Delta. The DISB will provide oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta through periodic reviews of each of those programs and reports to the Delta Stewardship Council. The Delta Science Program's mission is to provide the best possible unbiased scientific information to inform water and environmental decision making in the Bay-Delta region. The Delta Science Program's objectives are to:

- Initiate, evaluate and fund research that will fill critical gaps in the understanding of the current and changing Bay-Delta system.
- Facilitate analysis and synthesis of scientific information across disciplines.
- Promote and provide independent, scientific peer review of processes, plans, programs, and products.
- Coordinate with agencies to promote science-based adaptive management.
- Interpret and communicate scientific information to policy- and decision-makers, scientists, and the public.
- Foster activities that build the community of Delta science.

The Delta Science Program has particular expertise and experience organizing and facilitating independent scientific reviews. It also has primary responsibility for developing and implementing the Delta Science Plan. The Delta Science Program may review monitoring and research methods and results to provide technical support to the adaptive management process.

7 Reporting

Reports and plans will constitute the most visible documentation of the adaptive management process. In general, each adaptive management action will be proposed in a plan and its outcomes described in a report. Reports will take into account other existing processes and augment those efforts.

7.1 Annual Progress Report

At the end of each implementation year, Reclamation and DWR, through the BOCT, will develop an Annual Progress Report. The report will provide an overview of the activities carried out during the previous implementation year and provide information sufficient to demonstrate that the proposed action is being implemented consistent with the provisions of the BOs.

The annual progress report will include, among other things, the following types of information.

- Documentation of the implementation of habitat restoration and protection measures specified in the Proposed Action in relation to their schedule and performance specifications, including the following components.
    - A summary of the habitat protection and restoration actions that have been initiated, are in progress, or have been completed, including information regarding the type, extent, and location of protected and restored habitat for listed species. The report will document these actions on an annual and cumulative basis.
    - Identification of actions that have not been implemented on schedule and an explanation for the deviation from schedule. For actions that are behind schedule, a suggested schedule or process for completing them will also be included.
- Descriptions of actions taken pursuant to the adaptive management programs.
    - Documentation of the results of monitoring and research actions prescribed in the PA. This is to include a summary of the actions that have been initiated, are in progress, or have been completed for each conservation measure, including information related to type, location, and method of implemented actions. The report will document this on an annual and cumulative basis.
    - Adaptive management decisions made during the reporting period, including the scientific rationale for the action.
    - Use of independent scientists or other experts in the adaptive management decision-making processes.
- An accounting of the funding provided to support the monitoring, research, and adaptive management programs. The accounting will identify the source of the funds, the annual and cumulative expenditures to support the programs by cost category.

Deleted: <#>Annual Work Plan and Budget¶
On an annual basis, the IICG BOCT will prepare an Annual Work Plan and Budget for the upcoming year. The Work Plan will describe the proposed activities of the adaptive management and monitoring program. The Budget work plan will set out projected expenditures and identify the estimated costs and sources of funding for those expenditures.¶
The IICG will develop and approve the Annual Work Plan and Budget.. As part of this process, the Five Agencies will participate in developing the draft plan. As part of their participation on the IICG, the Five Agencies will ensure the draft plan accurately sets forth and makes adequate provision for the implementation of the applicable permit terms under which the CVP and SWP operate. ¶
A draft of the Annual Work Plan and Budget will be developed by the IICG, working with the Collaborative Science Workgroups, and posted for review and comment. A final Annual Work Plan and Budget will be completed no later than 1 month prior to the beginning of the activities described therein.¶
At a minimum, the Annual Work Plan and Budget will contain the following information.¶
A description of the planned actions under the adaptive management processes.¶
A description of the planned monitoring actions and the entities that will implement those actions, based on the structured decision-making described below.¶
A description of the anticipated research studies to be undertaken and the entities that will conduct the studies.¶
A budget reflecting the costs of implementing the planned actions.¶
A description of the sources of funds that will be used to support the budget.¶

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9 APPENDICES

Appendix 1—Initial Objectives Derived From Current Biops/CESA and CWF

Appendix 2—Key Uncertainties and Potential Research Actions Relevant to Listed Fish Species

Appendix 3—Key Uncertainties and Potential Research Actions Relevant to the 2009 NMFS Operations Biop RPA Elements for Yolo Bypass

Appendix 4—Key Uncertainties and Potential Research Actions Relevant to Tidal Wetland Restoration

Appendix 5—Key Uncertainties and Potential Research Actions Relevant to Channel Margin Restoration

Appendix 6—Delta Outflow

Appendix 7—Groups Involved In Each Phase of the Adaptive Management Program

Appendix 8- Estimated funding needed to support the Adaptive Management Program for the Existing Biological Opinions and CESA Authorizations for the Longterm Operations of the CVP and SWP and for CWF

Appendix 4—Key Uncertainties and Potential Research Actions Relevant to Tidal Wetland Restoration

Key Uncertainty	Potential Research Actions
How does tidal marsh restoration affect production of food suitable for listed fish species both within and outside of the restored sites?	Quantify primary and secondary production, including food suitable for listed species, both within restored tidal marsh natural communities and transported from restored areas to adjacent open-water habitat and the fate of that production.
How have hydrodynamic changes associated with tidal restoration affected organic carbon transport and fate?	Quantify the flux of organic carbon produced in restored tidal marsh plain into existing channels in the Action Area.
How has tidal marsh restoration affected benthic invertebrate communities? In particular, how are invasive mollusks affecting zooplankton production in restored tidelands?	Document and evaluate water quality conditions in restored subtidal aquatic habitats.
Do juvenile sturgeon use restored tidal wetlands?	Capture and acoustically tag juvenile sturgeons in Action Area, then track movement using existing hydroacoustic array. Assess fraction of time in or adjacent to restored tidal wetlands. Begin the 3-5 year-long study when 20% of the tidal wetland restoration acreage is achieved.

Deleted: **Appendix 1—Initial Objectives Derived From BDCP, Current Biops/CESA and CWF**¶
This appendix and the table below describe species-specific objectives that were originally identified during the BDCP planning process. The objectives are preliminary. They are not necessarily achievable by the Central Valley Project and State Water Project, given the extensive physical, chemical and biological changes that have occurred within the ecosystem, many of which are not due to the CVP or SWP. Further, the preliminary objectives were developed to achieve a conservation standard that is not required to meet the Section 7 standard of avoiding the CVP and SWP from jeopardizing or adversely modifying designated critical habitat. Final objectives for this adaptive management program will be developed using collaborative processes and limited to those actions necessary to achieve applicable regulatory standards. The IICG will consider those final objectives when implementing this AMP. ¶
¶
Objectives (Triggers for Adaptive Management action) ...

Deleted: Assess density and foraging effectiveness of Asian clams or other invasive species that colonize restoration sites. Periodically repeat surveys to determine if delayed colonization occurs.

Deleted: What is the relationship between life cycles of listed fish and those of invasive mollusks?

Deleted: Identify constraints limiting larval transport, settlement and establishment of invasive mollusks; the role of nutrients in facilitating invasion; and potential control mechanisms for invasive mollusks.

Deleted: To what extent does intertidal wetland restoration result in changes in contaminants that could affect listed fishes?

Deleted: Compare contaminant concentrations at representative sites in/near restored areas before and after restoration has occurred. Must occur prior to restoration, and following restoration, with sufficient sampling intensity over a variety of hydrological conditions to allow inferences to be made about a range of water-year types.

Deleted: How effectively do minimization measures limit production and mobilization of methylmercury from tidal restoration sites and the food web?

Deleted: A connected group of studies will be needed, likely at a representative selection of restoration sites. Studies will evaluate wetland management strategies intended to minimize methylation, evaluate the ecological fate of wetland-generated methylmercury, evaluate the biological thresholds for mercury exposure for listed ...

Deleted: What are the most effective designs of tidal restoration sites to achieve tidal flow velocities that preclude rooting by invasive aquatic vegetation (IAV)?

Deleted: Resolution of this question requires conducting a linked series of studies: (1) empirical and lab studies to determine flow constraints on rooting of IAV species of concern, (2) model studi ...

Deleted: How are restored natural communities being affected by IAV and have there been changes in existing areas of IAV presence?

Deleted: Evaluate the effect of tidal restoration on the establishment of IAV in subtidal aquatic habitats. Evaluate whether or not there have been changes in the abundance and distribution ...

Deleted: Is it feasible to create conditions that favor the growth of native pondweeds (Stuckenia spp.) rather than IAV?

Deleted: Various approaches exist to address this topic, potential ones include (1) evaluate environmental conditions that support native pondweed stands, focusing on abiotic factors (particularly salinity) that determine growth and distribution of native ...

Appendix 5—Key Uncertainties and Potential Research Actions Relevant to Channel Margin Restoration

Key Uncertainty	Potential Research Actions
How is predation affecting listed fishes in restored channel margin habitat?	Quantify abundance of nonnative fishes in restored channel margins. Assess effects of nonnative fish predation on listed species in restored sites. Identify ways to avoid and minimize those impacts.
Does channel margin enhancement contribute to an increase in survival of fry-sized Chinook salmon in restored river reaches?	At representative channel margin enhancement sites, mark and recapture fry-sized Chinook salmon. This work should include collection of 3-5 years of data before implementation at the site in order to establish a baseline condition capturing years with varying hydrology and an additional 3-5 years of data collection after the channel margin enhancement has been constructed.

Deleted: How frequently are channel margins enhanced under the CWF inundated and how frequently are existing riparian and wetland benches inundated? How do these frequencies change as a result of the CWF?

Deleted: Develop, in collaboration with USFWS, NMFS and DFW, a study to more precisely define this uncertainty and resolve it using a combination of modeling and field data collection.

Delta Smelt Pre-Adult Habitat

The integration of Suisun Marsh Salinity Control Gate operations in the late summer and manipulation of salinities into the fall is proposed based on the recruitment of Delta Smelt.Table 1. Key Questions and Possible Investigative Approaches to Address Delta Smelt Pre-Adult Habitat Management

Key Questions	Possible Investigative Approaches
Under what circumstances does survival in the fall affect subsequent winter abundance?	Quantitatively determine the contribution of Delta Smelt survivorship in the fall to inter-annual population variability. Review available lifecycle models for applicability.
Under what circumstances do environmental conditions in the fall season contribute to determining the subsequent abundance of Delta Smelt?	Investigate the relationship between fall outflow and the relative change in Delta Smelt abundance using univariate and multivariate and available historic data.
Under what circumstances is survival of Delta Smelt through the fall related to survival or growth rates in previous life stages?	Compare Delta Smelt survival during the fall to both survival in prior seasons and to fork length at the end of the summer/start of the fall. New data are being collected as part of the Fall Outflow Adaptive Management Plan (FOAMP).
Does outflow during the fall have significant effects on habitat attributes that may limit the survival and growth of Delta Smelt during the fall?	There may be competing approaches that will be simultaneously pursued. One is to develop graphs and conduct univariate and multivariate analyses involving survival ratios and growth rates. Another option is to test whether month-to-month declines in abundance or growth during the fall is greater when X2 is located further east. See also the analytical approach in MAST report, as well as work by Kimmerer, Burnham & Manly.
Under what conditions (e.g., distribution of the population, prey density, contaminants) do fall operations have significant effects on Delta Smelt survival?	Utilizing relationships identified in the above studies, simulate how changes in project operations may influence survival of Delta Smelt during the fall.
Source: Collaborative CAMT (2014)	

Deleted: **Appendix 6—Delta Outflow**¶
The Outflow Focus areas are a structured element that will assist in determining initial flow criteria for CWF. Any revisions to the operating criteria would be enacted according to the adaptive management process described in this Program. There are three outflow focus areas; two address summer and fall outflow and their importance to Delta Smelt and the other addresses spring outflow and its importance to longfin and Delta Smelt. (See the December 2013 public draft of BDCP Section 5.5.1.1.2, *Fall X2 Outflow Process*, for an explanation of the importance of the fall outflow to Delta Smelt, the potential outcomes associated with each branch of the fall outflow topic, and the prevailing sources of uncertainty in those outcomes. The December 2013 public draft of BDCP Section 5.5.2.1.1, *Spring Outflow Process,* provides the corresponding discussion for longfin smelt.)¶
Fall X2¶
Resolution of the fall X2 questions requires ascertaining Delta Smelt's fall outflow needs to determine what is needed to avoid jeopardy and adverse modification to Delta Smelt critical habitat. The fundamental premise is that Delta Smelt abundance can be improved by providing fall outflow consistent with the current RPA.¶
Resolution of the fall X2 questions requires the following process:¶
Convert existing conceptual models to a spatially explicit numeric model using studies that calibrate transitions between life stages within the conceptual model (Newman life-cycle model, USFWS in development).¶
Develop a numerical model based on Bever et al. (2016) to evaluate a range of scenarios that use various outflow values and various configurations of tidal restoration to describe flow-habitat equivalency.¶
The conceptual model for Delta Smelt performance is based upon the habitat metrics presented in the objective in Appendix 1—Initial Objectives Derived From Current Biops/CESA and CWF), which states:¶ ...

Deleted: Are there biases in the IEP survey data? How should the survey data be utilized if biases do exist?

Deleted: Convene a workshop to discuss possible survey problems and identify opportunities to address with existing data.

Deleted: How much variability in tidal, daily, weekly, and monthly fluctuations in fall X2 is attributable to water project operations?

Deleted: Use hydrological modeling tools to determine the prospective locations of X2 in the fall under circumstances with and without project operations. An analysis of historical data will also be carried out to examine outflow during periods when the projects were required to meet specific outflow requirements, to evaluate the degree of control that has been possible at various time scales.

Deleted: Can an index based on multiple habitat attributes provide a better surrogate for Delta Smelt habitat than one based only on salinity and turbidity?

Deleted: Review approaches in existing literature. There may be competing approaches that will be simultaneously pursued, depending on expert advice. One possible approach is to develop suitability index curves and combine geometrically to create a habitat quality index. Data from areas where Delta Smelt are frequently observed will be utilized to assess habitat quality.

Deleted: **Spring Outflow**¶
Based on the fall midwater trawl indices of longfin smelt abundance, there are significant correlations between Delta outflow during the winter-spring months and subsequent longfin smelt abundance in the fall (Rosenfield and Baxter 2007; Kimmerer et al. 2009; Baxter et al. 2010; Rosenfield 2010). Particular attention in CWF is focused on resolution of the spring outflow needs to avo ...

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