

SCIENCE WORK PLAN

Shasta RPA Adjustment

VERSION

August 28, 2017 - Initial Drafting

September 1, 2017 - Updates for coordination with NMFS and others prior to a Sept. 21 workshop rollout.

PURPOSE

1. This draft is to solicit feedback from stakeholders and other interested parties.
2. Reduce uncertainties for compliance with the 2009 Biological Opinion RPA Action Suite I.2.
3. Identify near-term monitoring, modeling, and analysis and synthesis needs to improve fish and water management decisionmaking regarding Action Suite I.2.
4. Improve likelihood of achieving desired fish and water management goals

BACKGROUND

In 2015 and 2016, Reclamation and NMFS utilized Action I.2.3.C to manage Shasta Division operations due to drought conditions. During this period, drought conditions across the Central Valley impacted ESA-listed species in the Sacramento and San Joaquin river basins and Bay-Delta. Activities as part of the CVP/SWP Drought Contingency Biological Monitoring Plan for WY 2015 documented the impacts of the drought, created new models for fish and water management, and improved data collection, distribution, and analyses. Information developed during this period showed poorer performance of ESA-listed species than expected based on the actions taken as part of Biological Opinion's Action I.2.3.C and multiple Temporary Urgency Change Petition. Based on new information related to multiple years of drought, recent data demonstrating extremely low listed-salmonid population levels for the endangered winter-run Chinook salmon, and new information available and expected to become available as a result of ongoing work through collaborative science processes Reclamation requested reinitiation of consultation on the long-term operation of the Central Valley Project and State Water Project towards the end of water year 2016.

In 2017, NMFS provided Reclamation with a draft amendment to the 2011 amended RPA related to Action Suite I.2 in the biological and conference opinion on the long-term operations of the CVP and SWP. NMFS cited work including drought operation of Shasta and Keswick reservoirs, drought conditions, and new science and temperature survival models. Reclamation reviewed the draft amendment and hydrologic indicators suggesting 2017 would be well suited for conducting

a study to evaluate if the CVP could be operated to meet a temperature target of 53.0 daily average temperature near the Clear Creek Confluence as a surrogate for a target of 55.0 seven-day average daily maximum at the most downstream winter-run redd during the 2017 temperature management season. The study would assess the efficacy of the DAT and temperature threshold and consider potential factors, other than temperature, that may impact survival of juvenile salmonid rearing and migrating through the Sacramento River. Additionally, the 2017 pilot effort would consider requirements under NEPA and develop a science plan to address uncertainties and areas of potential controversy. To facilitate the likelihood of the analysis and science plan to be successful, the process for development and reporting are being undertaken in a transparent and inclusive process that includes water users and other interested parties. Similarly, an inclusive efforts focused on any remaining uncertainty regarding CVP's Shasta Division, ESA listed fishes, and temperature processes will improve the likelihood of success for achieving desireable fish and water management goals

This document provides a review of science activities initiated as part of the CVP/SWP Drought Contingency Biological Monitoring Plan for WY 2015 and identification of new topics and remaining data gaps requiring prioritization and implementation to inform Shasta Division temperature operations. A timeline is proposed to identify the necessary steps for inclusion of proposals in future programmatic work planning. The result will be a near term work plan to improve biological objectives and operational capabilities. Additionally, a framework for the use of this Science Plan in adaptive resource management of the coordinated operations of the CVP and SWP is described in relation to current and potential types of programs.

A Science Plan's Role in Adaptive Resource Management

CVPIA

CWF

STATUS

This section describes a status regarding recent science related to the Shasta Division, ESA-listed species, and temperature. These efforts have included observational and modeling studies, but future efforts may also require laboratory investigations.

Table X. Science Activity, Topic and Category, Status

Category	Type	Science Activities	Status
Shasta Division, temperature	modeling	Sacramento River temperature modeling review	Currently reviewing 2 draft TMs

temperature, ESA listed fish	modeling	Implementing the individual based model, inSalmo, in the Upper Sacramento River	Project Completion Date: April 2018
ESA listed fish	observational	Tracking Migration and Survival in Juvenile Winter-Run Chinook Salmon in the Sacramento River and Delta over Drought Years	Project Completion Date: April 2018
Shasta Division, temperature, fish	observational and modeling	Sacramento River Temperature Management Decision Support Tools	CVTEMP site established; review panel scheduled Fall 2017
temperature, fish	observational	Genetic Signatures of Drought Conditions and Disease in Central Valley Salmonids	Project Completion Date: December 2017
Shasta Division, temperature, fish	observational and modeling	Sacramento River Salmonid Passage Model for Data Assessment in Real Time	SacPAS site established
ESA listed fish	observational	Sacramento River Basin Salmonid Monitoring	Enhanced habitat monitoring occurring
ESA listed fish	observational	Red Bluff Diversion Dam Rotary Screw Trap Juvenile Monitoring Project	USFWS-desired sampling effort occurring
ESA listed fish	laboratory and model	Linking Drought and Southern DPS Green Sturgeon Recruitment	Project Completion Date: April 2018
Shasta Division, temperature	model	Workplan for Shasta and Trinity Division Seasonal Operational Water Temperature Modeling	Technical Team meeting continuing in Fall 2017
		TBD	
		TBD	
		TBD	

MANAGEMENT QUESTIONS

Management questions are developed in a tiered approach to identify areas and interest and direct the work to the most relevant issues for decision making.

Conceptual Models and Frameworks

Windell et al (2017) described a conceptual model for winter- run Chinook salmon, whose tiered linkages provide a foundation for identifying uncertainties and developing hypotheses regarding ESA-listed species and Shasta Division operations. Johnson et al (2017) used this conceptual model to highlighted activities that advance monitoring to assess the population's status and trend and better characterizing the dynamics of freshwater, estuarine, and marine viability objectives during specific life stages. Also, this model was used in the Salmon Resiliency Strategy (CNRA 2017) for identifying projects that target specific life stages, locations, and objectives that should contribute to increasing viability through increased abundance, improved survival and productivity, greater variation of life history diversity, and broader spatial distribution. This Science Plan will leverage this conceptual framework for relevant life stages and locations (Table X-X) to identify remaining management questions found across multiple landscape attributes, environmental drivers, habitat attributes, and response. Ultimately, deliberative consideration of the model's tiers may help managers better describe the multiple strategies necessary to protect, restore, and maintain ESA-listed species impacted by temperature and flow operations of the Shasta Division.

In the past five years, it is clear that there will be years when the CVP and SWP have the capacity to maintain listed species performance, while in other years the Projects will not be able to protect listed species performance. Most of the time, the CVP and SWP are operated to restore listed species, and for each of these distinct environmental management strategies have distinct management questions. These management questions can be prioritized through many generations of recovering the species depending on the species' performance and water management focus as they move from natal headwaters, rearing floodplains, and migration corridors.

Additionally, during the drought it is clear that there will be years when the Shasta Division is unable to protect listed species performance, but also years that exceed the desired biological objectives. Depending on how climate influences Shasta Division operations, decisions regarding hatcheries, harvest, exports, and habitat can be better structured by reducing uncertainties surrounding ESA listed species, Shasta Division and temperature processes.

Figure X.

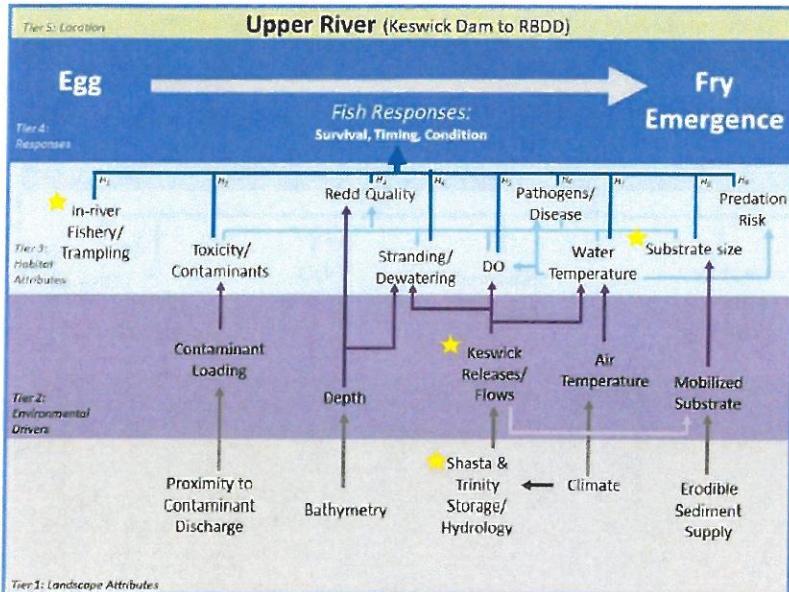


Figure 3. Conceptual model of drivers affecting the transition of SRWRC from egg to fry emergence in the Upper Sacramento River. Hypotheses referenced by the "H-number" are identified in the conceptual model 1 (CM1) narrative. Management actions are denoted by stars and are described in Table 1.

Figure Y.

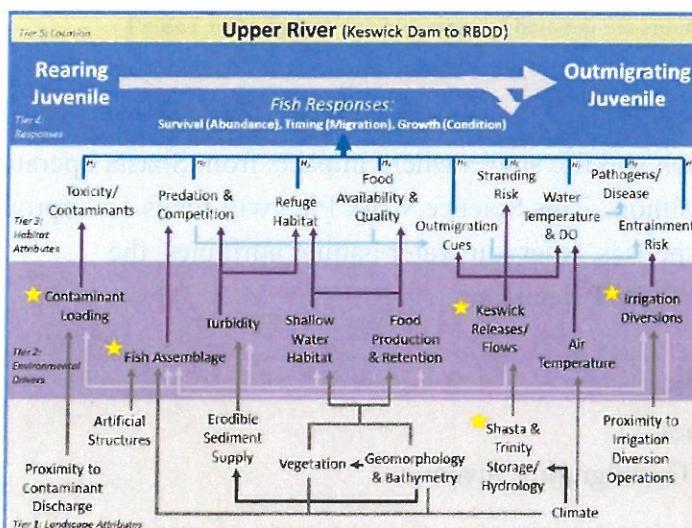


Figure 4. Conceptual model of drivers affecting the transition of SRWRC from rearing juvenile to outmigrating juvenile in the Upper Sacramento River. Hypotheses referenced by the "H-number" are identified in the conceptual model 2 (CM2) narrative. Management actions are denoted by stars and are described in Table 1.

Figure Z.

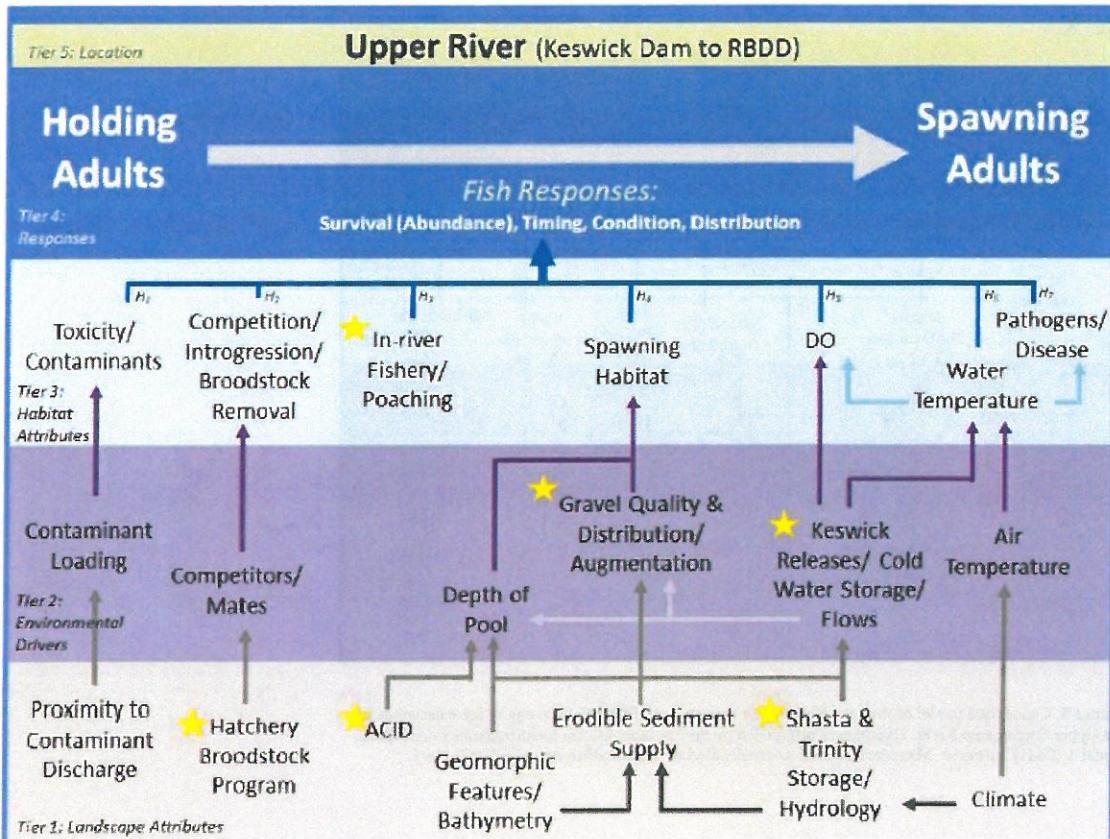


Figure 9. Conceptual model of drivers affecting SRWRC from holding adults to spawning adults in the Upper Sacramento River. Hypotheses referenced by the “H-number” are identified in the conceptual model 7 (CM7) narrative. Management actions are denoted by stars and are described in Table 1.

The Science Plan will focus on the location and life stages where impacts from Shasta operations are most likely for winter-run Chinook salmon. This Science Work Plan will focus on improving information about ESA-listed species responses, reservoir water habitat attributes, the environmental impacted by potential CVP/SWP decisions.

- Holding Adult to Spawning Adult
- Upper River Egg to Fry Emergence
- Upper River Rearing Juvenile to Outmigrating Juvenile

Tiered Questions

Holding Adult to Spawning Adult

Landscape Attributes

- TBD

Environmental Drivers

- TBD

Habitat Attributes

- How might additional populations above Shasta and in Battle Creek change requirements for populations below Shasta?

Fish Response

- TBD

Upper River Egg to Fry Emergence

Landscape Attributes

- What are the bounds of feasibility (Shasta storage, Climate) driving coldwater volume and storage?

Environmental Drivers

- What is the relationship between flows and spawning locations, where temperature dependent mortality may vary?
- How does release peaking operations influence the temperature of releases from Whiskeytown and Keswick?

Habitat Attributes

- What is a reasonable biological objective for temperature dependent mortality to maintain the winter-run Chinook population (percentage and year-to-year frequency)?
- What is a reasonable biological objective for temperature dependent mortality to restore populations (percentage and year-to-year frequency)?
- How does substrate influence egg to fry survival? Does substrate size affect the sensitivity to temperatures?

Fish Response

- What are the appropriate egg to fry survival biological mechanisms to model?
- Are the fish oxygen deprived?

Upper River Rearing Juvenile to Outmigrating Juvenile

Landscape Attributes

- TBD

Environmental Drivers

- TBD

Habitat Attributes

- What are the non-temperature dependent factors that may relieve pressures on cold water management?
 - Disease
 - Predation

- Rearing Habitat (Improve survival)
- Migration Cues (Improve Survival)

Fish Response

- TBD

Uncertain how they fit

- What level of storage is required from a prior year to maintain a reasonable level of protection for a subsequent year?
- What are the near real time indicators of a risk to winter-run populations and what measures can be taken in response?
- What Modeling Tools?
 - Forecasts Reservoir Stratification
 - Forecasts of Temperature Dependent Mortality Models
 - Other drivers of survival to Red Bluff
 - Where is the sensitivity
- What Monitoring?
 - Weaknesses in spatial and temporal resolution
 - Redd Location

HYPOTHESES

Hypotheses provide specific testable questions that, if proven or refuted, would answer a management question. Hypotheses guide the near-term approaches to addressing management questions.

1. Thresholds for O₂ respiration and flux are different in the Central Valley than scientific basis behind the 7DADM.
 - a. Prediction
 - b. Test
2. Background mortality and carrying capacity may explain variability
3. Alternative Strategy to Redd Protection may Improve Survival
4. Respawning Temperature Effects

TECHNICAL APPROACH AND COORDINATION STRATEGY

A framework for the use of this Science Plan in adaptive resource management of the coordinated operations of the CVP and SWP is described in relation to current and potential types of programs.

The technical approaches and coordination strategy describes the different initiatives, resources, and forums that may assist in addressing the management questions to identify the potential deficiencies.

Related Programs and Projects

2009 BiOp

SAIL

NCWA CE QUAL W2 (May be an initiative, may be separate?)

(b)(13)

Shasta Dam Fish Passage Improvement Project

NCWA Salmon Plan

Coordination Forums

Synthesis

Stakeholder Involvement

DSP Review Panel

SRTTG

WOMT

LOBO review in 2018

Methods and Study Design

Temperature Predictive Tools

- CEQUAL W2 Upgrade for Temperature Modeling (NCWA)
- Modeling Exploration of Stratification Predictions (Yong Lai U2RANS?) Would these types of efforts even be fruitful? Are the more efficient efforts that do not require predictions of stratification, e.g. Indexing approach? Uncertainty mechanisms on hydrology, temperature, mixing, etc.
- Desktop Analysis and Field Deployment of Monitoring Network Upgrades

Egg-Mortality Parameters

- Laboratory studies to refine and/or replace the 7DADM approach with relationships between temperature, oxygen demand, exposure duration and frequency, and sublethal effects.
- ?? Reach-specific carrying capacity analysis for background mortality
- Lit. review for FX of habitat quality, etc. on O2 flux

Population Level Effects

- LCM for population targets
- LCM for different survival strategies, e.g. sacrifice and pulse; removal of other stressors

- ?? Desktop analysis of prespawn effects and options on fish distribution.
- Mortality Model - Scenarios for temperature management, e.g. managing too early, too conservatively, not enough, falling back later in the season, etc.

Synthesis

- Real-Time Predictive Tools and Plans
 - Do we need super detailed space-time approaches or is Keswick sufficient?
- Independent Review

POTENTIAL ADDITIONAL ACTIVITIES

The following paragraphs describe additional activities necessary to augment the existing programs for the purpose of addressing management questions.